Balancing the equity equation: The importance of experience and culture in science learning

"All students, regardless of sex, cultural or ethnic background, physical or learning disabilities, future aspirations, or interest in science, should have the opportunity to attain high levels of scientific literacy… In particular, the commitment to science for all implies inclusion of those who traditionally have not had encouragement and opportunity to pursue science—women and girls, students of color, students with disabilities, and students with limited English proficiency. It implies attention to various styles of learning, adaptations to meet the needs of special students and differing sources of motivation" (NRC 1996).

Students enter school with different degrees of experience, interest, and support from home in science and mathematics. The importance of environmental influences outside of school has been the focus of numerous studies that support the home's influence on science learning. Students who come from homes primed with experiences that parallel curriculum are able to immediately participate in a productive manner. The aggregated effect is that experiences provide the foundation for subsequent learning. It is the schools' responsibility to identify science deficits and provide appropriate instruction to students. By not recognizing student differences, schools foster existing inequities. Students generally reflect their neighborhood population in terms of ethnicity, family structure, home environment, language, extracurricular experiences, and achievement. This diverse composition creates challenges, as well as opportunities for teachers to tailor lessons to meet student needs.

FIGURE 1 Demographic statistics

- By 2010—just seven years from now—at least one third of the eighteen-year-olds in the U.S. will be African-American or Latino, compared with one-fifth in 1988.
- By the end of 2002, 85 percent of the new workforce in the U.S. were African Americans, Latinos, and Caucasian women.
- Seventy-five percent of all goods manufactured in the U.S. will be produced by automation; the fewer jobs that will be available will either be limited-skills jobs or high-tech skills jobs.
- The median science and mathematics level of African-American, Latino, or Native American high school graduates is less than sixth grade.

* ADAPTED FROM ANDERSON 1997 AND NCES 1997

Understanding diversity

Teachers need to consider that cultural background, family characteristics, and home environment often play a part in a student's academic participation, progress, and achievement. Typically, inner-city school teachers find that approximately 32 percent of their students are African American and nearly 25 percent are Latino (Anderson 1997; NCES 1997). Minority students are more likely than Caucasian students to live in poverty, single-parent families, and urban areas (see Figure 1). Further, ESL students may have trouble speaking and reading science content in English. These characteristics are risk factors for future academic difficulties (Sable 1998; Sable and Stennett 1998).

Research suggests that educational opportunities can occur in a variety of situations after school and during vacations, but ethnicity and socioeconomic background play an important role in student participation. Although students from low socioeconomic backgrounds gain scientific knowledge from participating in after-school and summer activities (Frailer and Morris 1998; NCES 1996), inner-city and limited resource schools offer fewer learning opportunities for their students. Thus, the after-school hours of lower income, minority students are often unstructured (Rittenhouse 1998).

A common concern of science educators is how these inequities of learning opportunities can be reconciled with the established curricula. Schools should examine the establishment of partnerships with institutions in their communities. This may include museums, zoological parks, and industries. In addition, the inclusion of programs such as 4-H, the Audubon Society, and local environmental agencies provide instruction that supplements the science curriculum. Middle schools may also develop educational programs that incorporate the service of high-achieving high school students to help promote after-school science clubs, science

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FIGURE 2 **Teaching with diverse populations**

1. Good teaching for urban students has been described as good teaching for all students (Haberman 1996). The scientific pedagogy should be oriented toward reciprocal interaction. In reciprocal teaching, the teacher initially takes on the role of coach, enabling students to develop questions. Feedback from the teacher is given through summaries of students' questions, comments, and work product.

2. The teaching of science should be infused with the culture and language. Teachers are encouraged to examine how different cultures approach and solve problems.

3. Printed materials that are visually formatted with graphs, pictures, and diagrams that reinforce declarative and procedural knowledge can aid in science understanding.

4. Awareness of, and sensitivity to, students' native languages and cultures can assist in building self-esteem, improve students' attitudes toward school, facilitate the acquisition of knowledge, and aid in English language development.

5. The community should be encouraged to work collaboratively with the school and science classroom. Schools should establish partnerships with community resources such as museums, zoological parks, and industries, thus broadening students' background with reality-based learning.

