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ABSTRACT

This paper focuses on the potential value of cultural myths in maintaining the notion of science for all through educational reform. Cultural myths are defined as networks of beliefs and values, and they have the potential of influencing science and science education. Not until recently did educators realize the importance of myths and their influence on the discourse of school science. Four different cultural myths are explored: (1) scientific literacy is a necessity for all U.S. students; (2) it is possible to have a universally shared vision of scientific literacy for all students; (3) females and minorities and science; and (4) current reform rhetoric calling for "science for all" reflects the swing of the proverbial education pendulum. (Contains 35 references.) (YDS)

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Cultural myths in the making: The ambiguities of science for all

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Cultural myths in the making: The ambiguities of science for all

More than a century ago, Charles Eliot, president of Harvard

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University, asserted that schools must become places where Uall children can learn" (Eliot, 1961). This principle has been at the heart of scientific literacy since the early 1 900's and continues to be reflected in the science education reform documents of this decade.

At the turn of the 20th century, cultural norms of society placed significance on principles of democracy, and by extension, the obligation to educate the masses. The principle of Uall children can learna was eventually translated into the Uscience for all" corallary under the organizer of scientific literacy. As Hurd (1958) suggested, Umore than a casual aquaintance with scientific forces and phenomena is essential for effective citizenship. Science Instruction can no longer be regarded as an intellectual luxury for the select few." However, the cultural norms of the time supported concepts of intelligence based on individual and group differences, ultimately giving rise to programs which tracked students on the basis of ability. Some would argue that little has changed since that time and that our current treatment of the all children can learn science principle is ~little more than current window dressing for some old beliefs and practices (Oakes, 1995).

Explicit within the documents of today's Standards-based era of reform is the assumption that all students could and should participate in science. One need not look beyond the first sentence of the National Science Education Standards (NSES), which state that uin a world filled with the products of scientific inquiry, scientific literacy has become a necessity for everyone (National Research Council, 1997). The NSE Standards, whether viewed as a metaphor of vision, a flag in the chaos of battle, or a strugglew to move through changing terrain, provide a myriad of models, tables and taxonomies to define the WHAT and HOW questions of how we might facilitate science for all. As schools unconsciously define WHAT it means for all children to learn science, the question of HOW is reflected in a plethora of new curricula and programs

that attempt to customize science to fit a variety of learners. The emergence of UGirl Friendly," Anti-Racist," and "Indigenous" science curricula and progrmas, in response to the question of HOW we might go about making science affirming for all students,

_ Umay simply lead to the creation of new sterotypic boxes"

(Tippins & Nichols, in press).

It is simply not enough to articulate an educational vision of science for all. As we contemplate the dawn of a new century, we are challenged to consider the WHY questions of science for all. Recently, Ucritical" reviews of reform have been voiced to suggest thast scientific literacy is a means of perpetuating priviliged views (Kyle, 1996). As other science educators have joined in the discussion, they have questioned the prominence of Uscience for all" as an educational goal. We recognize the inability of Standards or Frameworks to uncover and represent tacit assumptions that shape our understanding of science for all. And we believe that research technlques borrowed from such fields as anthropology, literary criticism or history can be used to study the hidden infrastructures that influence compelling arguments for or against notions of science for all.

A culture develops myths to ensure loyalty to a particular set of values (Kincheloe & Simpson, 1992). By extension, the science education community constructs cultural myths that may be designed to support and maintain particular notions of educational reform. When Morris Shamos (1995) first conceptualized scientific literacy in terms of a cultural myth, we were struck by the potential value of examining myths as a way to study and make sense of the science for all metaphor in contemporary visions of reform. Accordingly, the purpose of this paper is to draw attention to powerful cultural myths which govern our understanding and structure the discourse of what it means for all children to learn science. In the process, our analysis enables us to construct understandings which are personally meaningful and challenges us to examine the ways in which our own assumptions about science for all are formed.

