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Abstract: Questions related to multiculturalism and curriculum have recently moved to the center of contemporary educational debate. Multiculturalists are raising questions that pose a fundamental challenge to those traditional forms of knowledge that have assumed Western canonical thought ought to compose the core of school curricula. Among the questions raised by multiculturalists are "whose culture are we teaching?", "whose knowledge is of most worth?", and "who benefits and who is harmed by current approaches to curricula?" In the process of raising such troubling questions, multiculturalists have pointed to the current failure to address adequately the literature, art, music, world view, and epistemologies of numerous minorities, including women, Hispanics, African-Americans, Asian-Americans, Native Americans, and gays and lesbians among others. In other words, what proponents of core or traditional liberal arts curricula have posed as our common heritage (e.g., the views of those like E.D. Hirsch 1987, Bloom, 1987, Ravitch and Finn 1987, Schlesinger 1991), is not really common but a heritage drawn from the frameworks of those who have dominated society and educational discourse (i.e., mostly white, male, and middle class).

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Multiculturalism, Universalism, and Science Education

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Questions related to multiculturalism and curriculum have recently moved to the center of contemporary educational debate. Multiculturalists are raising questions that pose a fundamental challenge to those traditional forms of knowledge that have assumed Western canonical thought ought to compose the core of school curricula. Among the questions raised by multiculturalists are "whose culture are we teaching?", "whose knowledge is of most worth?", and "who benefits and who is harmed by current approaches to curricula?" In the process of raising such troubling questions, multiculturalists have pointed to the current failure to address adequately the literature, art, music, world view, and epistemologies of numerous minorities, including women, Hispanics, African-Americans, Asian-Americans, Native Americans, and gays and lesbians among others. In other words, what proponents of core or traditional liberal arts curricula have posed as our common heritage (e.g., the views of those like E.D. Hirsch 1987, Bloom, 1987, Ravitch and Finn 1987, Schlesinger 1991), is not really common but a heritage drawn from the frameworks of those who have dominated society and educational discourse (i.e., mostly white, male, and middle class).

Science education has been touched by these debates, but mostly in superficial ways (e.g., counting numbers of minorities and women in science textbooks). For the most part, science education has remained immune to the multiculturalist critique by appealing to a universalist epistemology: that the culture, gender, race, ethnicity, or sexual orientation of the knower is irrelevant to scientific knowledge. It is the natural world that ultimately judges

our account of it, not the reverse (Matthews 1993). Put another way, the reality of the natural world is indifferent to the personal qualities of inquirers. This claim to universalism and the interchangeability of knowers is captured in Galileo's observation that "anyone can see through my telescope" (Harding 1991, p. 51). While it is widely recognized that individual scientists are frequently biased, in the long run, the processes of peer review and scientific methodology are assumed to provide an adequate means for correcting such distorting influences.

The universalist position permeates the discourse of science education, including the recent efforts to reform science education. Science for All Americans (AAAS, 1989) provides a case in point:

Scientists want, and are expected, to be as alert to possible bias in their own work as in that of other scientists, although such objectivity is not always achieved. One safeguard against undetected bias in an area of study is to have many different investigators or groups of investigators working on it. (p.28)

The universalist tradition has been challenged by philosophers of science, feminist scholars, and most recently, by multiculturalists. The multiculturalists, for example, have pointed out that non-Western approaches to science are not included in the current science curriculum. The universalist response to this has been to recognize the contribution of other cultures to Western science, but to deny that the knowledge systems of such cultures should be understood as "science". For example, the October 12, 1992 Discussion Document distributed by the National Committee for Science Education Standards and Assessment at the AAAS meeting recognized the contributions of other cultures to Western science. However, the Committee avoided characterizing the knowledge systems of such cultures as "science," choosing instead to refer to them as "personally constructed and culturally bound explanations of the natural

world" and "examples of humankind's struggles to understand the natural environment" (p.6). Furthermore they state that these controversies about different cultural approaches to knowledge should not be a part of school science.