6. The use of collaborative groups and peer tutoring to assist in teaching new concepts helps to increase understanding.

7. The use of culturally familiar role models in books, videos, and other materials provides reinforcement of students' self esteem. This includes the acknowledgement of multiple cultures' contributions to the advancement of society.

8. The use of manipulative materials connects informal, or everyday, concepts with formal concepts learned in school.

9. Assessment practices should include tasks that are set in a number of contexts or situations that engage students with different interests and experiences. Assessment practices should not assume a particular group's perspective or experience, but should include methods that help teachers understand the quality and depth of students' knowledge.

10. The goal of science assessment should be one of advocacy, not legitimacy of failure. The real question that teachers should consider is: "What does the student know, or what can the student do in science?" The wrong statement is: "Based on this test score, the student does not know science concept X." Working from a model of strength rather than deficit, teachers can identify what students are able to do. Based on results of formative assessment, instruction can be modified to fit the needs of the students (Cummins 1986).

and mathematics Olympiads, and computer clubs as a community service. Further, the classroom experience may serve to promote career interest for future science teachers.

Equity and assessment

Assessing student achievement fairly is a challenge for informal science educators as well as classroom teachers, and both should be aware of assessment strategies that level the playing field for their students. For example, culturally diverse students who speak a language other than English consistently perform worse than native English speakers on standard measures of academic achievement (Barba 1998). The emphasis on textbooks and lecture puts these students at a disadvantage. To remedy this, teachers should consider an inquiry-based approach to helping students develop important scientific concepts. Doing so will allow the teacher to select a more appropriate means of assessment and to identify examples of students' everyday science knowledge. This requires teachers to be aware of the differences between traditional and alternative assessment.

While traditional standardized tests (e.g., California Achievement Test, Stanford Achievement Test, Iowa Test of Basic Skills) address the need to measure achievement in broad curricular areas, this form of testing may not recognize the diversity in background, culture, language, opportunity, and experience of all students. The misconception that students share the same life experiences may result in a systematic misrepresentation of achievement levels.

In contrast, alternative assessment tools allow the teacher to capture the distinctive nature of the student's thought processes. This type of assessment does not separate formal and informal science activities from methods of assessment. In its most effective form, alternative assessment embeds the evaluation of the student into the classroom activity. Effective alternative techniques include interviews, observing processes for constructing scientific ideas—such as construction of models, recognizing cause and effect, visual representations, and written work—as well as a number of other non-traditional procedures. Once the informal scientific construct has been identified, teachers can develop methods to foster an environment in which students can appreciate the connections between their informal and formal scientific activities. Teachers have the responsibility to become aware of the advantages of incorporating alternative assessment into their repertoire of effective testing techniques.

Research needs to inform classroom practice

Choosing science content for formal or informal science learning is another challenge that educators face. Two basic positions on a multicultural approach to achieving science equity have been identified—one promoting educational assimilation and the other promoting multicultural education. Schools that adhere to the first position provide students from varying backgrounds with a means of assimilating into mainstream culture. Conversely, a school that adopts a multicultural approach fosters "cultural pluralism and social equity by reforming the school program for all students to make it reflect diversity" (Sleeter and Grant 1987).

"Goodbye Pythagoras" and "So long Newton" are some typical cries from individuals in the science world who question a multicultural approach, fearing that changing the curriculum will rob it of concrete science lessons. Although some educational researchers may support the inclusion of multicultural contributions, they remain skeptical of wasting students' time with lessons of little value to the dominant culture. Critics claim that there is little data to support the idea that a multicultural approach improves the number of students who take science courses (Greene 2000).

The dichotomous relationship between a more traditional approach to science teaching and a multicultural perspective in science teaching is in dire need of reexamination and focus. Without this process, the arguments continually fail to address the critical problem:

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- What is the best method for underrepresented students to learn science, and
- Does presenting a science concept by embedding it in a particular cultural milieu improve science learning?

Empirical data need to be gathered to support any claims of greater achievement in science education. The results should be that both teachers and students have greater scientific ability, improved interest levels in studying science, and an understanding of everyday science. ■

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