Science Learning for **ALL**

Celebrating Cultural Diversity

An NSTA Press Journals Collection

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Acknowledgments

The National Science Teachers Association (NSTA) is devoted to promoting excellence and innovation in science teaching and learning for all. *Science Learning for All: Celebrating Cultural Diversity*, which represents the best articles of five years of *The Science Teacher*is multicultural issues, aims to help educators include all students in science education.

This collection was developed by *The Science Teacher* staff and the NSTA Committee on Multicultural/Equity in Science Education. Shelley Johnson Carey (Director, Periodicals Publishing, NSTA) and Janet Gerking (Editor, *The Science Teacher*) selected the articles. Committee members Connie Cook Fontenot (Bethune Science Academy, Houston, Texas), Ellen Gaylor (Iolani School, Honolulu, Hawaii), and Elizabeth Hays (School of Natural and Health Sciences, Barry University, Miami, Florida) reviewed the articles and offered valuable feedback about resources and connections to the *National Science Education Standards*.

Jessica Green was the project editor for *Science Learning for All: Celebrating Cultural Diversity*. Beth Daniels and Michelle Chovan also provided assistance and advice in developing this compendium. Linda Olliver designed the book and the cover, Nguyet Tran did book layout, and Catherine Lorrain-Hale coordinated production and printing of the book.

NSTA Position Statement on Multicultural Science Education

Preamble

Science educators value the contributions and uniqueness of children from all backgrounds. Members of the National Science Teachers Association (NSTA) are aware that a countryís welfare is ultimately dependent upon the productivity of all of its people. Many institutions and organizations in our global, multicultural society play major roles in establishing environments in which unity in diversity flourishes. Members of the NSTA believe science literacy must be a major goal of science education institutions and agencies. We believe that ALL children can learn and be successful in science and our nation must cultivate and harvest the minds of all children and provide the resources to do so.

Rationale

If our nation is to maintain a position of international leadership in science education, NSTA must work with other professional organizations, institutions, corporations, and agencies to seek the resources required to ensure science teaching for all learners.

Declarations

For this to be achieved, NSTA adheres to the following tenets:

- Schools are to provide science education programs that nurture all children academically, physically, and in development of a positive self-concept;
- Children from all cultures are to have equitable access to quality science education experiences that enhance success and provide the knowledge and opportunities required for them to become successful participants in our democratic society;
- Curricular content must incorporate the contributions of many cultures to our knowledge of science;
- Science teachers are knowledgeable about and use culturally-related ways of learning and instructional practices;
- Science teachers have the responsibility to involve culturally-diverse children in science, technology and engineering career opportunities; and
- Instructional strategies selected for use with all children must recognize and respect differences students bring based on their cultures.

ó *Adopted by the NSTA Board of Directors, July 2000*

Introduction

What is a ìmulticulturalî classroom? Classrooms, even if they are filled with non-majority students, are not necessarily multicultural. There are three elements necessary for a truly multicultural science-learning environment: first, the sense that all students can learn and do science; second, the view that each student has a worthwhile place in the science classroom; and third, an appreciation for the contributions of all cultures to our scientific knowledge (Atwater, 1993; Hays, 2001). *Science Learning for All: Celebrating Cultural Diversity* focuses on the need for multicultural science classrooms, and addresses what makes a culturally diverse science classroom a multicultural one.

The last two decades have seen increasing interest devoted to multicultural education. The National Science Teachers Association (NSTA) recognizes its responsibility and duty to promote quality science education to diverse student populations, and states that NSTAís mission is ìto promote excellence and innovation in science teaching and learning for all.î In the early 1970s, minority NSTA educators began meeting informally. About 1980, these NSTA members formed a group to address concerns of minority educators, equity in science education, and the growing interest in multicultural science education. This groupóoriginally named the Black Caucus but now known as the Minority Caucusócontinues to serve as an important avenue within NSTA for voicing concerns about multicultural science education.

In 1989, NSTA formed the Multicultural/Equity in Science Education Committee to review NSTA policies, programs, and activities relating to multicultural science education. The Committee developed the NSTA position statement on multicultural science education in 1991 and revised the statement in 2000 (see page vi). The Committee often solicits feedback from an associated group of the Minority Caucus, the Association of Multicultural Science Educators (AMSE). The two groups co-sponsor Share-a-Thons at NSTA conventions, where teachers share their lesson plans, ideas, and resources. The Multicultural/Equity Committee also reviewed the articles chosen for this collection and guided the development of this book.

Each year *The Science Teacher*, NSTAís journal for high school educators, devotes an issue to multiculturalism in science education. *Celebrating Cultural Diversity* represents the best of these multicultural issues of *The Science Teacher*. One of the articles in this book holds a personal connection for me. When I read ìTeaching Essentials Economically,î I was very impressed with author Joy Dillard, a young minority educator making a difference in a rural African American science classroom in an impoverished area. This teacher was modeling success against all odds. I wrote to her to express my feelings about her article and encouraged her to persevere because she was doing good science education in spite of her schoolís isolation and lack of resources. At my urging, and with the help of an AMSE mentor, Joy is becoming more involved with NSTA and AMSE to learn about and guide multicultural science education. Joy Dillard epitomizes the hard work and dedication of many science teachers striving to make a difference in their classrooms. It is for teachers like her that *Celebrating Cultural Diversity* was compiled.

The 17 articles in this book have been grouped into three sections: Curriculum Reform, Teaching Strategies, and Science and Language. Each article has also been reviewed to determine which of the *National Science Education Standards* are addressed (see Figure 1).

The Curriculum Reform articles help teachers evaluate the cultural inclusiveness of their science curricula. Three of the articles describe how and why schools can profit from the diverse heritage of the United States by developing a learning environment of understanding, respect, and multiculturalism. Educators are urged to emphasize student unity, equity, and diversity. The other articles give examples of how to change school policies, programs, and curricula to include all students in science education and to meet the learning needs of all students.