It is the research agenda of the community of scientists, the ways in which research questions are formulated, and the rules of evidence and argumentation that should pervade the school curriculum. This is not to say that other cultures have not engaged in intellectual activities that share attributes in common with contemporary science, or that ways in which contemporary science is right or most productive, but only that it is not within the purview of school science to engage the critique. (p.6)

As should now be apparent, the definition of what counts as science is at the heart of the current debates. Narrow definitions of science based on the Western science tradition, are unlikely to have much impact on curriculum reform. Of course, this is not a problem for those who see the traditional Western conception of modern science and its universalist assumptions as correct. In contrast, a more pluralistic (or multiculturalist) conception of science would argue for significant curriculum reform.

Before we examine the arguments for a multicultural approach to science education, it might be helpful to make a few preliminary comments regarding our position. First, we do not take an anti-realist position, i.e., we assume a conception of reality that exists independently of what we may think or know of it. Furthermore we agree that the community of scientific inquirers is seeking to understand the nature of reality as part of their project. But, as we will argue below, our knowledge of reality will always be mediated, incomplete, and distorted. Second, we agree that it is desirable to strive for objectivity in scientific method. But we also think it is important to differentiate objectivity from objectivism. Whereas objectivism requires a

universal, value-free process, objectivity does not. Objectivity does require one to be rigorous in collecting and analyzing data, and to take necessary steps to ensure that one is not merely making the results to be what one wants them to be. Objectivity requires fidelity to methods agreed upon by a group of inquirers. We believe it also ought to require one to be aware of the particular framework one is using and that multiple perspectives brought to bear on any particular problem is an important way of achieving objectivity. In contrast, objectivism claims the possibility of knowledge determined by universal methods. Third, the position we take should not be construed as an argument that "anything goes" or one opinion is as good as any other. Rather, we will argue that our position does not require that we abandon the possibility of deciding on rational grounds to support one position as opposed to others. Thus, our position should not be confused with claims for radical incommensurability understood as either assuming the impossibility of dialogue across cultural frameworks or the human capacity for constructing a rational preference for knowledge produced within particular frameworks.

In the discussion to follow, we will focus on a few central issues. First, we present a brief review of the arguments against the universalist conception of scientific knowledge, including the consequences of holding a universalist conception. Next, we discuss the relevance of multiculturalism to science education. Finally, we conclude with a brief account of the implications our position holds for curriculum reform.

THE CRITIQUE OF UNIVERSALISM

The universalist view of science claims that it is the world that judges scientific accounts of it, and that this is unrelated to such things as human interest, culture, gender, race, class, ethnicity or sexual orientation. Such a view ignores the role of the scientific community in mediating

knowledge claims and retains some of the more problematic tenets of positivism.

Positivism has been the focus of critique for more than a century, and it is important that our position be understood within this wider context. Developments in the philosophy of science over the past century have been discussed by others, and we make no attempt to recount this story in any detail. However, it will be helpful to recall some of the key features of this critique to provide a basis for our discussion of science and multiculturalism. This is a complex issue since there is no unified conception of positivism. Nevertheless, we can point to certain key positivist assumptions that have been targets of criticism. Among these are: (1) a naive realist ontology that assumes the existence of a single, tangible reality that can be broken into segments to be studied independently;(2) a correspondence theory of truth in which "truth" is defined as knowledge that matches reality;(3) a universal conception of scientific language and method;(4) a verificationist method of justification;(5) the assumption that theory and observation (as well as the observer and the observed) could be kept separate;(6) the assumption of value free method and the separation of facts and meanings;(7) the temporal and contextual independence of observations.

Throughout the past century, each of these assumptions has been called into question, and universalists have come to reject many of the major tenets of positivism. For example, it is now widely acknowledged that there is no possible way to fully separate theory from observation, facts from meanings, or methods and values. Furthermore, Popper (1968) has made a convincing case that there is no way to determine scientific knowledge by verification. The only way to establish such knowledge is by a process of falsification. Thus, "scientific" knowledge is tentative in a most

precarious sense. Put another way, what we take to be reliable scientific knowledge is that which we have yet been able to disconfirm. It is, however, quite reasonable to act "as if" such knowledge were true until such time that we are able to disconfirm it.