Framing our theoretical perspectives: Cultural myths

Experience is embedded within a culture which reflects the Umeanings and values implicit and explicit in particular ways of life" (Williams, 1961). Thus science teaching and learning should be considered in a cultural context. Cultural myths are networks of beliefs and values that, on the one hand, are created as a means of engendering allegiance to that which is cherished within a particular culture. In this sense they may contribute to the propagation of a social group's collective conscience (Barthes, 1985; Levi-Strauss, 1966;Taylor, 1996), act

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to legitimize particular belief systems, forms of knowledge or histories, or serve to instill a sense of national pride. On the other hand, cultural myths can act to devalue, suppress or exclude particular forms of knowledge, understandings of the world or social practices. In either case, they act as Ucollective stories that serve as a source of group identity" (Goodman, 1992. However, Taylor (1996) points out that Umyths are not so readily pigeon-holed; one person's (or culture's) benign myth can be another person's repressive myth ." The concept of "myth" is actually quite complex, its various meanings associated with a long history that crosses many disciplines.

The examination of cultural myths can play an important role in moving us beyond one-dimensional thinking that frequently characterizes reform movements. Both as a foci for reflection and as a catalyst for change, myths have the potential to significantly influence science, school science and science education reform. Tobin & McRobbie (1996) point out that Ulearning in relation to cultural myths is associated with a belief that we need to understand a rationale for existing practices if we are to have a plafform for initiating and sustaining reform (p. 226).r However, when myths go unexamined by the science education community they propel cultural reproduction of educational practices that privilege the perspectives and histories of some groups such as might be reflected in a single account of science.

It is only recently that educators have come to recognize the importance of

cultural myths in terms of their influence on the discourse of the rhetoric of reform as well as the discourse of school science. Milne (1999) argues that "myths are characterized by their apparent invisibility once their historical evolution has been forgotten." However, she reminds us that Umany myths about science which no longer necessarily influence and inform the practice of science, continue to structure the culture of school science." In the sections that follow we explore four cultural myths that both promote and obscure our understandings of the reform goals of Uscientific literacy for all" and Uall children can and should learn science."

Cultural myths: The construction of science for all

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Among the many untested assumptions of US science educators, two in particular have recently become so widespread and deeply entrenched that they now have the status of cultural myths. One of these myths is the notion that all students need to become scientifically literate. A second myth, related to and following from the first, is that it is possible to have a universially shared vision of scientific literacy for all students. We address these two myths in this section. Myth 1: Scientific literacy is a necessity for all US students. Science for All Americans (Rutherford & Ahlgren, 1990, p. v), the first publication for Project 2061 of the Association for the Advancement of Science (AAAS), begins with these statements: UThis book is about scientific literacy. Science for All Americans consists of a set of recommendations on what understandings and ways of thinking are essential for all citizens in a world shaped by science and technology" (Rutherford & Aglgren, 1990, p. v). Similarly, the NSE Standards open with the recognition of science as a necessity for all. Thus scientific literacy is claimed to be Uessential" or Ua necessity" for everyone by two of the leading policy documents of the current science education reform movement. However, neither the NSE Standards or Science for All Americans cite direct evidence or empirical studies to back up the claim that scientific literacy is essential for everyone. In fact, such studies seem to be lacking from the science

education literature in general (Shamos, 1995), as far as we can tell. Whether or not science for all is essential is not the main issue. Rather, we are pointing out that basing Uthe fundamental goal of science education" (Bybee, 1997, p. 46) on unconfirmed assumptions leaves that goal open to criticism, makes it hard to defend on a rational basis, and certainly qualifies it as a cultural myth.

