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ABSTRACT

Showing evidence of planing multicultural education in curricula is required by the National Council of Accreditation of Teacher Education (NCATE) for accreditation of professional education programs. This paper presents discussions on this issue over the last three decades, points out the increasingly diverse student population in the United States, and questions the effectiveness of teachers in providing multicultural instruction to students. Different issues in multicultural education, science teacher education, and multicultural science teacher education are examined. The meaning and structure of multicultural education is also discussed. (Contains 51 references.) (YDS)

Incorporating Multicultural and Science-Technology-Science Issues into Science Teacher Education Courses: Successes, Challenges and Possibilities

by
Aldrin E. Sweeney

INCORPORATING MULTICULTURAL AND SCIENCE-TECHNOLOGY-SCIENCE ISSUES INTO SCIENCE TEACHER EDUCATION COURSES: SUCCESSES, CHALLENGES AND POSSIBILITIES

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Historical Precedents

Beginning in January 1979, colleges and universities applying for accreditation of their professional education programs by the National Council for Accreditation of Teacher Education (NCATE) were required to show evidence of planning for multicultural education in their curricula. While it may be said that multicultural education has been, in various forms, part of the American social fabric from the turn of the century, the concept of *multicultural teacher education* is relatively new (Goodwin, 1997, p. 5). In 1973, the American Association of Colleges of Teacher Education's (AACTE) first Commission on Multicultural Education issued the following policy statement:

> Multicultural education programs for teachers are more than special courses or special learning experiences grafted onto the standard program. The commitment to cultural pluralism must permeate all areas of the educational experience for prospective teachers (p. 264)

This statement sent a clear message to the AACTE membership that teachers needed *specific* preparation to teach a culturally and racially diverse student population; in the United States, this is an educational issue which continues to be hotly debated nearly three decades later (see for example Ladson-Billings, 1994; Pomeroy, 1994). By 1979, the Commission's work became the stimulus for subsequent changes in NCATE standards, presaging an era of greater accountability where rhetorical commitments to the notion of multicultural teacher education

required support by substantive actions in order to meet professional requirements of practice (Goodwin, 1997, p. 5).

As the population of ethnically, culturally and/or linguistically diverse students in the United States increases (Hodgkinson, 1992; National Center for Education Statistics, 1997a; 1997b), questions of mainstream classroom teachers' ability to effectively instruct these students remain (see for example Rodriguez, 1998). This is reflected in the inclusion of multicultural education policies in teacher preparation programs (including, but not limited to an understanding of linguistic and cultural diversity) found in accreditation standards of the National Council for Accreditation of Teacher Education (e.g., NCATE, 1998) and guidelines for other professional educational organizations. However, a recent comparative assessment of 59 institutions disclosed that "only 56% were found to adequately address cultural diversity and/or exceptionalities in the professional education curriculum" (Gollnick, 1992, p. 236), while only 68% had teacher certification candidates working with culturally diverse children. As suggested by Goodwin (1997), if such trends continue, then this is indicative of an approaching crisis in K-12 education.

What is Multicultural Education?

A major difficulty facing teacher educators seems to be that of defining just what multicultural education *is*. According to Banks and Banks (1995),

> 'multicultural education is a field of study and an emerging discipline whose major aim is to create equal educational opportunities for students from diverse racial, ethnic, social-class and cultural groups. One of its important goals is to help all students to acquire the knowledge, attitudes and skills needed to function effectively in a pluralistic democratic society and to interact, negotiate and communicate with peoples from diverse groups in order to create a civic and moral community that works for the common good' (p. xi).

Banks and Banks (1995) consequently describe multicultural education as a 'field of study designed to increase educational equity for all students that incorporates, for this purpose, content, concepts, principles, theories and paradigms from history, the social and behavioral sciences, and particularly from ethnic studies and women's studies' (p. xii). As they suggest, it is because of these characteristics that multicultural education may be termed a "metadiscipline". In a subsequent publication, Banks and Banks (1997) propose that multicultural education is a synthesis of at least three entities, i.e. an idea or a concept; an education reform movement; and a process. Boutte (1999) concurs with the notion of multicultural education and development as a process, and proposes three successive stages of multicultural growth spanning four dimensions (i.e. self-awareness, emotional response to differences, mode of cultural interaction and approach to teaching). These illustrate that when multiculturalism is employed as an educational process, an individual develops from holding unidimensional to adopting multidimensional perspectives (pp. 27-31). Boutte (1999) also addresses a common *misconception* about multicultural education when she states that many educators mistake the term "multicultural" to mean addressing only the needs of minority children (p. 75). This is a *pseudomulticultural* approach since it does not consider the needs of *all* children and assumes that the needs of the mainstream student population are generally taken care of in the classroom (p. 76).

Flaxman, Schwartz, Weiler and Lahey (1998) propose that multicultural education is a theory of the content of education, the teaching and learning process, and the very purpose of education. As a theory of social inclusiveness for example, multiculturalism provides the intellectual and political basis for bilingual education in schooling and for minority language maintenance in the larger mainstream community. What are now considered multicultural education practices in the school and the classroom include, for example, an inclusive curriculum leading to self and societal transformation, cooperative learning, culturally relevant pedagogy, and a greater family and community involvement in education.

