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SCIENCE FOR ALL: A PROMISE OR A PIPE DREAM FOR BILINGUAL STUDENTS?

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Abstract

Scientific and technological literacy are important learning outcomes the nation has committed to develop in order to maintain a globally competitive economy. Students who bring to school diverse languages and cultures provide a rich resource of experiences on which to develop a scientifically literate work force. Unfortunately, in spite of the national commitment to "science for all," the process of promoting scientific literacy has not yet been fully operationalized across school settings. This article compares and contrasts opportunities for science learning at two schools with diverse student populations, one suburban and one urban. Three sources of information are considered: (a) students' prior knowledge and backgrounds, (b) perceptions of teachers and administrators, and (c) the schools' instructional environment. Vast differences are found in the science learning opportunities at these two sites. As the nation strives to promote equitable learning opportunities, these data sources provide beginning points for harnessing the energies for making science for all a reality.

> The Congress finds that… as the world becomes increasingly interdependent and as international communication becomes a daily occurrence in government, business, commerce, and family life, multilingual skills constitute an important national resource which deserves protection and development (Bilingual Education Act of 1994, Sec. 7102 [a] [10]).

Scientific and technological literacy are important achievements for both the students who are to become the work force of the 21st century and for industrialized nations seeking to maintain their positions in an increasingly competitive global economy. Students who enter school proficient in languages other than English have unique opportunities for literacy development. Because of their already developed proficiency in another language, they have the potential for literacy development in multiple languages. In addition, they can acquire the scientific and technological literacy needed to benefit themselves, their families and communities, and the nation as they use their language skills.

The necessity that all Americans develop scientific literacy has been established as a national priority in the National Education Goals 2000 (PL 103-227). Many educational and political leaders have contributed to this expanded view of literacy as a national imperative. Vice President Albert Gore (1993) stressed:

> Education for science should be a mind-stretching voyage of discovery for all of us. It is as fundamental as our understanding of ourselves, of our surroundings, and of life itself... The joy of learning and the wonder of scientific discovery are frequently lost in attempts to 'sort out' those who are 'not really serious' about science. We do not have a single child to waste; not one future parent or teacher or scientist; not one productive citizen of the United States (p. 48).

The need to incorporate learners who have been traditionally under-served has also been emphasized by national science organizations. These professional groups have been preparing national standards in curriculum, instruction, and assessment to ensure that all students develop scientific and technological literacy. National reports indicative of comprehensive reform efforts within the science community include *Science for all Americans* (1989); *Benchmarks for Science Literacy* (1993); *Scope, Sequence, and Coordination of Secondary School Science* (1992); and *National Science Education Standards: An Enhanced Sampler* (1993).

National level efforts at increasing technological and scientific literacy became focused through the dissemination of the report Science for all Americans, in which the American Association for the Advancement of Science (1989) emphasized, "In particular, the recommendations [for improved and more inclusive science instruction] pertain to those who in the past have largely been bypassed in science and mathematics education: ethnic and language minorities and girls" (p. x). The National Committee on Science Education Standards and Assessment (1993) added its support by stating,

"... the commitment to 'Science for All' implies inclusion not only of those who traditionally have received encouragement and opportunity to pursue science, but of women and girls, all racial and ethnic groups, the physically and educationally challenged, and those with limited English proficiency" (p. 5).

In addition to these national level efforts, states have also begun to play important roles in expanding the vision of science education. In Florida, for example, the Department of Education (1989) included as one of the major educational goals,"... to increase motivation, incentives, and opportunities for minority, female, at-risk, disabled, and gifted students to pursue programs and careers in mathematics, science, and computer education" (p. 7).

Science Learning for Culturally and Linguistically Diverse Students

The foundations of scientific literacy are grounded in general literacy development. Literacy is, however, more than a set of skills for oral and written communication. It is the basis for problem-solving and reasoning. Manipulation skills, communication skills, and critical-response skills are also intricately interwoven to form the basis for scientific literacy. These, in turn, foster the development of the habits of mind necessary for bringing the intellect to focus on practical matters through applications of scientific literacy (American Association for the Advancement of Science, 1993).

Do educators have sufficient knowledge to guide their efforts to promote scientific literacy of all students? Assessment of the learning needs of the students to be included in the instructional process has yet to occur (Darling-Hammond, 1994). To date, only limited attention has been given to the instructional needs and learning differences of students who are culturally and linguistically different from the norm (García, 1991; LaCelle-Peterson & Rivera, 1994).

The interplay between language development and science learning with culturally and linguistically diverse learners has not been adequately addressed. Most of the research on student performance in science has involved student groups for which language and culture were not considered as major variables. Only a few recent studies have focused on bilingual or non-English dominant students. Among these is the work of Michaels and O'Connor (1990) who described Haitian students' science reasoning and explanations of outcomes. Rosebery, Warren and colleagues also observed Haitian students engaging in daily life tasks and constructing meaning using scientific discourse (Rosebery, Warren, & Conant, 1992; Warren, Rosebery,

& Conant, 1989). Similarly, Barba (1993) examined the cultural and instructional congruence between Spanish-speaking students and their teachers in science instruction. This research provides valuable insights into the learning needs and strengths of the students and also highlights the importance of cultural understanding in promoting science learning.