The Teaching Strategies section highlights techniques that teachers can adapt for their individual classrooms. Teachers learn to employ cultural knowledge, sensitivity, and interpersonal skills to maximize studentsí learning potential. The articles showcase innovative teaching programs that improve learning in diverse classrooms. This section also offers concrete teaching tips and practical suggestions for incorporating the diverse history of science into the classroom.

The final section, Science and Language, addresses the special concerns of learning the language of science while also learning English. The articles provide practical suggestions for integrating science with English, where English is a studentís second language. Science itself can also be seen as a second language, and the articles offer methods to help students acquire academic language and scientific vocabulary. All studentsóEnglish language learners and those already fluentóbenefit from a curriculum that emphasizes the in-depth teaching of concepts, process skills, and critical-thinking skills. When I teach science to non-science majors at the college level, I emphasize that part of being successful in science courses is learning the language of the field, and I suggest that students treat my course as they would a language course. This helps some students overcome the anxiety of science that is often brought to the college-science classroom.

Celebrating Cultural Diversity provides valuable ideas and strategies for bringing multicultural education to your classroom. The articles demonstrate that such an equitable classroom is inclusive, provides opportunities for all students to learn science, and shows students that people like them can make scientific contributions to improve our world. The reader should recognize that this book is a collection from one source, *The Science Teacher*, and reflects the articles written for this journal. There is much more that has been published and said about multicultural science education. Appendix B lists additional resources suggested by the Multicultural/Equity Committee; this collection represents just a small number of the resources available to help teachers meet the needs of the diverse student population in their classrooms. Enjoy these articles and resources, and make your classroom a true multicultural learning environment.

Elizabeth Hays, Director
NSTA Multicultural/Equity in Science Education Committee

Cultural——Inclusion

Where does your program stand?

SEPTEMBER 1995: A MEXICAN FAMILY just moved to a small Midwestern city where the mother had been recruited to be a professor at the state university. The father was employed as a teacher in a local school district. The mother accompanied her daughter, a sophomore, to the local high school for registration and counseling. The daughter was excited about the prospect of registering for a genetics course and an advanced biology course because of the excellent science experiences she had the previous year. The counselor ignored the daughter's desire to take the advanced biology courses and told her, "I believe you will be happier in the regular biology course because most girls are." The young lady has been bored because she has had much of the work previously.

April 1993: A lesson on the circulatory system was being conducted in a middle school classroom. As a part of discussion on blood transfusion and preservation, the contributions of Charles Drew were included. During this discussion the science instructor passed out photographs of Drew. An African American student in the class, on seeing the photos, exclaimed "Was Dr. Drew Black?" The instructor responded "Yes, he was." The African American student replied "He *couldn't* have been (Black) and *done* all those good things."

August 13, 1995: *Parade* magazine printed a short feature entitled "Recalling the Golden Age of Inventors," which focused on inventions created in the United States from 1850 to 1900. Several inventors—Samuel Morse, Thomas Edison, Elias Howe, Alexander Graham Bell—all white males, were depicted as receiving help from the *Scientific American* magazine patent office in applying for patents for their inventions. However, there was no mention of Jan Matzeliger, Elijah McCoy, Granville T. Woods, Andrew Jackson Beard, and Lewis Latimer, all well-known African American inventors of this period.

BY H. PRENTICE BAPTISTE AND SHIRLEY GHOLSTON KEY

These examples illustrate the need for implementing science that is multicultural. Science should be presented in a non-elitist, culturally diverse context that includes all students. Presenting science as a hands-on, activity-based, problem-solving instructional program couched in constructivist theory enables all students, including students of color, to excel in science.

When African American students were asked through a survey and interviews (Key, 1995) whether they prefer to study science topics relevant to their culture, they responded positively. Examples of potential science topics included in the survey were:

- Benefits of African American astronauts in space flights,
- The inventions of African American scientists and engineers,
- How African American inventions have affected society,
- The diseases of African Americans such as sickle-cell anemia,
- The diseases that affect Hispanic Americans, and
- The diseases that affect Asian Americans.

These kinds of culturally inclusive items were chosen at a much higher rate ($p < .001$) by students of color than items on the survey that did not specifically address their cultures.

TYPOLOGY FOR CULTURAL INCLUSION

The following typology can help science teachers evaluate and determine to what extent cultural inclusion is present in their science program. Cultural inclusion is

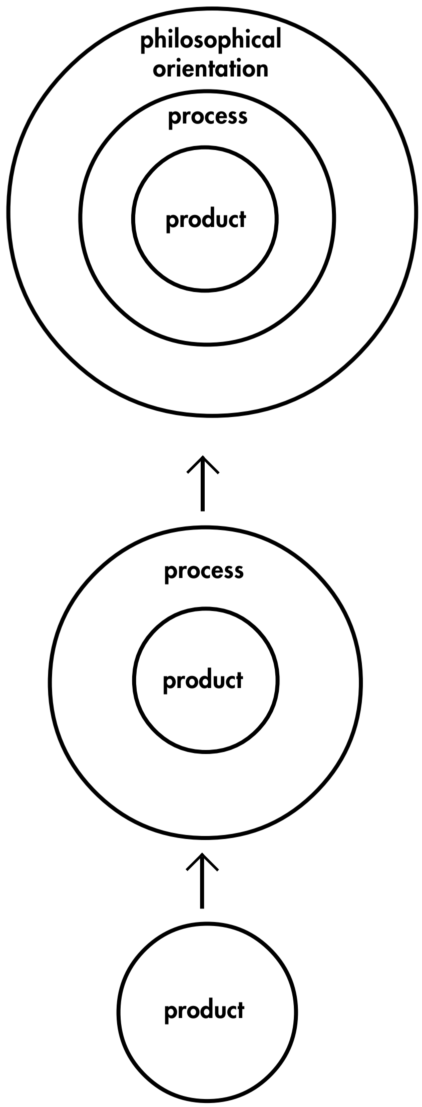
FIGURE 1.