However, multicultural education is not without its detractors. As an educational philosophy, it has been criticized for its championing of intellectual relativism and for divisions in the unity of American democratic and cultural ideals that it is thought to engender (see for example Ravitch, 1990; Schlesinger, 1991; Hirsch, 1999).

Multicultural Science Teacher Education and the STS Approach

In terms of the professional preparation of science teachers, Atwater (1996) argues that there must be a union of science teacher education and multicultural education to develop research and teaching agenda for *multicultural science teacher education.* Madrazo (1998) has cautioned that the integration of multiculturalism into any subject or content area can be tricky; in particular, science and mathematics educators (who might regard their disciplines as being purely objective) may find it especially difficult to develop new frameworks which incorporate a multicultural approach. Madrazo (1998, pp. 21-22) provides a description of a "multicultural science teacher continuum", going from *addition* (adding a multicultural component to science curriculum and instruction) to *integration* (relating data and information from various cultures to the concepts and theories of canonical science) to *accumulation* (consideration and appreciation that the manner in which scientific knowledge is constructed is influenced by cultural factors) and finally to *advocacy* (consideration and appreciation that various frames of reference and cultural assumptions influence the accumulation of knowledge).

Norman (1998) succinctly states that an important component of scientific literacy is an understanding of the reciprocal impact of science and the general culture on each other (p. 365; see also Allchin, 1998). This perspective seems to lend substantial support to Madrazo's (1998) conceptions of *accumulation* and *advocacy* as part of a multicultural science teacher continuum of development. However, Norman (1998) advises that the pedagogical strategy he proposes as a means of developing scientific literacy (cf. Madrazo's *transforming knowledge* or *advocacy*) has an apparent limitation in that it might lead to the introduction of too much noncontent material in the science curriculum. This becomes a particularly important issue in the current era of 'educational standards and accountability' when addressing charges (some well founded) that

* Drug abuse
* Soil and landmass erosion
* Euthanasia
* Food preservatives or additives
* Fossil fuels
* Genetic engineering
* Greenhouse effect/global warming/depletion of the ozone layer
* Hazardous waste
* Hunger
* Land usage
* Mineral resources
* Nuclear power
* Warfare (nuclear, biological)
* Overpopulation
* Pesticide usage
* Rainforest preservation
* Water quality/water usage

More recently, Barba (1998) has specifically addressed the integration of STS issues in the multicultural classroom by advising science educators to seriously consider the following questions: How can students become engaged in taking action on social issues? Why is the integration of science, technology and society important? How does STS education fulfill the need for "real world" applications of science?

Multicultural Science Education -- A Typology

As mentioned above, teacher educators and others associated with the professional preparation of teachers typically find it difficult to propose (and agree upon) a specific definition of multicultural education. This continues to be especially true in the discipline of science education, where the notion of "multicultural science education" currently remains as highly

science teachers (and elementary science teachers especially; see for example Tilgner, 1990) are not adequately prepared in the science content areas. To counter this, Norman (1998) suggests that scientific literacy should therefore become the responsibility of the whole school and not just that of the science teacher (p. 372).

Issues of multicultural education, science teacher education and multicultural science teacher education are implicitly foregrounded by Barton and Osborne (1998, p. 340) who urge science educators to address the following questions in their teaching and research agenda:

1. How can historically marginalized students become involved in science?
2. How can we shape practice and curriculum to address the needs of diverse learners?
3. How does reshaping practice and curriculum alter our thinking about the discipline or science itself?

These questions and related issues concerning multicultural science teacher education, scientific literacy and advocacy (as defined in Madrazo, 1998) seem to be addressed very well in the science/technology/society (STS) approach to science teaching.

According to Yager (1990, p. 52), STS may be defined as an integrated approach to science teaching that seeks to:

1. Prepare students to use science for improving their own lives and for coping in an increasingly technological world;
2. Teach students to deal responsibly with technology/society issues;
3. Provide students with a fundamental knowledge of STS issues; and
4. Give students a knowledge of career opportunities in STS-related fields.

Wraga and Hlebowitsh (1991) have defined STS as a topical curriculum that addresses a broad range of environmental, industrial, technological, social and political problems including (but not limited to) the following:

* Acid rain
* Air quality
* Deforestation

contested epistemological and pedagogical terrain. Since "multicultural education" has come to have many different meanings and conceptualizations during its evolution from the civil rights era of the 1960s to the present time, it is important to provide clarification regarding the different definitions, goals, assumptions and principles of multicultural education and their manifestations in multicultural science education.

Burnett (1994) has proposed a typology of multicultural education, comprised of programs which are broadly divided into three categories according to their primary emphasis. *Content-oriented* programs are the most common and immediately recognizable variety of multicultural education. Their primary goal is to include content about different cultural groups in curriculum and educational materials in order to increase students' knowledge about these groups. In its most fundamental form, this type of program adds a multicultural "piece" to a standard curriculum, perhaps incorporating a number of assignments or a few in-class celebrations of cultural heroes and holidays within the school year. Other versions of content-area programs take a more thorough approach, adding numerous multicultural materials and themes to the curriculum. More sophisticated versions of content-oriented programs actively transform the curriculum by seeking to develop multicultural content throughout the disciplines; incorporate a variety of different viewpoints and perspectives in the curriculum; and transform the canon, ultimately developing a new paradigm for the curriculum (Banks, 1994). In the science curriculum, a content-oriented multicultural science education program might, for example, include a component which acknowledges and studies the contributions to industrial chemistry made by the ancient Egyptians and Mesopotamians over 5,000 years ago (see for example, Williams, 1984; Hernandez, 1989; cf. Madrazo's [1991] stage of *addition* in the multicultural science teacher continuum).