The point we wish to make is that, despite disclaimers to the contrary, the universalist position retains a significant positivist influence. The universalists are heirs of Popper, who rejected the verificationist arguments for scientific knowledge, yet retained positivism's universalist assumptions regarding methodology. For Popper, the process of refutation consisted of deducing observable results from a theory, and then deducing the falsity of the conjectures when the predicted results are not shown to be the case (Brown, 1977, p. 71). Although in his later writing Popper appears to support the idea that the acceptance or rejection of a theory depends at least in part on scientists' decisions (Popper, 1968, p. 108), he denies that this process reflects the culture or interests of the decision-makers. He claimed such methods are universal and independent of particular human interests or the cultural characteristics of scientists. Furthermore, he believed that without universal standards for making such decisions, we would have no way to judge or determine if one description of reality was better than any other. For Popper, this sort of relativism posed a real danger to our democratic society.

The fear of relativism expressed by Popper and contemporary universalists reflects what Bernstein (1983) aptly described as "Cartesian anxiety", i.e., either we can identify some foundation or method for determining what is true or we are faced with the abyss of relativism, skepticism, and nihilism. In other words, if universal knowledge is not possible, then no knowledge is possible. Bernstein (1983) has not only described the absurdity of such

an argument, but also explains how it is not relativism that poses a threat to democratic society but the false claims for a foundationalism we can never have. We will return to this issue when we discuss the consequences of holding a universalist conception of science. At this point we need to recognize that the claim for a universal scientific method to falsify our scientific conjectures cannot be sustained. For one thing, Popper had no way of knowing what would constitute the grounds for falsification of conjectures in all contexts and for all times. But there is a related and more serious reason for rejecting the universalist claim for scientific knowledge.

The work of Feyerabend, Kuhn, Lakatos, Toulmin and others calls our attention to the role community plays in the process of scientific inquiry. Put another way, the activity of modern science is rooted in the community of scientific inquirers. This is a point carefully elaborated a century ago by C. S. Peirce. For Peirce, what we take to be scientific knowledge or "true" is determined by the tentative consensus established within the scientific community. We have no unmediated access to reality, thus we can only establish scientific knowledge through the interpretive efforts of those engaged in scientific inquiry. It is true that such groups will work to determine methods for making judgments, but such methods are always the result of community deliberation. In other words, what we choose to study and the methods we use are determined by human dialogue and interpretation. Thus, there is nothing universal about such methods as they are subject to ongoing reconsideration and reconstruction as the group of scientific inquirers constantly changes. While we agree that the natural world provides the community with some constraints on what could be a reasonable accounting of the natural world (e.g. apples fall to the earth), it is the community of scientists who ultimately decide what sense to make of such observations.

Feminists have also been prominent in this critique of universalism (Haraway, 1988; Harding, 1986, 1992). They argue that there is no universal standpoint from which we all process knowledge in interaction with reality. Consequently, human knowledge is always partial and distorted. Furthermore, science has become a problem because its distortions and limitations reflect the culture and politics of the community of scientists that created it, which have been mostly white, privileged males of Western heritage. Scientists have arrogantly believed they "could tell the one true story about the world that is out there, ready-made for their reporting, without listening to women's accounts or being aware that accounts of nature and social relations have been constructed within men's control of gender relations" (Harding, 1991, p. 141). The universalist ideal of a disinterested, detached, objective observer that is free from the limitations of a standpoint is not only a myth, but it is a myth that allows science to align itself with a culturally-defined male norm. The alignment of scientific and masculine norms then serves to eliminate culturally-defined feminine values from the practice of science (Keller, 1985).

We will return to these ideas of community and their relationship to multiculturalism, but before doing so, we would like to show how the argument against a universalist view of science is not merely an academic one. In fact, the universalist view of science has had serious negative impacts on the lives of many people, particularly those who have had low status in society in general, and have been mostly excluded from participating in Western scientific discourse.