The goal of science for all is not without critics. The most vocal critic of the scientific literacy movement is Morris Shamos, a former president of the National Science Teachers Association. In his book, "The Myth of Scientific literacy," Shamos (1995) criticizes the ~facts" purported to support the goal of universal scientific literacy, the mechanisims by which science educators hope to acheive it, and--most importantly--the necessity and desirability of the goal itself. It is not our intention to reiterate Shamos' arguments here. Instead, we wish

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to emphasize that there has been very little outward reaction by educators to Shamos' criticisms, if one is to judge by the published literature. Even Roger Bybee's (1997) recent book, UAchieving Scientific Literacy: From Purposes to Practices," mentions Shamos by name on less than a dozen pages, and not always in an adversarial role. We believe that the ability of the science for all metaphor to stand up to vigorous criticism despite the lack of a research base is furthur evidence that this goal has taken on a mythical status. Myth 2: It is possible to have a universally shared vision of scientific literacy for all students. A related but different contemporary myth of science educators is the idea that it is possible to articulate a universally shared vision of the science knowledge, understandings, skills, and dispositions that all American students need, want or will find useful. We are not merely pointing out that it is impossible to please everyone. Nor are we talking about whether the National Science Education Standards provide a better Udefinition" of scientific literacy than Science for All Americans, or vice versa. What we are trying to point out here is that the very notion that any given document or definition can apply to everyone seems to be an unfounded myth.

Recall that the first sentence of Science for All Americans states that it is Uabout scientific literacy" (Rutherford & Ahlgren, p. v, emphases added). We contend "science for all" and Uscientific literacy" are different and potentially contradictory concepts. The goal of scientific literacy seems to be based on the notion that there is a single (though dynamic) set of knowledge, understandings, skills, and dispositions that all students should possess. The essential characteristics of the scientifically literate student have been codified in the form of benchmarks (AAAS, 1993) and standards (NRC, 1996). On the other hand, the phrase "science for all" evokes images of school science being accessible, relevant, and interesting to students (Rascoe, et al., 1999; Tippins, et al., 1998). There is reason to suspect that the science students are exposed to in school, the science they presumably Uneed" to become scientifically literate, is of little interest or value to them (Shamos, 1995). In part, this outcome is a result of the great diversity of racial, religious, geographic, and economic backgrounds among US students. What a poor white student from south Georgia finds useful may be entirely uninteresting and irrelevant to a middle-class Hispanic student in California, or even to a black urban student of any economic status in Atlanta. Students in these various settings not only have different backgrounds and past educational experiences; they also have different aspirations, hopes, and dreams. These observations suggest that instead of more unity in school science, what is needed are more diverse curricula and pedagogical methods (Eisenhart, Finkel & Marion, 1996; Rodriguez, 1998), and perhaps more individual choice in the science that one studies in school.

In short, the concept of Uscience for all" implies different science for different students, whereas Uscientific literacy" implies the same science for all students. Thus, Uscience for all" does not have to mean Uthe same science for all." In fact, the closer we get to having Uscience for all," the furthur we move from achieving scientific literacy. From our perspective, there is certainly a tension between these two concepts, and as long as it remains unresolved, it will be impossible to come to consensus on a vision of

scientific literacy for all students in the US.

Some may view our discussion of these myths as being too rational, and might point out that few, if any, educational goals are based on empirical data. Indeed, we do not want to leave the reader with the impression that we are against either the goal of scientific literacy or science for all students. Instead, we are attempting to make other science educators aware of the shaky foundation on which we stand, which leaves our discipline open to criticism, distrust and Uband-wagon" effects. We are calling for science educators to help shore up these foundations by examining them and reframing them in more sturdy arrangements. As currently articulated, scientific literacy as a necessity for all students may not be a defensible goal, but it does seem defensible to say that science educators are responsible for making the opportunity to become scientifically literate equally available to all students. All students may not need or want to learn the same things in science, but all deserve quality science education experiences. We suggest that science educators carefully re-examine the goals and assumptions of their discipline so that all students can equitably experience quality school science instruction that will provide them with the knowledge, skills, and dispositions they want or need for their lives. Myth 3: Females and minorities. due to

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their historical exclusion from science. are particularly at risk in terms of becoming scientifcally literate. Since the mid 70s, a plethora of research has indicated that females and minorities have not performed well with respect to sciencce learning, and have not participated in science or science related careers. Attempts have been made by science educators to identify reasons why these groups have not participated in science. However, little to no research has been conducted to look at the historical basis of this myth. There is evidence to suggest to the contrary that indeed--females, at one point in time, enjoyed science as a central curricular emphasis.