Based on the concept of multicultural education as an effort to reflect the growing diversity of America's classrooms, many programs move beyond curricular revisions typical of content-oriented programs to specifically address the academic needs of carefully defined groups of students, often minority students (Burnett, 1994). Banks (1994; 1998) notes that while curricular

programs primarily attempt to increase the body of knowledge about different ethnic, cultural and gender groups, *student-oriented* multicultural education programs are intended to increase the academic achievement of these groups, even when such programs do not involve extensive changes in the content of the curriculum. According to the description provided by Sleeter and Grant (1993), many of these programs are designed not to transform the curriculum or the social context of education in particular, but to assist culturally or linguistically different students make the transition into the educational mainstream. In so doing, these programs often utilize the varied linguistic and cultural backgrounds of their students. What results is that student-oriented programs may adopt many different forms, some of which are not typically thought of as types of multicultural education. Banks (1994) has described four broad program categories which serve as characteristic examples of such student-oriented programs, e.g. programs that use research into culturally-based learning styles in an attempt to determine which teaching styles to use with a particular group of students; bilingual or bicultural programs; language programs built upon the language and culture of African-American students; and special math and science programs for minority or female students. Due to this variety (and because such programs attempt to help students make the transition into the mainstream) many student-oriented multicultural education programs can be viewed as being compensatory in nature. Indeed, such programs might often be practically indistinguishable from other compensatory programs which may or may not be multicultural in their emphasis (Burnett, 1994). In the science curriculum, a student-oriented multicultural science education program might, for example, provide science content classroom instruction in languages other than English for those students who do not speak English as a first language. The epistemological and pedagogical rationales here would be that these students should be given opportunities to utilize the cognitive and linguistic "tools" at their disposal in order to construct viable, contextual and experiential understandings of science. Such a perspective opposes the typical *modus operandi* in many U. S. science classrooms where learning and achievement in science are predicated on the mastery of English-only science vocabulary (see for example, Rosebery, Warren & Conant, 1992; Gallard &

Tippins, 1994; Lee, 1997; 1998).

Socially-oriented programs are the third type of multicultural education program described in the typology proposed by Burnett (1994). Generally, these types of program seek to reform both schooling and the existing social, cultural and political contexts of schooling. The aim is not simply to enhance academic achievement nor to increase the body of multicultural content knowledge in the conventional school curriculum, but to have the much broader impact of increasing cultural and racial tolerance and reducing bias. Sleeter (1992) and Sleeter and Grant (1993) extend this type of multicultural education to include a much broader spectrum of programs with socially-oriented and social activist goals. The programs they advocate (i.e. those emphasizing intellectual pluralism and cultural equity in society as a whole and not only within the schools) are much less common and potentially much more controversial. Many emphasize the application of critical thinking skills to critiques of racism, sexism and other repressive aspects of society; some emphasize multilingualism; others attempt to examine issues from a large number of epistemological perspectives, some of which may be radically different from those of the predominant culture; and others utilize cooperative learning approaches and decision-making skills in order to prepare students to become socially-active citizens (cf. Barba, 1998). In the science curriculum, a socially-oriented multicultural science education program might, for example, emphasize the study of history and philosophy of science (HPS), in a manner that integrates science content with relevant STS issues (see, for example, Stinner & Williams, 1998). Such an approach would focus not only on required science content, but also would challenge students to explore and critique how contemporary canonical science as a way of knowing has evolved and developed in the contexts of various sociocultural, epistemological and political paradigms.

As a university level science educator responsible for the professional preparation of K-12 science teachers, I subscribe to a socially oriented perspective of multicultural science teacher education. This perspective places joint emphasis on preparing science teachers who possess a comprehensive understanding of canonical science content together with a highly developed

level of scientific literacy and the ability to make reasoned, informed judgments about the influences and impacts of science in everyday life (cf. Carson, 1998; Stinner & Williams, 1998). My conception of multicultural science education also reflects the "multiculturalism as a process" definition (Banks & Banks, 1997; Boutte, 1999). The enterprise of "science", as a way of thinking about and making sense of the world can be traced historically and shown to have multiple and complex cultural, social, economic and political underpinnings which all interrelate (see, for example, Wiener & Noland, 1957; Proctor, 1991; Allchin, 1998); therefore, I take the perspective that a sound, quality program of professional preparation in science education (which includes an understanding of the development of scientific philosophies, theories, laws, principles and applications) *necessarily* must be multicultural.

Addressing Multicultural Issues in Four Science Methods Classes: Data, Findings and Analysis

The University of Central Florida (UCF) is a four-year college, and part of an extensive state system of community colleges and universities. Approximate enrollment figures for the 1997-1998 academic year were 2,500 undergraduates and 1,300 graduates in the university's College of Education. The majority of students in the College of Education major in elementary education (approximately 60%) and many graduates remain in the central Florida area, teaching in local schools.