CONSEQUENCES OF A UNIVERSALIST CONCEPTION OF SCIENTIFIC KNOWLEDGE

There are at least two negative consequences of a universalist conception of scientific knowledge: (1) it

allows scientists to pretend to have a God's eye view of the world, giving them permission to "tell the truth" without being held responsible for these truths (Haraway, 1988) and (2) it rationalizes the destruction of knowledge systems deemed inferior by Western standards. We will illustrate both of these points with particular examples.

The idea of a universal scientific method has been extended to psychology because of the claim of scientific method to generate unbiased truth. Researchers in human intelligence have long held the view that they merely report evidence on such factors as race and intelligence, and as scientists, should not be persecuted if others do not like the way the data turn out. This research has a long history that has been documented by Gould (1981) as an example of how scientists cannot escape their own culture and view the world "as it really is." It should be surprising to no one that when racial differences are explored in the context of a racially-stratified society, blacks fare poorly. This outcome is not merely a matter of the individual biases of scientists. For example, J. F. Blumenback and Alexander von Humboldt were defenders of equality. They vigorously opposed slavery and fought for improved living conditions of blacks. Yet personal beliefs did not enable them to create alternative views about the meaning of human intelligence.

Research in intelligence continues today, with researchers making the same claims that they are not racists, they are scientists who must be given the freedom to speak the truth. Indeed many of their findings are quite rigorous, e.g. the mean difference in IQ scores of blacks and whites and the predictive value of such scores on success in school (although there are quarrels regarding the size of these values). Many of these findings are difficult to dispute within the scientific framework that grounds the research. What these researchers do not recognize or acknowledge, is

that this is a particular way of viewing intelligence, not the only way.

For a variety of reasons, IQ tests have fallen out of favor with the U.S. public, but one should not underestimate the powerful influence these ideas continue to have on our schools and cultural beliefs about intelligence (Wolf, et al., 1991). Intelligence is considered to be a unitary trait that has no varieties, only ranks. It is an immutable capacity that is measurable, normally distributed in populations, and predictably located in privileged races and sexes. This ideology of intelligence has deeply influenced the way in which schools have been structured. With this theory of intelligence there must be individuals at the bottom of the curve whose ability to achieve is very limited. The purpose of schools then becomes one of delivering to students their inevitable lot in life. Beliefs about intelligence are then used to justify testing systems and tracking programs that lead to unequal opportunities for children in our schools (Oakes, 1990).

The second deleterious consequence of universalism is that it rationalizes the destruction of knowledge systems deemed inferior to modern science. Let me give two examples of this. There have been many criticisms of European imperialism in Africa and the way entire cultures were destroyed (Rodney, 1982). One of the consequences of imperialism in Africa was the replacement of many indigenous sciences with Western science. Indigenous agriculture was destroyed and replaced with more efficient and profitable, but ecologically destructive Western agriculture (Jacobson, 1989; Upawansa, 1988). As a result, today in many areas of Africa, the farmers are unable to grow food for their own families and must live on land that has been perhaps permanently stripped of its usefulness.

A second example of this is in the practice of midwifery in the U.S. When men became interested in delivering babies at the end of the 19th century, they did so as part of the growing medical establishment that had always opposed midwifery and effectively discouraged its practice. Physicians appealed to science and its methods as a promise of improving on the childbirth practices of midwives. "He shared with his patients an outlook that was progressive rather than conservative. Both had great faith in the promise of science and were disposed to believe that interventions would improve on the natural process." (Tew, 1990, p. 50). By arguing that labor ought to be scientifically conducted and controlled by the expertise of physicians, they were able to convince those who could afford the "best" health care to opt for physician-attended births (DeVitt, 1979). Ironically, this led to higher maternal and infant mortality rates for the wealthier classes. At no time in U.S. or European history have midwives had mortality and morbidity rates as high as physicians, in spite of the fact that historically midwives were more likely to serve malnourished women in poor health and living in unsanitary conditions (Tew, 1990). Even today, when death in childbirth is extremely rare by either midwife or physician-attended deliveries, research shows that the practices of midwives (e.g. extensive prenatal education of mother and family, keeping mother and baby together immediately after birth, letting the mother choose the birthing position, avoiding Caesarian sections and episiotomies) lead to less maternal and infant morbidity than the practices of gynecologists (Tew, 1990). So by what criteria do we establish what ought to count as good science?

