

# SETTING SCIENCE STANDARDS: PREPARING THE NEW ERA

An Interview By Ron Nief



Greg Baker

It has been said that, if a farmer were transplanted from an 11<sup>th</sup>-century English fief to an 18<sup>th</sup>-century New England farm, he would have just gone to work, feeling quite at home. The industrial era changed all that, making gods of scientists and engineers, and leaving us with a visibly expanding universe—up, out, and down, faster, fuller and more efficient ... and more isolated.

As we acknowledge the close of this industrial period that touched on five centuries and “changed the way human beings lived, worked, and viewed themselves and their world,” according to Jeremy Rifkin in his book *The Biotech Century*, humanity finds itself facing “a dwindling of the Earth’s non-renewable energy reserves, a dangerous build-up of global warming gasses, and a steady decline of biological diversity.”

As we come to terms with the close of that age, we are confronted not only with a biotech revolution, but the realization that, like it or not, we are citizens of a scientific and technological universe where our moral and ethical interpretations, our political conclusions, and the direction of our society as a whole may potentially be controlled by an elite and powerful set of researchers, commercially driven gene designers, and a new-age, profit-oriented science industrial complex. We face the fearful prospect of finding decisions in the hands of the private research and health maintenance practice of Jekyll, Caligari, and Frankenstein.

But there are those who, like

Biology Prof. John Jungck is principal investigator for the Beloit-based BioQUEST Curriculum Consortium, which is revamping the way biology is learned internationally, but his Beloit students always come first. Here, he talks with Cass Brookes’99 (St. Thomas, Virgin Islands), a medical biology major.

Thomas Hardy, “wonder, ever wonder, why we find us here!” and take that inquiry as a charge to pursue the preparation of a new generation of educated citizens. They take on the conflicting theories, principles, and attitudes of the new century and give them purpose and meaning, and give those citizens knowledge and confidence.

For Beloit College, science education is the stuff of research, outreach, and concern. For those who tread the crowded corridors of Chamberlin Hall, the question of how we develop scientifically educated citizens has long been the focus. The success of that investigation and the quality of the outcomes have brought two of the nation’s major science education support programs—the BioQUEST Curriculum Consortium and the ChemLinks Coalition—to the campus.

Why here? Why at a small liberal arts college in the upper Midwest? Why, specifically, at Beloit?

These questions gave rise to a Friday afternoon conversation in the biology seminar room with John Jungck, biologist, Mead Family Professor of the Sciences, editor of *The BioQUEST Library*, and newly named fellow of the American Association for the Advancement of Science. We are actually forced to this room of interlocking hexagonal tables by the fearsome prospect of squeezing into his office, which defies description. It is unlikely that anyone could survive a good tremor if standing in the center of the space, which is lined, ceiling-high, with overflowing bookshelves, and jammed with items of furniture that long ago lost their identity as they took on the primary purpose of raising from the floor research papers, articles, books, travel itineraries, and other works in progress. His only word to describe it is: “tilt.”

This is John Jungck’s answer to Thomas Hardy’s question.



# SETTING SCIENCE STANDARDS: A CONVERSATION WITH PROFESSOR JOHN JUNGCK

*The concept of scientific literacy frequently describes a base-line culture, and at Beloit we are working hard to exceed any of those minimalistic expectations.*

## The Students

The major thing that we try to develop in terms of students dealing with issues is to prepare them to see problems in a multi-dimensional perspective. They need to see many sides to an issue, and consider data that are relevant. They need to understand that it is multiple variables not single variables, that it's heuristics not algorithms.

They need to know that with freedom comes responsibility. There is a deep sense of contextualization dealing with complexities, innuendo, and subtleties. The basic model that I and others use here is to say "here are many contributing kinds of factors," and that puts you in a very different kind of place, where you draw on culture, on history, on sociology, on science. It is legitimating and respecting those divergent points of view.

This multi-dimensional decision-making model is a critical element of Beloit's high-tolerance kind of curriculum.

*Prof. Jungck's biology colleague and health-care studies program chair Marion Fass comes into the seminar room to pick up some materials. He turns to her for confirmation, and she adds: "Science is not value-free. One of the things that we are trying to help students look at is that their values help guide their scientific research, determine in which direction their research is going, and what decisions are made. Those decisions are not made in pure value-free settings."*

This represents a respect for the talents and backgrounds of the students that we have. ... This is a rich, heterogeneous kind of society. For instance, the international students in our programs matter enormously to the conversation and to the desire of our students to have an international experience. Their presence means that you are able to move beyond the xenophobia and parochialism of a lot of American culture. Getting past that ethnocentricism matters enormously in terms of having a conversation.

You can't beat the fact that you are bringing in students from very disparate places who share some kind of common commitments about concern for others, yet they have some interest and desire to know others from different backgrounds. It works in so many ways.

One of the things that works well for me in terms of heterogeneity of background is what the students bring to the table. International students frequently have had calculus while many of the biology students in this country have not. Culturally, there is a different type of expectation of what the science is. It means that, if you are talking about evolution and ecology, that they have experiences with different types of ecosystems, with local types of environmental problems, with different types of cultural appreciations of food and diet. All of these things have enormous impact in terms of thinking about evolutionary questions, ecological questions, and physiological kinds of health questions; you're able to draw upon even the geographical diversity in the United States in those kinds of expectations.

*My greatest frustration in teaching biology is students' preparation in mathematics. We, however, do draw a significant number of American students who score extremely high in math and sci-*

*entific experience. Therefore, the science division—the smallest of the three academic divisions at the College—does routinely graduate one-third of the students from the College.*

There are four elements of the teaching approach at Beloit that provide both a model for others and a superior learning opportunity for students.