Over the course of the calendar year Fall 1997 to Fall 1998, I taught four undergraduate level science methods classes. Although an additional two sections of a graduate (Master's) level science education course were taught in the Summer 1998 semester which also explored a number of multicultural issues relating to science teaching and learning, I will focus only on the undergraduate level classes (predominantly preservice teachers) for the purposes of the present analysis.

SCE 3310, *Teaching Science in the Elementary School*, is the elementary science methods course, designed specifically for elementary education majors. It is a required course for the baccalaureate degree in Elementary Education, and accounts for 3 of the 9 credit hours of science coursework contributing to the 120 credit hour requirement for the

degree. SCE 4360, *Science Instructional Analysis*, is the secondary science methods course, and is a required course for the baccalaureate degree in Science Education (with specializations in biology, chemistry or physics, respectively). The course accounts for 4 of the 38 credit hours of science specialization coursework contributing to the 120 credit hour requirement for the degree. Typical students in this class are preservice middle/high school science teachers intending to specialize in integrated science, biology, chemistry or physics, or are postbaccalaureate inservice science teachers needing middle/high school science certification or recertification.

Class Demographics

SCE 3310, Fall 1997:

Number of students, 30 (females, 26; males, 4); Minority students, 3 (1 African-American female, 2 Hispanic females).

SCE 4360, Spring 1998:

Number of students, 12 (females, 8; males, 4); Minority students, 5 (1 African-American female, 2 Hispanic females, 1 Hispanic male, 1 Native American female).

SCE 3310, Summer 1998:

Number of students, 35 (females, 30; males, 5): Minority students, 6 (2 African-American females, 3 Hispanic females, 1 Asian-American female).

SCE 3310, Fall 1998:

Number of students, 60 (females, 49; males, 11): Minority students, 5 (3 African-American females, 1 Hispanic female, 1 Lebanese-American female).

Total number of students, N=137; Female students (elementary classes only), 84% Minority students (all classes), 14%.

Class Assignments Dealing with Multicultural Issues

In addition to class discussions/debates which occurred relating to various multicultural issues (e.g. multiple intelligences; learning/cognitive styles; culturally relevant pedagogies; culturally fair testing and assessment; Eurocentric vs. Afrocentric science curricula, etc.), the most

frequently employed manner of eliciting deliberately considered student responses to multicultural issues impacting the teaching and learning of science was through the use of reaction paper assignments. A description of the format for reaction paper assignments is reproduced below (Figure 1):

Figure 1
Format for Reaction Paper Assignments in SCE 3310 and SCE 4360

Reaction papers are reviews of journal articles, books, book chapters or other reading assignments which are intended to elicit your reactions and reflections.

This structured response is divided into three categories which closely resemble Bloom's Taxonomy of the domains of learning -- the cognitive, the affective and the psychomotor. The main difference here is that the 3-R format deals with the reaction of the affective domain first, rather than the cognitive as does Bloom. The rationale for the difference in placement is to increase your awareness of affective response, and then to address the cognitive merit of the learning regardless of the positive or negative affect with which it is associated. Please include the following in your papers:

1. *Reaction (affective domain, to feel).* What was your affective response to the material you read (favorable, unfavorable, mixed)? Cite at least one example from the text that illustrates your response.
2. *Relevance (cognitive domain, to think).* How is the article or text related to the issue at hand, and how is it related to other readings and discussions in this course? How is the article meaningful, or how does it contribute to your understanding of the course material and/or issues being discussed? What are some alternative points of view? Cite examples from the text to support your perspective.
3. *Responsibility (psychomotor domain, to do).* How will the knowledge or perspectives gained from this reading be used in your professional practice? Give at least one example of possible application to your personal or professional life, or explain why you think this information is not useful. What are some questions you still have regarding this topic?

Reaction papers were based either on portions of the representative texts indicated below, or the complete texts where appropriate (see References):

SCE 3310 (Fall, 1997): Reaction papers to selected portions of Ogbu, 1978 and Ogbu, 1995 (voluntary and involuntary minority students and implications for academic performance in school); Banks & Banks, 1995 (definition and implications of multicultural education for science teaching and learning).

SCE 4360 (Spring, 1998): Reaction papers to Rodriguez, 1997 (critique of the National Science Education Standards); Banks & Banks, 1995 (definition and implications of multicultural education for science teaching and learning); Ladson-Billings, 1994 (issues and implications for science teaching and learning of culturally relevant pedagogies).

SCE 3310 (Summer, 1998): Reaction papers to Rodriguez, 1997 (critique of the National Science Education Standards); Banks & Banks, 1995 (definition and implications of multicultural education for science teaching and learning).

SCE 3310 (Fall, 1998): Reaction papers to Madrazo, 1998 (diversity issues in the science classroom); Banks & Banks, 1995 (definition and implications of multicultural education for science teaching and learning).

Findings and Analysis

A cursory examination of the demographic information above provides good support for the findings of the research literature cited in Atwater (1996): most prospective elementary teachers continue to be White, female and middle class, and it is still comparatively unusual for males to enter the field of elementary education. People of color continue to be underrepresented in both prospective and practicing teaching pools, even though there has been a substantial increase in the number of students of color in the nation's schools (pp. 3-4). Allowing for the fact that the information above represents just one calendar year of courses taught by one member of faculty, it is nevertheless interesting to note that no African-American males were enrolled in any of these science methods courses.