A commissioned study in Britian from 1864 to 1868 reported that the sciences

(e.g., botany, chemistry, physiology, natural history) were quite popular in girls' schools; whereas middle-class boys' schools focused almost exclusively on classical studies (e.g., Latin, Greek). Kim T.olley (1996), interested in comparing this study to American education, analyzed newspaper advertisements, published accounts of school examinations, and state superintendents' reports to inquire about boys and girls secondary studies in the US from 1974-1850. She found that middle and upperclass females educated in the South experienced science as an integral part of the curriculum during the first half of the nineteenth century. Similar to their British counterparts, boys' schooling focused on the classics including for example: Latin, Greek, rhetoric, applied geometry (surveying), and navigation. The turn in economic events of the 19th century brought the need to educate males for employment in the new industrialized society. Accordingly, females were needed to fill in the gaps left at home and in schools. Curricular changes were reflected in the education of females as their education now focused on preparation to be homemakers, good wives, and teachers of children. Mythologies supporting the view that females Udon't do science" began to thrive. Science education reform agendas including those such as ~science for all" or Uscientific literacy" are premised on myths generated from a particular perspective. In the section which follows, we look at how myths, promulgated over time, play a role in science education reform to perhaps prevent substantial changes from taking place. Myth 4: Current reform rhetoric calling for Uscience for all" reflects the swinq of the proverbial Ueducation pendulum." DeBoer (1991), in the opening section of his text "A History of Ideas in Science Education: Implications for Practice," advises readers that science education can be improved by learning from the past: A study of history reveals that most ideas have had their origins in other times and places. The validity of ideas over time give them a legitimacy for today, and this makes us less likely to treat them as trivial-in vogue today, out of vogue

tomorrow. It makes our decision about curriculum and instructional strategies more intelligent and our evaluation of these strategies more cautious (p. xii). Illustrated throughout DeBoer's book, are a number of themes of reform from over a century ago that have resurfaced in the debates and policies of science education throughout this century. As education is involved in what is often referred to as the third wave of reform, there is a great deal of contention as to what should be learned or built upon from past practice. As the focus of this paper concerns myths associated with science for all, we want to specifically consider the extent to which historical and institutional memories can serve to inform reform which calls for science for all learners. According to Bowyer & Linn (1978), the term scientific literacy first appeared in an article of the Saturday Reviewwritten by Bailey in 1957. At that point, scientific literacy was valued for its potential to develop an effective citizenship in a society dominated by science and technology. In 1966, Pella, O'Hearn & Gale conducted document analyses to examine references to scientific literacy represented in public and professional texts. Texts reviewed were predominantly targeted toward university readership, although popular texts such as the journals Time and Vogue were included. The authors systematically reviewed literature to identify references pertaining to scientific literacy which they broadly defined as statements which promoted: U...science for effective citizenship (p.199,1966)." From their analysis of 100 documents, the noted the following referents for scientific literacy:

1) Science and society; 2) Ethics of science; 3) Nature of science; 4) Conceptual knowledge; 5) Science and technology, and 6) Science and humanities.