Typology for multiculturalizing science.

Level III: Process/philosophical orientation. Science teachers must be social activists. They can help their science students promote equal opportunity, respect for those who differ, and power/equity among groups both in the school and in the local community. After teachers have internalized the parameters of Levels I and II, they actively design, develop, or seek out science programs that are truly antiracist and multicultural. Science instruction is then culturally inclusive with a commitment to the philosophy of multicultural science education.

Level II: Process/product. Infusion into science curriculum of diverse cultural perspectives and contributions to a science concept development and/or evolvement. Scientists of color and women scientist's experiences and contributions are tied into the teaching of science concepts and topics. Science instruction is commensurate with diverse learning and cognitive styles. Problem solving processes and scientific method are used in elucidating the faultiness of racial and sexual stereotypes, prejudices, and ethnocentrism. Contextual array of science content is permeated with diversity.

Level I: Product. Focus on scientists of color and women scientist's contributions, in isolation. Highlighting an ethnic or cultural group invention, discovery or contribution, or scientist of color birthday. Multicultural additions are made to the curriculum in merely an additive, superficial way. A science textbook might end each chapter with a vignette on a scientist of color. During African American History month, students might read isolated material about famous African Americans in the field of science.



the integration of the learner's culture into the academic and social context of the science classroom to aid and support academic learning (Key, 1995). It values cultural identity while promoting personal, human, and social development. Cultural inclusion is needed to develop competent science students who are socially responsible participants of a culturally diverse society where group identity is valued and preserved.

Cultural inclusion stresses changing science programs to make them culturally consistent, relevant, and meaningful to diverse populations. It helps to eliminate bias, to create a new standard of measure, and to provide equitable curriculum and pedagogical practices.

The typology of cultural inclusion (See Figure 1) is modeled after Baptiste's (1994, 1992, 1986) typology for assessing multicultural science education. The model has three levels, each encapsulating the previous one or ones. The model enables science teachers to determine the extent that currently used instructional strategies, curriculum, textbooks and other resources, activities and laboratory experiences reflect an internalization of cultural inclusion. Each level has a distinct set of characteristics and represents a qualitative level of accomplishing cultural inclusion.

LEVEL I

This level can be described as additive and tangible. Science experiences, perspectives, and contributions of people of color and women are presented in isolation or as additives to the regular science curriculum at Level I. Among science teachers, as with other teachers, this is the most popular strategy for multiculturalizing science instruction. The following topics are illustrative of Level I.

- Studying African American scientist Charles Drew's work on blood preservation and organization of the first blood banks in a biology class during Black History month as opposed to incorporating his scientific contributions into the curriculum lessons on blood and circulation. Studying contributions of the Mexican American physicist Luis W. Alvarez (winner of 1968 Nobel Prize in Physics) during May (Cinco de Mayo) or September (Mexico independence) as opposed to studying his contributions during the curriculum focus on subatomic or resonance particles.
- As part of the school's celebration of Native Americans' contributions, the science teachers use some of the following contributions and experiences of Native Americans: the Anasazi recorded the supernova of A.D. 1054 in paintings and built solar observatories in what is now Arizona and New Mexico; the Zuni people's historical contributions to ecological, engineering and land man-

agement of the arid lands that they have occupied for centuries; the practice of agricultural polycropping (intercropping) facilitated soil enhancement in nutrients and a prevention of soil erosion, and numerous contributions of medicinal derivatives (such as quinine) from indigenous plants for the treatment and prevention of certain diseases.

LEVEL II

There is an infusion into science curricula (Figure 1) of diverse cultural perspectives and contributions to a science concept development and/or evolvement. Contributions of scientists of color and women are integrated into the science curriculum, not just tacked on. Science teachers operating at this level enable their students to use science problem-solving processes and the scientific method in elucidating the faultiness of racial and sexual stereotypes, prejudices, and ethnocentric behavior. The following examples are illustrative of Level II.

Ecological Technology. Students investigate products from "useless" raw materials. The peanut, cotton seed, and rice hull can be selected as raw products to investigate in both biology and chemistry classes. The discoveries and contributions of the following scientists: George W. Carver (peanuts), Eli Whitney (cotton seeds), Oto Yakamoti (rice hulls) include butter, oil, and fertilizer. Biology and chemistry students can study the lives of an ethnically diverse group of scientists as they replicate their investigations.

Cellular Biology. The study of the cell, the basic unit of life, takes place in life science, biology, and advanced biology classrooms; however, little mention is made of Ernest Just, an African American biologist who spent a lifetime studying cytoplasm, the cell membrane, and other components of the cell. This would be the appropriate time for the biology teacher to include Just and his contributions.

Earth Sciences. The study of the solar system and the universe tends to take on a Western cultural perspective in many of our Earth science classes. We very seldom, if at all, include in our Earth science classes Eastern perspectives and discoveries such as Zhou Yue, who around 300 B.C. in China modeled the Moon's movements; Hypatia, a woman mathematician in Alexandria, Egypt, who around A.D. 400 developed the astrolabe, an instrument used to observe the position of celestial bodies; Aryabhata the First of India, who in A.D. 497 deduced the Earth's rotation.

The manner in which the Islamic culture unites art, religion, and science into a fundamental world view is a perspective seldom shared in science classrooms. In spite of the Native American culture geographically within our midst, our ethnocentric attitudes have prevented us from understanding their sophisticated perspective of the complex relationship of science, religion, and nature that provides their world view.