Below are seven selected excerpts from reaction papers providing a cross-section of student responses to articles or other texts addressing multicultural issues in science teaching and

learning. Selection of the excerpts was based on the range of responses over the course of the Fall 1997-Fall 98 calendar year of which they are representative and also on the stated willingness of the students in question to allow their responses to appear in this paper. The responses are reproduced *verbatim*, and begin to provide some insight into the thinking and attitudes held by these students toward multicultural science teacher education.

SCE 3310, Fall 1997 (Student A, White male):

> Before the debate on multicultural education begins, should it not first be given a clear cut definition of what it entails, along with any and all current subsets of its definition? Is it simply to plan teaching lessons and strategies to transcend any and all learning barriers due to cultural differences, or does it go farther than that? According to his 1994 book Multiethnic Education", James A. Banks lists 5 different dimensions of multicultural education, ranging from the construction of knowledge process to prejudice reduction. Perhaps it is more than just adapting lesson plans for cultural differences. The successful and effective teacher has been molding and adapting his/her classroom and lessons to meet the needs of individuals long before the P.C. buzzwords of multicultural education. Have we not had enough of the "victim" in education? And have we not had enough of labeling minorities to receive different- sometimes earlier, sometimes more- instruction than the rest of the field? This went into full swing with the Johnson Administration, and with a few microcosms of success, has not worked.
>
> There have been 2 or 3 generations of minorities who have received this additional educational treatment, so why do we still need to do more? [ ] This country was founded, and grew with astounding fervor, by its united spirit, a common united American spirit. Look what the current spirit is doing to the country now. There is no need to surrender your heritage, your history, your culture, but this is America, not someplace else. Not yet, anyway.

SCE 4360, Spring 1998 (Student B, Hispanic female):

My affective response to this article is mixed. I respect Dr. Rodriguez' argument that the NRC uses a discourse of invisibility to lay out its massive reform for science education in the United States. However, I think he is giving too much emphasis to the ethnic part. Like Dr. Rodriguez I am also from Hispanic origin and I see the effort of the education system to try to incorporate the multicultural diversity in our schools. He mentions in page 21 (third paragraph), that words like Latinas and Latinos, African Americans, Asian Americans, and/or First Nations Peoples are not mentioned through the entire document. I don't see the necessity to do that. I think that we don't need to be dividing people by ethnic groups, especially our students, when we talk about them. In my opinion, this will cause more division between people. We don't need more of that. We need to focus in the things that unites us not the ones that divides us. [ ] The knowledge gained in this article will not be used in my future professional practice. I don't agree that the science education standards are framed in a discourse of invisibility. I have noticed a big emphasis in multicultural education in our system. But like I said before, I respect Dr. Rodriguez' point of view. I see more positive aspects to the National Science Education Standards than negative.

SCE 4360, Spring 1998 (Student C, White male):

Learning more about multicultural education and multiculturalism has been an interesting educational experience, especially in a science methods class! It is good that you give us the opportunity to argue and to agree or disagree in class - this is what developing critical thinking skills is all about. However, I must say that I feel uncomfortable with being asked to incorporate all of this "multiculturalism" into my teaching. I am a chemistry teacher, and I get paid to

teach chemistry, not social psychology, not sociology, not anthropology, but chemistry. I can see the relevance to chemistry of the STS approach we talked about in class, but I feel that much of the pro-multicultural perspectives we read about are better directed to social workers or guidance counselors or to school psychologists. That's their job, i.e to raise students' self-esteem and to make sure that diversity issues in the school are dealt with appropriately and so forth. I teach kids chemistry.

SCE 3310, Summer 1998 (Student D, White female):

When I began reading this paper, I had an unfavorable reaction. As I continued to read, I began to have mixed feelings. Certain parts I agreed with and others I felt strongly about. I certainly agree that students need to have an integrated and diverse education. I do not think that minority students learn differently than non-minority students and I do not think that a teacher should have to work their classroom around the sensitivities of minority students as mentioned in the article. I do not feel students think they are being excluded because a lesson is revolved around an American society. Each student, minority or not, is a different learner. They all have a culture and to only pay attention to the "sensitive" ones is also neglect. The article also makes reference to learning each child's learning style and I do think this is very important because, as I mentioned, each child is going to have a unique way of learning. People are still going to be able to live and work in a diverse society even if you do not present each subject with a careful cultural thinking.

SCE 3310, Fall 1998 (Student E, African-American female):

After reading the article "Embracing Diversity" I have come to better understand what exactly is necessary to create a multicultural learning

environment. I had some mixed feelings about the issue at hand, but more favorable than not. I especially agreed with the line that stated "ethnic identity and cultural, social and economic background of students are as vital as [students] physical, psychological and intellectual capabilities". This is something that I feel is often ignored. We are a country who place a lot of emphasis on our standardized testing scores, but those type of examinations often don't take into account the personal beliefs and experiences of the students taking them.