MULTICULTURALISM AND SCIENCE EDUCATION

What does all this have to do with multiculturalism? We need to consider the idea of a community of inquirers as conceived by Peirce as it relates to a multiculturalist position. As noted above, other scholars (e.g., Kuhn, Lakatos) have emphasized the communal nature of scientific

inquiry. The very conception of paradigm rests on a view held by a group within a particular culture, and the same is true of the research programs discussed by Lakatos. What such a community of inquirers requires, among other things, is the capacity to generate and consider various possibilities for understanding and determining knowledge.

If we consider an extreme example of a community with only one perspective or framework for knowing, the limited possibility for generating new knowledge combined with the high risk of knowledge distortion become apparent. Universalists might object that we only need one perspective if it is the perspective of modern science. We hope we have made clear above why this is a false hope. In the end, the universalist position is not universal at all but only one perspective among others. This is not to argue either that all other frameworks are equally sound or that we have no way to make rational judgments regarding the superiority of particular frameworks in specific contexts. Thus we find the modern science framework is quite powerful when applied in certain situations. But, Western scientific frameworks cannot provide a vantage point beyond other frameworks whereby we could judge, once and for all, what we can know.

Given these limitations, the advantage of a community of inquirers representing multiple perspectives begins to emerge. The multiplicity of perspectives in and of itself does not ensure reliable knowledge. However, the multiplicity of perspectives does create the conditions required to make scientific progress possible. If the community of scientific inquirers is to engage in a self-correcting process as suggested by Peirce, a monological (single framework) community would be antithetical to such a process. Human interpretation aimed at the realization of new knowledge requires the dialogue of multiple perspectives (frameworks).

While Peirce, Kuhn, Lakatos, and others recognized the importance of community and cultural values, they said very little about the composition and power structures of these communities. The feminist literature is much more useful in showing how the perspectives that have been most frequently excluded are those belonging to marginalized groups in our society. Bringing these kinds of perspectives into science is essential.

An example of how previously excluded perspectives could be used to benefit science has been developed by Harding (1991). She argues that contemporary Western scientific discourse has become a cultural monologue, and that the perspectives of those historically excluded from science could be used to improve science. The inclusion of a feminist standpoint in science would benefit science by identifying background assumptions that could distort results in unproductive ways, by conceptualizing research designs in ways that can avoid powerful cultural biases, and by using sophisticated social theories to help predict and eliminate the negative impact of technologies on women. Furthermore, these standpoints are preferred because they are least likely to deny the critical and interpretive nature of scientific knowledge (Haraway, 1988).

IMPLICATIONS FOR THE SCIENCE CURRICULUM

The definition of what science is has always played a critical role in decisions about what ought to be in the science curriculum. However, what we have shown here is that excessively narrow definitions of what science is (e.g., science is what Western scientists have produced during the last two hundred years) is too exclusionary of multiple perspectives and is ultimately, detrimental to both science education and to science. Multiple perspectives should be seen as a rich resource for science and science education.

This is not to say that we believe the sciences of various cultures should be given equal weight in the curriculum as Western science. At least in the United States, Western science is dominant. Failing to provide students with a firm understanding of the Western scientific tradition would unquestionably limit their ability to participate in contemporary scientific discourses. Although we believe U.S. students must become competent in Western scientific discourse, they also need to understand that this is one particular way, among many, of thinking about the natural world. Understandings of this nature are important if students are to avoid repeating the negative consequences of a universalist view. Teaching the sciences of other cultures could be an important way of showing how Western science is a particular way of thinking about the natural world, rooted in Western culture. If students can also learn how the purposes of scientific activity have varied in different cultures, and how other cultures have developed sciences to meet these purposes, then they can also learn that the form of contemporary Western science is not universal, inevitable, or unchangeable. This kind of understanding is needed to encourage the critical thinking about the purposes Western science has served, and how these could be changed to create future sciences that better meet the needs of the diverse societies that support them.

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