LEVEL III

Science teachers operating at Level III of Baptiste's typology for multiculturalizing science are social activists. His or her science instruction is culturally inclusive. The science teacher at this level is committed to design, develop, or seek out science programs that are truly antiracist and multicultural. This science teacher will help students promote equal opportunity, respect for those who differ, and promote power equity among groups both in the school and in the community.

Merely presenting illustrative examples of science lessons reflecting Level III will not suffice. Level III has a strong philosophical orientation couched in the fundamental principles of equity, valuing of the respect for human diversity, and moral commitment to social justice for all. An equitable learning environment must be established in the classroom that positively supports various learning styles and all science instruction and content must be purged of all elitism.

Multiculturalizing science must focus on pedagogy and content concerns. Science teachers operating at Level III of Baptiste's typology understand the importance of implementing instructional strategies that are amenable to all students and are culturally diverse; and selecting science content that reflects various cultural perspectives and represents the diverse cultural roots of science knowledge. ✧

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EMBRACING

As the U.S. population becomes more culturally diverse, schools can profit from this rich heritage

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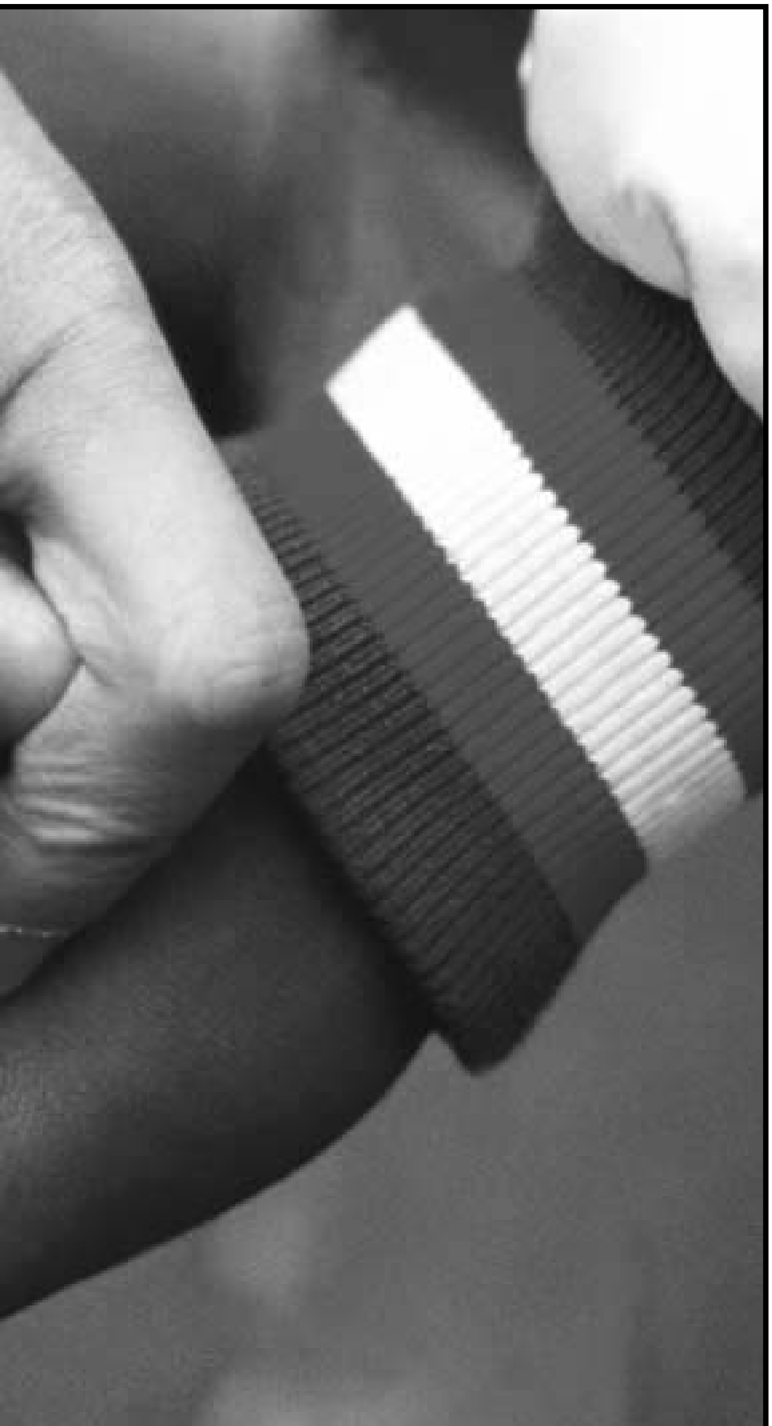
DIVERSITY



THE FACE OF THE AMERICAN CLASSROOM has changed dramatically in recent years and will continue to do so. As the number of students from varied ethnic backgrounds grows, so will the mix of ideas, interests, languages, and cultures brought to the classroom. This mix offers teachers an exciting opportunity to provide insight and leadership while integrating the diversity of their students' backgrounds into their lesson plans.

Multicultural education means defining school goals so that all students have an equal opportunity to learn. The *National Science Education Standards* (National Research Council, 1996) are clear in their intent—science is for all students, regardless of age, gender, cultural or ethnic background, ability, aspirations, or interest and motivation in science.

In planning and implementing effective educational programs, schools should recognize that "ethnic identity and cultural, social, and economic background of students are as vital as [students'] physical, psychological, and intellectual capabilities," according to Geneva Gay (1994), professor of education at the University of Washington and an expert in cultural diversity and equitable education.

MULTICULTURAL CURRICULA

Integrating multiculturalism into any subject can be tricky, and science and math educators (who are thought to work with purely objective disciplines) may find it especially difficult to develop new frameworks. The process of integration can be illustrated in the form of a continuum (Figure 1) that begins with an additive process—adding something multicultural to science curriculum and instruction. Teachers can move from

BY GERRY M. MADRAZO, JR.

addition to integration to accumulation and then towards attainment of multiculturalism, called advocacy of multicultural science education.