SCE 3310, Fall 1998 (Student F, White female):

I have mixed feelings about the article, "Discrimination," by Gerry M. Madrazo Jr. My initial thought was that people are emphasizing multicultural education way too much. I definitely believe in an "equal opportunity to learn", but I must be a very ignorant person. I know that discrimination occurs, but I don't think I realize how often it occurs. Before I read the paper, I really didn't see the need or validity for this education. Also, I didn't feel that multiculturalism has any relevance in science. Gravity is just as strong in Canada as it is in Ethiopia. Though I felt that multicultural education was a waste of time, after reading the article and discussing it in class I have come to a new understanding of its importance.

SCE 3310, Fall 1998 (Student G, White male):

The article titled "Diversity" gets under my skin in a big way. I think the term multicultural education was thought up by a group of elites to spark a sense of fear into educators so they don't seem to be racist. I don't think any teacher of mine ever took the time to configure their lesson plans to fit their students, myself included.

Overall, a greater level of resistance to the concepts of multicultural education and multicultural science teacher education was noted especially in the secondary level course. In open class discussions with these students, their rationale for this resistance was that they were more 'content oriented' at their instructional level (see Atwater, 1996, p. 4), and perceived that consideration of multicultural issues had little or no relevance to a middle/high school science curriculum. Student C for example, found it extremely difficult to think about relating chemistry content to multicultural issues in his teaching, and adopted the perspective that there was no place for "..... the highly subjective whimsies of multiculturalism in the objective world of chemistry". When probed a little further about part of his written response, "I can see the relevance to chemistry of the STS approach we talked about in class.... ", he explained that as a chemistry teacher, he could "see" chemistry everywhere in the world around him and wanted his students to gain an appreciation for the vast impact that industrial chemistry, for example, had on their everyday lives. When probed even further about the possibility of industrial chemistry having largely negative impacts on specific sectors of society (the example used being that of the disproportionate level of toxic waste or by-products being disposed of in minority neighborhoods or in so called "Third World" countries), his answer was revealing: "That's politics. I don't want to get into that in my classroom. That's not my job as a chemistry teacher". Student C was obviously scientifically literate in the sense that he could relate science content knowledge to many aspects of everyday life, but was reluctant to use his scientific literacy as a tool to analyze underlying and important social issues.

A distinctly lower level of resistance to the concepts of multicultural education and multicultural science teacher education was noted in the elementary level classes (possibly a function of these students being much less content oriented, and relatively uncomfortable with science content), although the notion of multicultural science education still seemed to be a difficult one to consider. Essentially, criticisms of incorporating multicultural issues into science education were encapsulated by the following question: "Are we teaching *science* or merely another education "feel-good" concept?" Student F, for example, was very conscious of her

comparative lack of science content knowledge and was keen to learn more science content and ways in which she could effectively teach science at the elementary level. Like Student C, she also questioned the relevance of incorporating multicultural issues into a science methods course and initially voiced the opinion that this detracted from what she had enrolled in the class to do, i.e. learn how to teach science. Unlike Student C, Student F was willing to use the scientific literacy she possessed to begin thinking more deeply about the ways in which science (and specifically, the ways in which it is taught) may have positive or negative impacts on different types of students. Interestingly, when asked why she had incorrectly referred to the title of Madrazo's (1998) article as "Discrimination" (see above), her response was that the article made her realize that the manner in which teachers decide to design and implement their instruction has an effect on which students are likely to be successful, and which are likely to fail. In her assessment, this was a form of discrimination (unintended or otherwise) and was something she had not thought about until being asked to consider the relevance of multicultural issues in science teaching and learning.

Students in the four classes appeared relieved that they were encouraged to give their *real* opinions in class discussions and in the formal reaction papers without threat of reprisal simply for disagreeing with the philosophical stance of the professor. Unfortunately, it appears from an analysis of these four classes over the past year that many preservice teachers simply "jump through the required hoops", and regurgitate the "multicultural mantra" without really believing in it, but simply as another requirement to be checked off in order to obtain teacher certification. This becomes an issue of some concern when one considers that the central Florida region (in which many of these preservice teachers will teach) has a very high proportion of ethnically, culturally and linguistically diverse K-12 students whose specific educational needs must be addressed by adequately prepared teachers.

One of my explicit goals in exposing my students to issues of multiculturalism in science teaching and learning is to emphasize the concept that teaching is a political act. How and what one teaches is the result of a conscious or unconscious political decision. Pinar, Reynolds,

Slattery and Taubman (1996) suggest that no serious curriculum scholar at the present time would advance the argument that schools in general and curriculum in particular are politically neutral (p. 244); however, many preservice and inservice science teachers with whom I interact seem to believe (before it being pointed out to them in my methods classes) that the school curriculum is politically neutral, or even apolitical. Nieto (1992) points out that knowledge (of any kind, including scientific knowledge) is neither neutral or apolitical, yet many schools and educators continue to treat it as if it were. Consequently, educators tend to present knowledge of the lowest common denominator, that which is sure to offend the fewest and is least controversial. However, history is full of debates, controversies and ideological struggles (e.g. the current debate over the canon and cultural literacy versus multicultural literacy) and educators must understand that all decisions that they make, regardless of how neutral they appear, impact in unconscious, but fundamental ways on the lives and experiences of *all* students (Nieto, 1992). Consistent with my socially oriented perspective of multicultural science teacher education and in seeking to emphasize to my students the political nature of teaching, at the conclusion of the respective elementary and secondary level courses, students have engaged not only with science content and science pedagogy, but also have begun to reflect more deeply about some or all of the following epistemological considerations:

