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Incorporating Diversity Issues into “Hard Science” Teaching: A Personal View  
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## **Introduction**

When the issue of diversity is mentioned in the context of the so-called “hard” sciences – physics, chemistry, mathematics, biology, geology, computer science, and the like – the discussion typically focuses on the continued under-representation of various groups (women, African-Americans, gay / lesbian / transgendered) among students and scholars in these disciplines. Though such discussion, and the research behind it, is of undeniable importance, it is worth noting that the actual scholarly and pedagogical *content* of the disciplines themselves, is rarely discussed in relation to diversity issues.

The purpose of the present work is to present a few preliminary ideas about ways in which in which diversity issues can be incorporated in the teaching of the “hard” sciences, with specific attention to our experiences in teaching undergraduate computer science courses. Our approach uses three perspectives: biographical, sociological, and anthropological / linguistic. We describe how these approaches may enliven classroom discussion, help students to re-examine traditional notions about science, and give diversity a more central role in the teaching and learning of quantitative disciplines.

## **The Current Dialog**

When diversity issues do arise in discussions of the teaching of the hard sciences, one typically sees either of two extremes. One of these comes in the form of ill-supported, negative generalizations about why certain groups are inherently unsuited to scholarship in these fields. As an example, one need look no further back in time or lower in the academic prestige hierarchy than Harvard President Larry Summers' recent “Daddy truck / Baby truck” anecdote about why women are biologically predisposed to be bad at science (Associated Press 2005)

Aside from the fact that such remarks are themselves egregiously unscientific, they reveal a fundamental, unquestioned assumption: namely, that the content of a discipline like physics or computer science is fixed by a scholarly and pedagogical agenda that has little or no intersection with issues of diversity.

The other extreme, coming from Poststructuralist literary and social critiques like Michel Foucault (1970) and Jean Baudrillard (2001), views science as just another form of human social activity, subject to the same biases and power struggles (notably, patriarchal and imperialist hegemony) as politics, religion, and other institutions, and – crucially – having no special claim on objective meaning or truth.

The unproductively hostile opposition between these two extremes came to a boil in a notorious 1996 article by physicist Alan Sokal, ostensibly presenting a cultural-studies critique of the theory of quantum gravity. Sokal deceived the editors of the journal *Social*

*Text* into publishing this article as a serious scholarly work, whereupon he immediately revealed it as a hoax – the implication being that (1) the “pure” subject matter of physics stands alone and apart from social critique, and that (2) discourse on the latter has reached such a level of absurdity that even a parody of it can be accepted by its practitioners as legitimate scholarship.

### **A Third Way**

The approach for which we would like to argue here represents a middle ground between the two extremes presented above. Unlike conservatives who see the methodology and language of science as a fixed, objective standard unrelated to “fuzzy” constructs like gender and culture, we believe that diversity issues can play a productive and enlightening role in science teaching – without undermining the rigor of scientific method, or substituting non-science material to appease students who have difficulty learning science. Unlike thinkers on the other end of the political spectrum, we acknowledge the fundamentally different status of quantitative disciplines, with their unarguable ability to predict natural phenomena with a precision unknown to the humanities and (with some notable exceptions) the social sciences. Our approach uses three perspectives: biographical, sociological, and anthropological / linguistic.

### **Biography and Bias**

Of the three perspectives we describe, the biographical is probably the most familiar to teachers. Many science textbooks contain biographical sketches, which are typically ignored by students and their instructors. Serious exploration of this material can provide a basis for discussion of diversity-related issues.

An example from our own field is its founder, Alan Turing, who is credited with the invention of artificial intelligence as a scientific discipline, and with breaking the German Enigma code during World War II. The latter accomplishment may well have been decisive in the outcome of that conflict. Not often discussed in computer science courses is the fact that Turing was an openly gay man during a time in which homosexuality in Great Britain was a crime punishable by imprisonment, and that clinical depression resulting from government-mandated, medically unsound hormone treatments was a likely contributing factor in his suicide (Hodges 1983). Presentation of this story in all its horrid detail can serve many positive ends, encouraging students to reexamine cherished notions - like their stereotypical image of a war hero - and forcing them to confront the terrible consequences of bias.

## **The Sociology of Science**

The sociological approach, familiar to philosophers and sociologists of science, makes even less of an appearance in science courses at the graduate or undergraduate levels. Critics of scientific methodology like Thomas Kuhn and Imre Lakatos provide insights that can be empowering to students struggling with what they believe to be their own ineptitude with difficult scientific and mathematical concepts. Kuhn (1970), for example, has shown how the personalities and sociological backgrounds of scientists profoundly influence the course of theory-making and experimental research. Such results undermine the still-prevalent notion that science is primarily a process of objective hypothesis testing, divorced from human concerns like culture and ethnicity. Lakatos (1976) describes the collaborative trial-and-error drama of how mathematics is actually done by mathematicians (as opposed to the way it is almost always presented in textbooks). Though neither of these philosophers directly addresses diversity, their work may well provide opportunities to make the enterprise of science accessible to a more diverse audience of students, while providing a more realistic view of how scientists go about their work.

## **Anthropology and Linguistics**

The approach that we have termed anthropological / linguistic is probably the least familiar to teachers of science and mathematics. We have found it beneficial to ask computer science students to think about formal systems like programming languages and mathematical notation as a special, extremely artificial case of human languages. Unlike formal languages, human languages are full of irregularity and ambiguity, and display an astonishing range of diversity in their means of expressing similar concepts.

Teaching about such phenomena has a number of advantages. First, it helps students appreciate the diversity of human language and culture in a novel context. Second, it helps students understand the language of science as one of many means of expression, which happens to be suited for a particular purpose and (unlike human languages) has been designed explicitly for that purpose. Such a view may give students perspective on their own difficulty understanding programming languages and other scientific objects. Third, by placing scientific languages in the context of human languages, this approach encourages students to attend to features that their own languages share with so-called “primitive languages”. An example is the special status given to the quantities one, two and three in the ordinal numbering system of English and many other languages. Table 1 (below) illustrates the absence of numbers higher than two or three in two so-called “primitive” languages (!Kung, spoken in southern Africa, and Warlmanpa, spoken in Australia), while indicating a similar privilege given to lower numbers in languages more familiar to most students (English, Spanish, French). Italicized pairs show that the numbers one and two are also given “special” status in familiar European languages, via irregular names for ordinals.

| Quantity | English              | French                    | Spanish                | !Kung | Warlmanpa |
|----------|----------------------|---------------------------|------------------------|-------|-----------|
| 1        | <i>one / first</i>   | <i>un / premier</i>       | <i>uno / primero</i>   | r e'e | jinta     |
| 2        | <i>two / second</i>  | <i>deux / deuxième</i>    | <i>dos / segundo</i>   | tsã   | jirrama   |
| 3        | <i>three / third</i> | <i>trois / troisième</i>  | <i>tres / tercero</i>  | n!eni | -----     |
| 4        | <i>four / fourth</i> | <i>quatre / quatrième</i> | <i>cuatro / cuarto</i> | ----- | -----     |

**Table 1** Numbers 1 – 4 in several languages. !Kung and Warlmanpa data are from Rosenfelder (2005).

In our own courses, we have been forced by time constraints to introduce such diversity-related material as a digression during lecture, or as extra-credit questions on quizzes and exams. The challenge we face is to integrate this new material into a science curriculum in a way that reinforces the fundamentals, instead of supplanting them.

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