First, students are accustomed to being our colleagues and participating democratically in our work. We have a long tradition of involving undergraduates in our research, and of utilizing students as peer tutors, teaching assistants, and research assistants.

We have a heavily contextualized approach to issues so that you are not surprised to find that all the environmental health and other issues come up directly in the process.

When it comes to technology, it's not just technology as some sort of information transfer. Rather, it is putting the powerful tools in the hands of students, and we typically expect the students to teach us how to use the tools. Students are expected to become really proficient, and they recognize that we are busy as faculty members and that we are relying upon them.

And finally, the scholarship of the faculty provides a seamlessness between our scientific scholarship and our educational initiatives. They are so integrated that it is not a token of your doing something for education, but instead education as part and parcel of who you are as a scientist.

As much as possible, we're trying to get students involved in how you make science rather than learning just how it was made. Einstein's theory of relativity and Darwin's theories mean a lot to us—we have a lot invested in them—but the difference that we try to get across to students is the difference between science ready-made and science in the making.

## Faculty Outreach: A Broad National Impact

The following is a selection of national organizations for which Beloit science faculty play prominent roles. Recognized as experts in their fields, the faculty members direct the educational, editorial, and other leadership activities of the organizations, thereby influencing science education and research well beyond Beloit.

American Association for the Advancement of Science  
American Chemical Society  
American Institute of Biological Sciences  
Animal Behavior Society  
Association of College and University Biology Educators  
BioQUEST Curriculum Consortium  
Botanical Society of America  
ChemLinks Coalition  
Coalition for Education in the Life Sciences  
Gordon Research Conference on Science Education

International Society for History and Philosophy of Social Studies of Biology  
Mathematical Association of America  
National Association of Biology Teachers  
National Association of Geology Teachers  
National Council of Teachers of Mathematics  
National Science Teachers Association  
Paleontological Society  
Pew Science Program in Undergraduate Education  
Project Kaleidoscope  
Society for Industrial and Applied Mathematics  
Society for Sedimentary Geology  
Society of Mathematical Biology  
Undergraduate Neuroscience Fund



*I tell my students that 50 percent of the science that I am teaching them is wrong, but I don't know which 50 percent it is.*

Science is not a litany of conclusions. It is a process by which you become discriminating as the problem-poser, the analyzer of data, the interpreter, the persuader, and you know that you can challenge people's claims at every one of those levels: Why did they pose this type of question? Why did they do this type of analysis instead of that kind? What are they bringing into their rhetoric of persuasion and what kinds of models are they employing in doing that?

## The Faculty

Part of the process, therefore, is that you have broken down the isolation of the classroom. Faculty here are talking to one another about their teaching and are having this sort of conversation on a regular basis. We didn't need to have a task force or some special meeting. This is what we do and what we think about. It's not that you fix curriculum. The lived curriculum of the students matters enormously.

This faculty is out there a lot, and a lot of teachers come in here because of our various special programs. And we reach out. If you look at the meetings I was at this summer—the Ecology Society of America, Botany Society of America, Society for Mathematical Biology, American Institute of Biological Sciences—these all reach college-level faculty. While our involvement with high school teachers is limited, we are still involved with such groups as the National Association of Biology Teachers and the National Science Teachers Association.

Whether traditional or reform, the faculty here invests extraordinarily in their students to do well with their courses. The kind of investment in the one-on-one kind of tutoring is exceptional, and the faculty have high expectations. And almost all faculty use a professional research model as the mirror they hold up to determine how they are doing.

In summary, there are no veils, you are always looking behind the Wizard of Oz. It's not magic. It's a group of faculty who constantly are earning credibility with their students and demonstrating the critical acumen of judgment and decision-making.

## The Reform Movement

Using BioQUEST as an example of pedagogical reform, the impact is not just of the BioQUEST project on the liberal arts, but also the other way. For instance, BioQUEST has never been just a gathering of undergraduate biology teachers talking with each other. This past summer, science and environmental writers gathered on the Beloit campus under the BioQUEST umbrella. Other groups have been historians, anthropologists, philosophers of science, and cognitive psychologists; they have all played an active role in BioQUEST planning. It is important that it remain an heterogeneous conversation.

A secret for the success of this and other reform movements in many cases is that, early on, our colleagues really did not care much about what we did with non-majors. So the non-major courses were those where we had the greatest license to pursue new ideas. I always taught non-majors and always had enormous freedom. And what is amazing about it is that you have non-majors doing very exciting things—such as teaching majors. And it's rather far along in our curriculum before we start to concentrate on just majors. And there is deep respect for non-majors intellectually, as citizens, decision-makers.

One of the benefits of the reform movement is that our studies show that students stay in the courses longer and they tend to take more courses than just minimal requirements. Much of the traditional curriculum in the past has been sink or swim, and very frequently intro courses were used as filter courses to get rid of people. What we're trying to do is not necessarily to win them over as majors—because we want them to do what they are interested in—but we certainly want them to have some deep respect for what we do and how it contributes to the society that they live in.

## Setting Standards

At Beloit, we make a differential impact in terms of what is going on in science education, setting standards in the overall concept of undergraduate science teaching. Whether physics, chemistry, geology, mathematics, or biology, the name of Beloit has taken on significant importance in the country.

There are a lot of places that can talk about the scientific research that's going on. There is no small liberal arts college that can match Beloit for the activity in science education plus the scientific research. There is no match.

Jim Lyga



Chemistry Prof. Brock Spencer, director of the national ChemLinks Coalition, works with students to build models of the molecular composition of fat as part of the ChemLinks module on fat.