* What is human knowledge? How and by whom is it validated and given credence?
* What is distinctive about scientific knowledge?
* Is Western science just one among many equal sciences?
* In what sense is science objective?
* How does science relate to mathematics and other areas of human knowledge?
* How do metaphysics, or worldviews, affect the creation and learning of scientific knowledge?
* Is science value free?
* Is there a feminist way of knowing?
* Do scientific theories make claims about an ontological world or about human perceptions and experience? (adapted from Matthews, 1998, p. 983)

Successes, Challenges and Possibilities

As a result of the issues, discussions, debates and formal assignments resulting from the classes, most students, especially younger undergraduates or preservice teachers (usually under 25 years of age) appear demonstrably more receptive to the concepts of multicultural science education and appear to demonstrate a deeper level of theoretical and practical understanding of the act of teaching. I am beginning to observe and hear reports of this being played out in their classroom internships where some students are attempting to explore a wider variety of approaches and techniques to teach science. It has been encouraging to note that more of an effort is being made by these preservice teachers to understand the varied social and cultural backgrounds from which their students come, which in turn positively influences their instructional decisions in the classroom.

Older undergraduates, postbaccalaureate students and inservice teachers (generally, over 25 years of age) tended to question the tenets and rationales of multicultural science teacher education more thoroughly than their younger classmates (which is certainly encouraged), and also tended to take the perspective that multicultural education is *not* a necessary component of the elementary or secondary science curriculum. Typical comments elicited in class debates (all classes) included:

* "It's more watering down of the science content, isn't it?"
* "There's a danger of reverse racism if you take this too far".
* "It's discrimination against the White mainstream". *(Usually prefaced by "No offense Dr. Sweeney, but...")*
* "This undermines the entire American ideal of *E pluribus unum*".
* "This creates more so-called victims of circumstance in the schools,... if they can't learn the same things as everyone else then that's their problem. They'll have to learn to sink or swim".

For these pre- and inservice teachers, it seemed very difficult to conceive of the curriculum as a political entity and of teaching as a political act. Science teaching in particular tended to be

perceived as the straightforward and uncomplicated transmission of '.... the scientific knowledge which they'll [i.e. their students] need to survive in modern day society'.

Whether cynical or accepting of multicultural education as a legitimate part of the science curriculum, there are promising possibilities which result from asking these students to engage in a dialogue about this and related issues. From my perspective as a science education professor, encouraging prospective and inservice science teachers to analyze more deeply the hows and whys of their teaching is likely to result in some level of improved professional practice (Nichols, Tippins & Wieseman, 1997) which has obvious implications for K-12 science education and scientific literacy in the general population. Continuing dialogues in science methods classes such as these also might be a means of attracting traditionally underrepresented populations into the fields of science and science teaching, if science is perceived by them to be both relevant and applicable to their lives.

Multicultural and STS issues in Science Methods Courses:

A Representative Activity*

The following activity is used in my elementary and secondary science methods classes to illustrate how a relatively simple chemical concept (the use of indicators to signal a predominantly acidic or basic solution) may be used as a means of introducing the relevance of multicultural/STS issues to science teaching and learning.

Probability/Dynamics of HIV Transmission

Instructional objective:

Students will demonstrate and understand the dynamics of how *Human Immunodeficiency Virus* (HIV) is transmitted.

Grade level and subject area:

Upper elementary to high school; biology, chemistry, social studies*

* Source: Adapted from *Teacher Talk*, published by the Center for Adolescent Studies at the School of Education, Indiana University, Bloomington, IN. Accessed on-line at http://education.indiana.edu/cas/tt/v1i3/earth.html.

Resources and materials:

Disposable cups, a base and phenolphthalein.*

Activities and strategies:

1. The teacher distributes a cup (half full of water) to each student. At least one student unknowingly receives a cup with the "AIDS virus", which can be any base, e.g. a small amount of baking soda or baking powder dissolved in water or a weak solution of aqueous sodium hydroxide

2. Students are asked to write on a piece of paper their 5 favorite foods; cars; types of music; and hobbies. The students then mill about the room interacting with other students, and exchanging a small volume of their water whenever they meet a person with similar interests to their own. (In a class of about 30 students, each student typically will exchange volumes with at least 10 other people). Finally, the teacher will go around the room and add a drop of the indicator, phenolphthalein, to each cup. Those cups which have been "infected" with the base will change from a clear to a deep pink color.

3. This activity can be followed by a discussion or serve as a bridge to other activities. The teacher can explain that the activity models the mechanism of transmission of the "AIDS virus" and that while it was unclear who was initially infected, many people were subsequently exposed to the disease.

Post-activity Discussion: Teaching Science Content and Multicultural/STS issues

As a method of introducing and teaching science content material (in this case, chemistry) the color change which occurs in this activity indicates the occurrence of an acid-base reaction. Depending on the level of the class, the mechanics of the reaction will be discussed using either the structural formula of phenolphthalein, or by using a schematic to represent the acid (H-X) where H indicates a dissociable proton. The very vivid color change sets the stage for defining the terms *acid* and *base*, which tend to be confusing for many elementary level teachers. The

discussion can then be led quite naturally into related concepts such as the *pH scale*, *exponential notation, neutralization, molarity, protons and hydronium ions, reactant-product equilibrium*, etc., and the depth of complexity appropriately modified for the target audience.