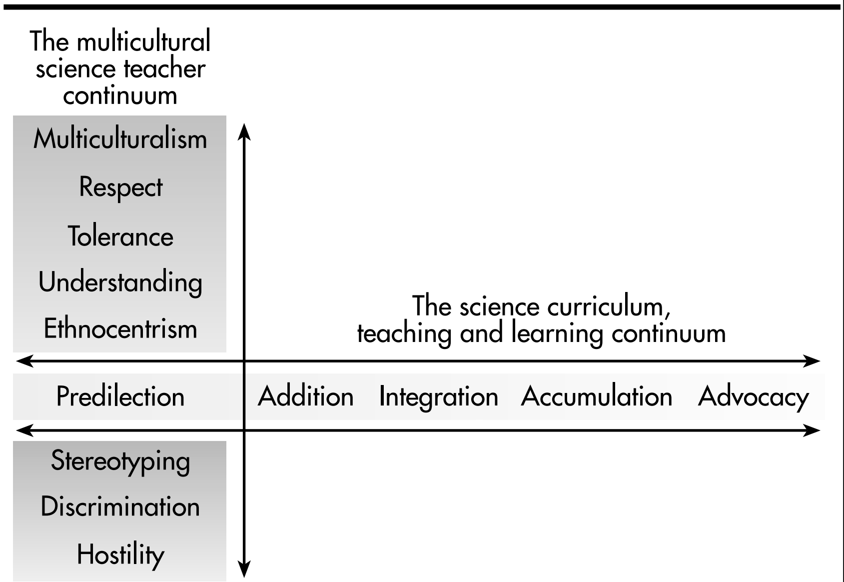
The extent to which teachers and students relate data and information from various cultures to the concepts and theories of science is called integration. Teachers help students understand how knowledge is constructed. In many respects this process reflects the procedures by which various scientists create knowledge in their disciplines. How knowledge is constructed can be influenced by cultural factors, and the teaching and learning process is only enhanced by using one's own cultural knowledge and perspectives. This mode of constructing knowledge is called accumulation.

When teachers and students discuss the ways in which various frames of references and cultural assumptions influence the accumulation of knowledge they experience a multicultural perspective. This leads to transforming knowledge or advocacy. Teachers and students are empowered by the knowledge, attitudes, and skills necessary to survive in a multicultural society. They have attained a mode called advocacy.

In 1991, the National Science Teachers Association (NSTA) issued a position statement on multicultural science education that said the welfare of the American classroom is ultimately dependent on the productivity and general welfare of all students. NSTA outlined the responsibility of each level of the educational community for multicultural education and pointed out that the entire educational enterprise—educators, parents, industry, community leaders, and policymakers—must believe that all students can learn successfully and must be willing to commit resources toward this end.

FIGURE 1.

Continuum illustrating the integration process.



[Madrazo, 1997 (Modified from Hoopes, 1979; Banks, 1993)]

School districts must design curricula and instruction to reflect and incorporate diversity, while individual schools must provide science education programs that nurture all children academically and help them develop a positive self-concept. Science teachers are encouraged to educate themselves about students' learning styles (which may be culturally influenced) and make all students aware of career opportunities in science, mathematics, and related technological fields.

As schools enter the 21st century and the U.S. population becomes more diverse than ever before, multicultural science classrooms should reflect the principles outlined below:

▲ A multicultural curriculum results in respect for diversity flowing from knowledge. With that respect will come the ability of people to live and work together in a diverse society.

▲ Teachers can help students develop the decision-making, problem-solving, social, and political skills necessary for participation in a culturally diverse society. (Teachers can encourage open discussion of how learners feel about the subject.)

▲ Laboratory investigations and course content can be integrated into authentic activities relevant to minority students' everyday lives, interests, and experiences.

▲ Science instruction should represent a variety of traditional and historical viewpoints that integrate literature, math, history, and the arts. By presenting science as an ongoing, creative story with many parts, students will see their own cultural experiences reflected in the lesson.

The content and methodology of multicultural science and curricula (including resource materials) should be significant to students in school and at home. The curriculum should help students see the connection between their local and global environments and think conscientiously and critically about their role in these relationships.

THE MULTICULTURAL ENVIRONMENT

Every science teacher integrates multiculturalism into education to a degree. The direction of multicultural science curriculum, teaching, and learning will be defined and acted upon by each teacher. The following strategies may be helpful to science teachers:

▲ Choose curricula and science programs that are culturally sensitive to diverse student populations, and particularly to those who are traditionally underrepresented in science.

▲ Infuse discussions of scientific concepts and experiences with appreciation of the different cultures that influenced the nature and structure of the scientific enterprise.

▲ Maintain a classroom climate that encourages students to pursue careers in science, mathematics, medicine, engineering, and technology. Such a learning environment should reflect the equitable contributions of various scientists and educators.

▲ Use both cooperative and individual learning activities in doing laboratory investigations and during class discussions. Peer tutoring and problem-solving groups are especially useful and encourage students with different learning styles and backgrounds.

PHOTO BY LIZ DELANEY

▲ Encourage students to be active participants in the learning process. Multicultural science instruction emphasizes dynamic inquiry and exploration, not static, memorized right and wrong answers.

▲ When discussing a lesson, examples can be used that appeal to all students. Teachers can incorporate student opinions into discussions to validate student understanding of concepts.

▲ Teachers can give students role models by bringing minority scientists into the classroom to talk about science and their field of expertise.