The authors concluded that, overall, scientific literacy has foused primarily on the first three referents of this list. For the most part, these historical analyses are not

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concerned with WHO is, or is not, practicing science. Only recently have there been discussions which critique "science" as a socially constituted practice. These discussions have lead to questions about how and why science and science education have been re-presented in society. Both are represented through historically generated mythologies--or shared systems of reasoning which shaped our views and practices of science in science education. The myth that we can, and should, draw on our historical knowledge to inform current and future science education activities may perpetuate hegemonic practices which undermine goals such as promoting science for all. Much like a "myth," Popkewitz (1997) uses the term Uregister" to refer to how systems of reasoning work to privilege certain knowledge and processes associated with the construction of knowledge. For the purposes of this discussion, we might think of a ~register" as a myth which sustains hegemonies. An example of a register can be seen in reform associated with gender equity in science education. Reform associated with gender equity has been premised on historical myths which hold that: 1) Women were not permitted to participate in science; and 2) Girls have not liked science. Science educators have responded by highlighting the historical contributions of females, limited as these might be, and by developing curricular approaches (e.g., female-friendly science) in attempts to help females overcome such historical barriers. Mclntosh developed a model that looks at various ways academic contributions of females have been represented in historical accounts. The model (cited from Rosser, 1990) presents five phases:

I: Womanless History: Only great events and men in history are deemed worthy of consideration.

Il. Women in History: Heroines are exceptional women, an elite few, who have benefited society--according to standards developed by those having power to determine the criteria.

Ill. Women as a Problem. Anomaly. or Absence in History: Women are victims who have been deprived opportunities to participate and contribute. Again, categories used to determine causes are derived from those in power.

IV. Women as History: Women experience the world differently, thus there are plural versions of reality. The identification of

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what counts as a contribution must be analyzed from more racially inclus~ve, and multifaceted perspectives.

V. History Redefined and Reconstructed to Include Us All. Women are both part of and alien to the dominant culture and the dominant version of history. More inclusive constructs are needed which validate a wider sample of life. (Rosser, 1990,100-101).

This model invokes questions about whose historical accounts and experiences have been used to inform analyses which have determined directions taken in science education. While such efforts have served to discontinue the myths associated with females' exclusion from science, the "register" which concerns the control of females' epistemological and sociopolitical status remains larely untouched. What would appear to be a pendular swing of an educational reform agenda might, more accurately, reflect the maintenance of registers which work to regulate hegemonies deeply embedded in school and society. Scientific literacy, if regarded as a register, signifies historical knowledge and social processes working to maintain the system of reasoning (i.e., rationality) which assigns science knowledge its elite status. On the surface, it would appear that the reform rhetoric promoting scientific literacy might offer new opportunities for the, otherwise, disadvantaged. Okhee Lee (1995) warns that before educators proclaim what counts as "scientific literacy," and support this view in educational policymaking, we must first examine what views of knowledge are presumed: While the lofty goal of achieving scientific literacy for all students is admirable, what do science educators know about this? Very little, there is even a danger in implementing educational programs or establishing policy priorities without an adequate knowledge base.

Lee (1995) comments that scientific literacy, as it relates to students with diverse cultures and languages, should raise three questions:

_ What is the nature of science in the science community, and how is this issue related to students with diverse cultures and languages?

_ What is the norm of instructional practices in science classrooms, and how is this related to students with diverse cultures and languages?

_ What are the ways to acheive scientific literacy for all students and what course of action can science educators take?

Kyle (1995) similarly asserts that debates about curriculum have moved beyond whether the humanities or sciences ought to be the focus of curriculum, to questions such as:

_ What constitutes literacy, in both the sciences and humanities, as we prepare students to lead fulfilling lives in the 21 st century?

_ How should we assess whether students have acquired the knowledge and skills assocaited with citizenship and social responsibility?

_ How can we ensure that students develop the scientific and technological literacy for self- and social-empowerment? How can we ensure that students ultimately utilize their acquired literacy as adults in society?

Ultimately, the myth that we can build upon our historical ideas to shape current and future activities in science education warrants cautious and critical reflection. Not only are we challenged to identify and overcome myths associated with science for all and scientific literacy; we most move beyond historical memories or registers which work to regulate or maintain the pendular movements of educational change. We might therefore ask: What systems of reasoning have been previously used to promote notions of scientific literacy or science for all in science education? What alternative systems of reasoning might be considered in deciding what is best in science education for all? And, to what extent do we encourage alternative ideas that can potentially inform our historical analyses and future actions?

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