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High Impact STEM Learning and the Humanities

Using Civic Challenges to Bridge the Imaginary Divide

University of Denver, June 2016

What Divide? Disciplinary Arguments

- Steven Pinker (experimental psychologist) to Humanists: “Science is Not Your Enemy”

- Leon Weiseltier (literary scholar) to Pinker: Science Doesn’t Have all the Answers

- Gary Gutting (philosopher) to Steven Pinker: Scientists More Responsible for the Science/Humanities Gap

How those arguments play out in educational policy and state funding:

- "I want to spend our money getting people science, technology, engineering and math degrees," said Governor Rick Scott of Florida in a radio interview. "That's what our kids need to focus all of their time and attention on: those type of degrees that when they get out of school, they can get a job."

AND….

BUSINESS DAY

A Rising Call to Promote STEM Education and Cut Liberal Arts Funding

By PATRICIA COHEN FEB. 21, 2016

“Kentucky governor, Matt Bevin, suggested last month that students majoring in French literature should not receive state funding for their college education, he joined a growing number of elected officials who want to nudge students away from the humanities and toward more job-friendly subjects like electrical engineering.”

Historical Context for STEM/Humanities Divide

While empirical studies of nature and scientific methods are thousands of years old, the designation of “science” as a distinct category of knowledge is more recent. The term “scientist,” to describe a professional group, is a modern coinage, emerging in the 19th century to replace the designation “natural philosopher.” By the early 20th century the acceleration of scientific knowledge gave science a decided edge in the debate over what categories of knowledge counted.

Consequently, the roots of STEM, much as the roots of the social sciences (or “human sciences”) are in modes inquiry that we now classify as “humanistic."

Why Do This?

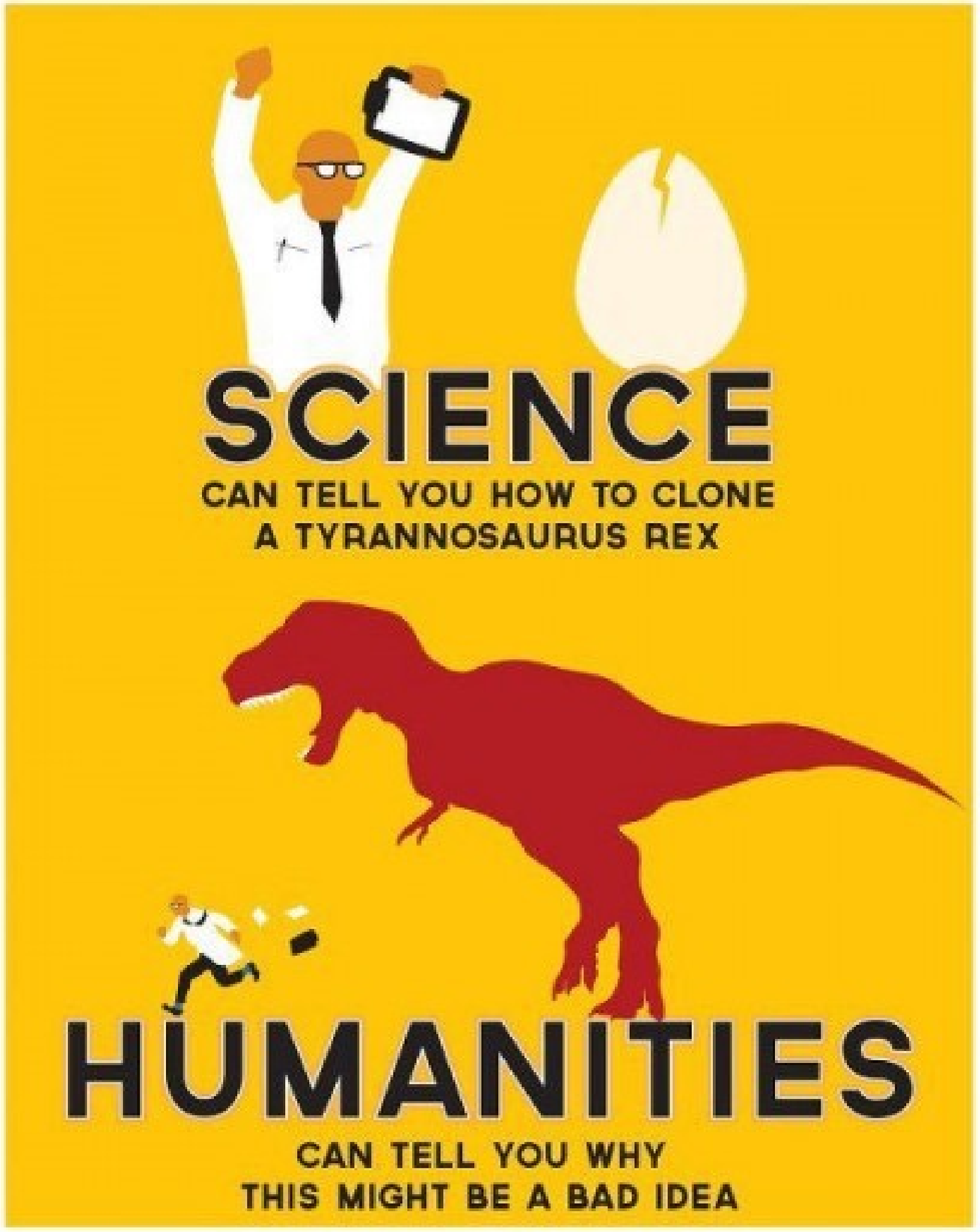
Old and New Arguments

Alfred North Whitehead on the problem of disconnected curriculum

- “There is only one subject-matter for education, and that is Life in all its manifestations. Instead of this single unity, we offer Algebra, from which nothing follows; Geometry, from which nothing follows; Science, from which nothing follows; History, from which nothing follows; a Couple of Languages, never mastered; and lastly Literature with philological notes and short analyses of plot and character to be in substance committed to memory.”