MYTHS AND REALITIES

Though many people recognize the need to address different viewpoints, some fear that without an agreed-upon cultural position, the classroom will become an arena in which ethnic groups clash and significant contributions of one group are reduced in order to laud the achievements of another. The same people fear that equity issues may be compromised. When carried out according to its true spirit, however, multiculturalism benefits all students as they gain an understanding of themselves and an appreciation for their peers. According to James Banks, an expert in multicultural education, the tremendous social and racial chasms that exist in American society make it naïve for anyone to believe that the study of ethnic diversity will threaten or exacerbate any notions of national cohesion (Banks, 1993).

Another common myth some educators believe is that "white" American or Western culture is excluded in multicultural studies. Contrary to popular belief, a multicultural curriculum does not leave out or undermine the European experience. Gary Howard, a multicultural education specialist who focuses on curricular and staff development, encourages white Americans to learn about other cultures and investigate what those cultures bring to the learning table. He also says that white Americans are not without their own cultural histories, though they may be several generations removed from those ancestors who "worked so hard to dismantle their European identity in favor of what they perceived to be the American ideal" (Howard, 1993).

Science teachers have always been at the cutting edge of changes in education and society. If we are to achieve scientific literacy for all students, science teachers and other educators must realize that curricula, as well as science teaching and learning, must change to reflect the diversity in our society. The better prepared our teachers are to embrace diversity, the more skilled our students will be to work, live, and prosper in a global community. ✧

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ENCOURAGING Equitable Enrollment

One district's efforts toward increasing minority participation in math and science

EDUCATORS CONSTANTLY TALK ABOUT the need for reform in science and mathematics education. We implement program after program and try innovation after innovation. Is it possible that we are looking in the wrong places, working on the wrong things?

What if the most essential place to focus is on the relationships within the school and school community? This includes the quality of the interactions between students and teachers, teachers and administrators, parents and school personnel, and business and the school family. Until we work at making these relationships more meaningful, alternative training plans, innovative hands-on programs, and well-meaning reforms will rest atop an unstable base.

As educators we always seek exceptional results and miraculous improvements, but we often wait for others to change. We want students to come better prepared, parents to be more involved, administrators to be more supportive, and legislators to provide more funding. Educators can work on all these areas, and we probably should, but until we choose to develop and transform ourselves, our goals for systemic change will remain unfulfilled.

The Winston-Salem/Forsyth County School System is an urban school district in the piedmont section of North Carolina. The system's minority population is approximately 42 percent, with African American being the dominant minority.

The system recently finished the first year of a five-year National Science Foundation grant funded by the Comprehensive Partnership for Math and Science Achievement (CPMSA). The grant is designed to increase the number of minority students who enter and successfully complete upper-level science and math courses. The specific benchmarks focus on:

BY STAN HILL AND PAUL B. HOUNSHELL

1. The number of minority students completing Biology, Chemistry, and Physics.
2. The number of minority students completing Algebra I, Geometry, Trigonometry, Pre-Calculus, and Calculus.

The initiative is called Project JUST (Join Underrepresented in Science and Technology). The major goal is to create an atmosphere of systemic change within the district that results in minority students excelling in upper level math and science courses.

We are framing our reform efforts around the six National Science Foundation systemic change drivers:

1. How do systemic policies affect the project's goals and objectives?
2. How does district leadership, governance, and management affect the project's goals and objectives?
3. Does the district have a standards-based curriculum that is related to actual teaching practices?
4. How are periodic and annual assessments used to inform the district teachers, counselors, and administrators about their role in systemic reform?
5. Are professional development activities ongoing, developmental, content-based, and constructionally oriented?
6. Are partnerships, parental involvement, and public awareness active components within the project?

The focus of this article will be our district's efforts around drivers 2 and 3—the districts' leadership and