As a simulation model for HIV transmission, the activity is extremely effective in allowing students to see just how easily one "infected" person subsequently "infected" everyone else in the class. The activity usually generates a heated debate when I pose the question "Should this activity be used to teach about HIV transmission, or simply of any communicable disease as innocuous as the common cold?" Preservice elementary level teachers especially felt very uncomfortable with the idea of broaching such issues with elementary age students; the secondary level preservice teachers were approximately evenly divided both for and against the idea of using this activity specifically to teach their middle and high school students about HIV transmission. Should a social issue such as this be a legitimate curricular concern for the science teacher, or should this exclusively be the purview of the social studies curriculum, or of school social workers?

To stimulate discussion, students are asked to read and respond to a handout which I have prepared for this part of the activity (reproduced below in Figure 2).

Figure 2
NABT Position Statement: The Role of Biology Education in Preventing the Spread of AIDS
(adopted by NABT Board of Directors, 1990)

Since the first reports of its occurrence in 1981, Acquired Immunodeficiency Syndrome (AIDS) has grown to an epidemic of major proportions, both in the United States and abroad. The impact on individuals, families and society is profound. In the absence of effective treatment and cure, *experts in all areas of biomedicine and healthcare agree that education holds the most promise for controlling this deadly disease* (my italics). The National Association of Biology Teachers (NABT) believes that biology education must play a central role in this important effort. Biology education *at all levels of instruction* (my italics) should help to develop and improve understanding of the many dimensions of the AIDS epidemic by stressing the importance of topics which include the following:

* The role of the immune system in the protection of the individual;
* The natural history of AIDS;
* Patterns of HIV transmission;
* Behaviors associated with transmission; and
* Implications for prevention.

(Adapted from National Association of Biology Teachers, 1990).

In the class discussion which follows, students and I debate the importance and legitimacy of using this activity in upper elementary-high school classes as a means of exploring multicultural and STS issues in science education. The following information serves as an example of additional material which also is provided in order to make the issues at hand "real" and to encourage further conceptual exploration of the relevance (or not) of multicultural and STS issues in the science curriculum:

> Florida has one of the highest rates of HIV infection in the United States. Since July 1997 when name reporting began in Florida through February 1998, 4,123 people have been reported as infected with HIV. This means that approximately one in 172 people in Florida are estimated to be HIV positive. AIDS is the number one killer of nonwhite women aged 15-44 in Florida (North Central Florida AIDS Network, 1998).

In addition to clarifying the difference between HIV and AIDS (a pertinent example of scientific literacy; many students do not distinguish between the two), important questions and concerns arising from the class discussions include:

* Why are nonwhite women in Florida aged 15-44 so particularly at risk from AIDS?
* Are certain sectors of the upper elementary-high school student population more at-risk than are others, and why?
* The incidence of a widespread "drug culture" in some schools and its impact on the spread of HIV infection/development of AIDS (e.g. unhygienic use of needles in intravenous heroin

use).

* Adolescent/preteen/teenage pregnancy and sex education.

From a socially oriented multicultural science education perspective, it is apparent that substantively addressing these questions and concerns necessitates an understanding of the various cultural, social, economic and political factors contributing to these issues. Not only should science teachers be able to provide an appropriate level of content instruction in general science (including human biology and biochemistry) which educates these populations in preventive measures, we also should be able to modify and tailor that instruction in ways which are meaningful and applicable to the specific populations being served. From an STS perspective, addressing such social issues becomes, by definition, an exercise in promoting a greater level of scientific literacy since students are being taught how to understand and use science for improving their own lives.

Multicultural Science Teacher Education: Future Challenges for Teaching and Research

Given the demographics concerning the 'changing face' of K-12 students in this country's public education system (Hodgkinson, 1992; National Center for Education Statistics, 1997a; 1997b), it would seem prudent that the knowledge base for teacher preparation be founded firmly on what is known about multicultural education and teaching diverse populations. This is especially pertinent in the fields of science education and science teacher education, where practitioners at all levels typically have found it difficult (both conceptually and procedurally) to incorporate issues of multiculturalism and student diversity into their instruction. If we do indeed subscribe to the professional ideal that "science is for all students" (National Research Council, 1996, p. 20), then the formulation of such a knowledge base for science teacher preparation requires a synthesis of existing knowledge about multicultural science teacher education together with a comprehensive determination of what needs to be known. This study has sought to address some of these concerns by describing the successes, challenges and possibilities which have arisen from an intentional and sustained incorporation of multicultural and STS issues in science teacher education courses. It is hoped that this study might prove to be

a stimulus for further, more comprehensive reform-oriented research into understanding and addressing the educational challenges here indicated.

In anticipation of these efforts toward reform, it becomes possible to envision the continued development and sophistication of a knowledge base, elucidation of philosophical positions and subsequent improvement of pedagogical practices which will become the framework for a transformation of science teacher education in America from monocultural to multicultural comprehensiveness. Ultimately, this will lead to the provision of better, more meaningful science education experiences for not just a select few, but for *all* types of learners in our systems of education.

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