“Can such a list be said to represent Life, as it is known in the midst of the living of it? The best that can be said of it is, that it is a rapid table of contents which a deity might run over in his mind while he was thinking of creating a world, and has not yet determined how to put it together.”

The Aims of Education, 1929



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Clearly this debate has been going on a long time….

"You can give humanistic value to almost anything by teaching it historically. Geology, economics, mechanics, are humanities when taught with reference to the successive achievements of the geniuses to which these sciences owe their being. Not taught thus, literature remains grammar, art a catalogue, history a list of dates, and natural science a sheet of formulas and weights and measures."

William James, "The Social Value of the College Bred," 1907)

BTW, William James, who was chair of Harvard's Philosophy Dept for decades had a medical degree and not a PhD

Scientists and science faculty themselves have always understood the inextricability of scientific and humanistic modes of analysis…. we have scientists themselves to thank for surfacing the degree to which science is a subjective (and value laden, “human”) enterprise, though one with characteristic codes, methods, and ideals: As John Dewey, Werner Heisenberg and others have noted, the practice of science is “a dialog with the natural world.”

Werner Heisenberg

“Natural science, does not simply describe and explain nature; it is part of the interplay between nature and ourselves.”

The Debate is Shifting:

- Fareed Zakaria's argument against narrow focus on STEM in college education and a renewed emphasis on the Liberal Arts
- Recent report from the National Academies of Science on the "Value of Integrating STEM, Humanities, and the Arts in Undergraduate Education."

From Colorado School of Mines

- The **Humanities in Engineering** helps turn a **technical** education into an expansively **human** one.

But….

that doesn’t help us in an institutional and policy environment that sees these bodies of knowledge as espousing competing values, and worse, as competitors for educational and intellectual resources

What to do?

- Can SENCER Help?

SENCER is strategy for making sense of that “table of contents”and re-connecting learning to “life and all its manifestations”

- SENCER improves science education by focusing on real world problems and, by so doing, extends the impact of this learning across the curriculum to the broader community and society. We do this by developing faculty expertise in teaching "to" basic, canonical science and mathematics "through" complex, capacious, often unsolved problems of civic consequence.

The SENCER approach

- Part of the solution to both the disciplinary divide and the

SENCER's starting assumption:

"Science" takes place in a social context. Scientists, social scientists and humanists occupy the same universe, but bring their distinctive history and experience to the task at hand. They may be exploring the same problems, but they are asking different questions (e.g. science adds to the knowledge of genetics, infectious disease, or nano-technology, but can not guide the ethical, legal, and political decisions about how that knowledge will be used.) Conclusion: Science is best understood as an important component of a complex and dynamic system of human inquiry and knowledge production.

SENCER was a curricular reform project to reground STEM education in the larger common agenda of helping students to see that the power of their understanding was needed.

The SENCER Ideals

- SENCER robustly connects science to other bodies of knowledge by teaching "through" complex, contested, capacious, current, and unresolved public issues "to" basic science.
- SENCER approaches encourage student engagement with unsolved multidisciplinary civic challenges that require immediate attention.
- SENCER shows the power of science by identifying the dimensions of a problem that can be better understood through mathematical and scientific ways of knowing.
- SENCER seeks to extract from the immediate issues the larger, common lessons about scientific processes and methods.

SENCER courses integrated STEM, humanities, and social science content from the start

The Model Courses

What we have found over 15 years is that both STEM and the non-STEM faculty in the SENCER community have long understood the importance of relevance to student learning, and the role of integrative and interdisciplinary approaches to deepening student understanding and retention of STEM content.

We have found that the successful disciplinary integrations evolved organically from an interest in defining and addressing the *problem* and are not forced collaborations.

Ethics

- From the earliest years of the project ethics emerged as a critical context for SENCER courses:

- Biomedical Issues of HIV/AIDS
- Human Genetics

- Chemistry and Ethnicity: Uranium and American Indians

- STEM Cells and Social Justice

- AIDS Research: Global Understanding and Engagement (gender, history, anthropology) received the Josiah Charles Trent Memorial Foundation Award in Medical Ethics and Humanities at Duke University in 2006

Casting a wider disciplinary net over issues:

As SENCER participating faculty cast a wider disciplinary net, we noticed increased attention in their courses to cultural, psychological, economic, and historical factors,in short, an increase of systems approaches to complex civic problems

Pregnancy Outcomes (gender and ethnic studies)

The Chicken (zoology, food policy, cultural studies, literature)

Science Outreach: Public Understanding of Science (rhetoric, communications)

What disciplinary background will produce the next big discovery?

- “It is no accident that bacteria were first understood by a canal engineer, that oxygen was isolated by a Unitarian minister, that the theory of infection was established by a chemist, the theory of heredity by a monastic school teacher, and the theory of evolution by a man who was unfitted to be a university instruction in either botany or zoology”…C.D. Darlington, Conway Memorial Lecture on the Conflict of Society and Science, 1948 quoted by John Dewey in Reconstruction of Philosophy

- Quoted by John Dewey in Introduction to revised edition of Reconstruction of Philosophy

DO YOU HAVE A COURSE THAT INTEGRATES HUMANITIES AND STEM CONTENT BY TEACHING “THROUGH” A COMPLEX, UNSOLVED, CIVIC PROBLEM?

CONSIDER SUBMITTING IT AS A SENCER MODEL!