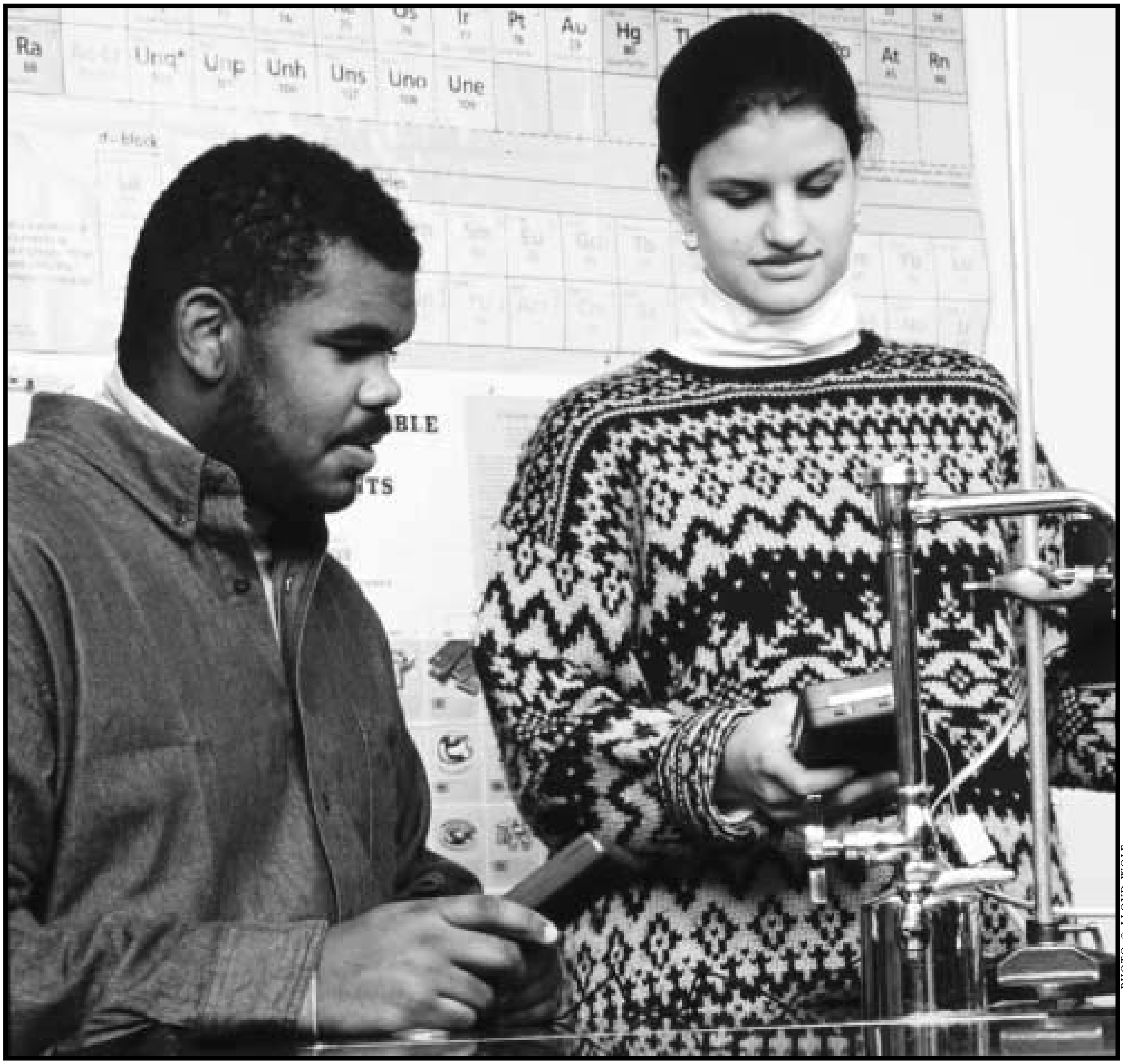


PHOTO © LLOYD WOLF

instruction efforts—and how we can grow and develop in these areas.

LEADERSHIP, GOVERNANCE, AND MANAGEMENT

The district superintendent, Donald L. Martin, Jr., is the principal investigator for the CPMSA grant. He has aligned the goals of the project with the overall goals of the system and is committed to bridging the gap in academic achievement between white and minority students. This commitment is evident in every agenda he sets dealing with student performance—whether it is in the community, with his management team, or with the district's school board. As project director, I meet regularly with school staffs to emphasize project goals and promote systemic change.

Many of the major systemic interventions associated with Project JUST were created at the school level by teachers, counselors, and administrators. When the project first began, I met with each school's counseling and administrative staff. Meetings were also held with the math and science teachers within the school. Each school was invited to create a local intervention that would drive systemic changes. This effort has yielded some of our most impressive efforts:

■ A bridge course between Mineral Springs Elementary and Mineral Springs Middle schools allows fifth-grade students and teachers to work with sixth-grade middle school teachers in the middle school classrooms. This bridge occurs during the periods of intersession. (Mineral Springs Elementary is on a year-round schedule.)

- Walkertown Middle School trains its entire core teaching staff in a yearlong training initiative called Problem-Based Learning. This effort focuses on a partnership with the Bowman Gray School of Medicine of Wake Forest University.
- Parkland High School has created the Achievers Program, which allows students in biology and geometry to extend the time it takes for them to complete their course work as long as they are making satisfactory progress.
- Glenn High School has developed a training effort around effective communication. The local teacher association representative and I lead a staff development initiative designed to improve each teacher's ability to relate to their students as exceptional learners.
- Reynolds High School has created the district's first counselor-driven intervention. The counseling staff has provided special training sessions for parents, tutoring sessions for students, and evening classes in which community leaders work with students and parents on effective study skills, skills needed for the workplace, and the steps necessary to enter careers related to math, science, and engineering.
- North Forsyth High School has created both a summer bridge program and an in-school mentoring program. The bridge program places 9th- and 10th-grade students in a two-week enrichment session. Students improve their process skills and visit local businesses and industries where they are trained in the practical applications of the science and math concepts they are learning. The mentoring program is conducted by the Alpha Phi Alpha fraternity. Mentors work with students during the school day and provide after-school tutoring and enrichment opportunities. In addition, they monitor students' attendance, course selection, grades, and attitudes.

The district is combining many of its federal and private funds behind the CPMSA systemic reform goals and objectives. Eisenhower professional development funds, Howard Hughes Foundation funds, and local funds support the school initiatives mentioned above along with curriculum innovations.

The district is also partnering, through subcontractual arrangements and informed agreements, with other agencies, including Winston-Salem State University, Wake Forest University, Bowman Gray School of Medicine, the Alpha Phi Alpha Fraternity, the North Carolina Math and Science Educational Network, the North Carolina State Department of Public Instruction, the Winston-Salem Urban League, SciWorks Nature Museum, and R. J. Reynolds Company.

A STANDARDS-BASED CURRICULUM

The national standards in science and mathematics are the foundation for our standards-based curriculum. Teachers have worked through the summer to translate national goals and objectives into local goals and objectives that can be adopted and applied in actual teaching situations. We are emphasizing assessment, the teaching and learning environment, technology, effective communication, and professional teacher development.

A major effort in the area of curriculum and instruction focuses on problem-based learning. At its core, problem-based learning involves students in resolving real-world problems that require the acquisition, analysis, and interpretation of data and the use of problem-solving skills. This makes mathematics and science more relevant and allows students to work in cooperative groups and become investigators to solve problems. Students become the focus of the learning with the teacher guiding their inquiry.

The problems that students tackle (see example problem below) are jointly developed by teams of district math and science teachers and faculty members from the Bowman Gray School of Medicine. Topics explored include forensic science, bacteriology, the mathematics

Family Vacation
(A Problem-Based Learning Initiative)

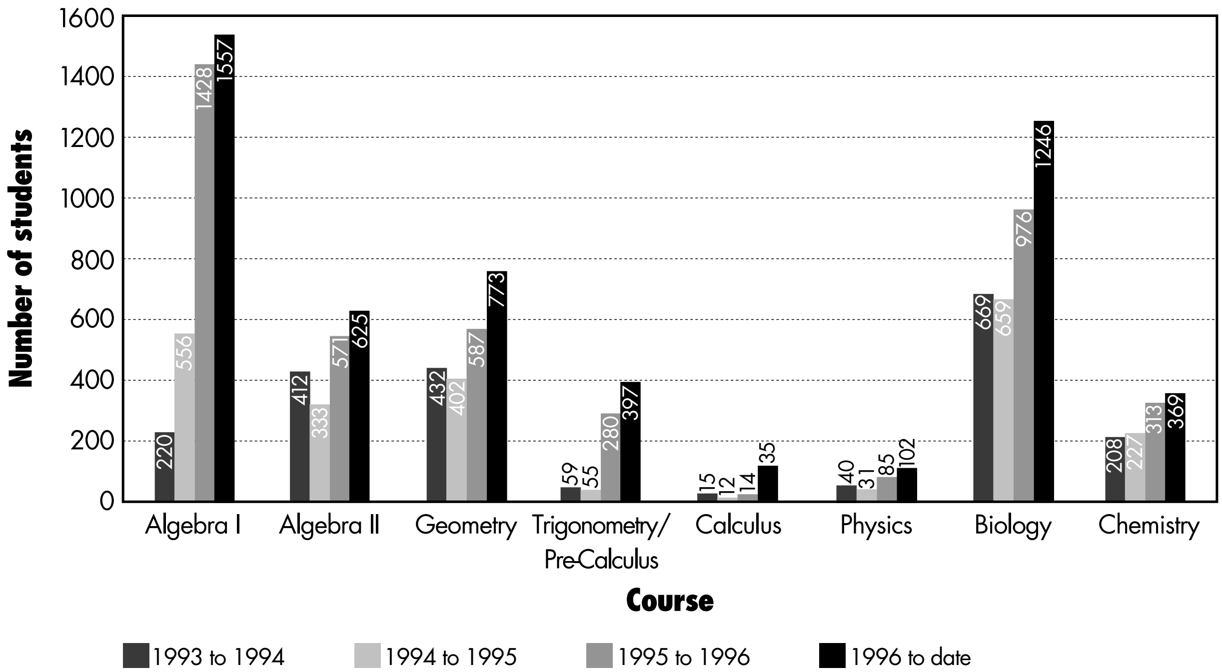
Problem: Students pretend that they are just starting a new year of school and have been asked to write an essay about a memorable event or experience they had during the summer. Their task is to make up the ending to an essay about an unforgettable camping trip with friends from New York. On the camping trip, a six-year-old girl gets very sick.

Rationale/Goal: Seventh- and eighth-grade students will use the scientific method to study the concepts of risk exposure to chemical poisons, bacteria, or viruses; the effects of concentration of these agents (child versus adult); and strategies for quantitative and qualitative analysis of data.

Case Presentation: Depending upon labs used, this can take up to four hours of class time, which is divided into three phases. In Phase 1 students become familiar with the setting of the camping trip and begin to imagine themselves having the experience. The phase ends with students making initial hypotheses about why a six-year-old girl gets sick. In Phase 2 students explore alternative hypotheses for the girl's sickness as her condition worsens. In Phase 3 students complete their assigned essay using their choice of hypothesis and its associated facts, symptoms, and so on. As students conduct their investigations, they connect the child's symptoms (nausea and headache) and the facts provided in the story (symptoms occurring within three days of eating apples from the orchard) with organic phosphate poisoning. In addition to satisfying their curiosity, they have also been engaged in quality science directly related to state and local curriculum objectives.

FIGURE 1.

Enrollment data for Project JUST.



of community road design, geology, and human physiology. The problem-based learning concept is in its 10th year as a parallel curriculum offering for first- and second-year medical students.

Surveys of students and teachers involved indicate that problem-based learning is more effective than lectures, makes lab activities more relevant, and has everyone more excited about coming to class. Teachers report that this method provides an integrated approach that impacts self-esteem and student research skills.

FORMATIVE DATA

After a year of operating, Project JUST has seen significant increases in minority participation in upper level science and math classes. The data (Figure 1) indicate that we are moving in the right direction. The 1993–94 data reflect our benchmark number. The 1995–96 data represent our first year of operation under the National Science Foundation grant. Enrollment of minority students in upper-level math and science courses is steadily increasing. The rapid rise in Algebra I and Biology enrollments can be partially attributed to a North Carolina requirement of Algebra I and Biology for high school graduation. Enrollment increases in Geometry, Algebra II, Trigonometry/Pre-Calculus, Calculus, Physics, and Chemistry can be directly connected to recruiting initiatives.

In addition to increasing enrollment, we must also address the number of students who are successfully completing our courses. In 1995, 45 minority students successfully completed the science sequence of Biology, Chemistry, and Physics. In 1996, 88 minority students successfully completed the science sequence. The completion rate of minority students in Geometry and Trigonometry/Pre-Calculus has doubled during the same period of time.

THE NEXT STEPS

Although we are making progress, our work has just begun. There are still too many students, especially minority students, who are not getting the benefit of rigorous math and science classes. We still have upper level science and math classes with high failure rates. As we work to increase enrollment, we must make sure we do not set students up for failure. We must encourage more teachers to transform their classrooms, more parents to get actively involved in their child's education, and more community partners to align with school administrators in a focused commitment to systemically change education.

Systemic reform is necessary for the growth and survival of public schools. It is a messy and difficult job with no short cuts. The key is to put resources where essential changes can take place. In Winston-Salem and across the nation we must look within ourselves and trust that every child possesses the fundamental desire to be successful and must believe that we can make a difference. ✧

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