The percentages of non-English language background (NELB) students in most states and school districts continue to grow more rapidly than those of students from the traditional mainstream (Olsen, 1991). While Spanish remains the most frequently used non-English language, both the overall numbers of NELB students and the numbers of different languages used in public schools are increasing (U. S. Department of Commerce, 1992a, 1992b). If improvements are to occur in the opportunities for learning science, the instructional needs of NELB students with diverse educational experiences and a broad range of language proficiency in English and in other languages must be included in the planning process (García, 1994).

Further complicating the process of promoting scientific and technological literacy is the reality that teachers often have had inadequate preparation in two important areas: (a) providing effective instruction for students who lack English language skills (García, 1991, 1994), and (b) providing effective instruction in science (National Committee on Science Education Standards and Assessment, 1993). Difficulties usually begin at the elementary level. Most elementary teachers are women who themselves constitute a minority with limited exposure to science instruction (National Committee on Science Education Standards and Assessment, 1993). Many elementary teachers feel unsure about science content and uncomfortable presenting it. Often they also lack the instructional strategies and the understanding of how to prepare and use equipment and resources for making science learning meaningful. In addition, many teachers are unfamiliar with the languages and cultures of their students and are unaware of ways in which to link science learning with students' prior experiences and interests.

The process of making science available for all students goes well beyond planning and development of a new set of guidelines, or science lessons and materials. Learning opportunities are often related to economic circumstances (Bradley, 1994; Kozol, 1992). While limited science learning opportunities pose serious difficulties at many schools, limitations are often most pronounced in areas with large numbers of economically disadvantaged students, many of whom are also in the process of developing English language proficiency. Frequently, the development of academic skills required for effective science learning is closely tied to general educational opportunities available within the school. Enhancing scientific literacy requires systemic modifications and monitoring to ensure students' effective participation. The challenge of improving science education requires not only pedagogical changes, but also modifications in the ways that resources are allocated and used.

Planning to promote science learning for culturally and linguistically diverse students involves at least three different areas: (a) identifying students' learning needs; (b) determining teachers' science knowledge, use of instructional skills, and perceptions about teaching science; and (c) examining the relationship between the instructional environment and the ways that teachers and students engage in science learning. Information about students' needs, teachers' practices and perceptions, and the schools' instructional environment can be used in enhancing science instruction. Developments in each area can be charted on a continuum for planning, monitoring, and evaluating science learning opportunities and outcomes. Modifications within each area can be addressed specifically, or considered as a whole, as schools enhance science learning for their students.

Case studies of two elementary schools with ethnically and linguistically diverse student populations are offered as illustrations of schools along the continuum. These cases also reveal some of the contrasts that occur, even within one school district, in the opportunities currently available for science learning.

Glimpses Along the Continuum of "Science for All Americans"

Two elementary schools with different opportunities for science learning are described in this section. The descriptions serve as a means for discussing the role of family and community, the perceptions and needs of teachers, and the impact of the school environment in making science learning a reality for all students. The information presented here was gathered as part of a research project funded by the National Science Foundation to describe the language performance, science knowledge, and cognitive strategy use of four ethnolinguistic groups (Fradd & Lee, 1994). The two schools, one suburban and one urban, both had high percentages of NELB students. The challenges facing these schools and the responses they made may reflect the dilemmas facing many urban school districts now and in the 21st century.

Descriptive snapshots of the schools are presented in three areas: (a) students' prior knowledge and background experiences, (b) the instructional environment of the schools, and (c) teachers' and administrators' perceptions about science learning. While this information does not represent a comprehensive study of science instruction within the district, or even within the schools themselves, it does offer insights into the challenges that many schools face in implementing effective programs affording all students opportunities to develop scientific literacy.

Suburban School's Efforts at Promoting Science Learning

Suburban School was located in a quiet middle class subdivision on the edge of a large and rapidly growing metroplex. Parents, regardless of their ethnolinguistic background, were clear in their expectations of education and of the school. The diverse ethnolinguistic mix of more than 1,000 students consisted of 65% Hispanic, 23% white non-Hispanic, 7% Black, and 5% Asian (school district data).

Students' prior knowledge and background experience. Although many students were recent arrivals from other countries, most of the intermediate students who participated in this research entered school with well-developed literacy skills in at least one language. For the Suburban School students, opportunities for learning science abounded at home and in the community, as well as within the school. For example, the local library near the school collaborated in promoting science learning. Stores and shopping centers near the subdivision provided a variety of materials for science projects and other learning activities.

The school served as a center for promoting many positive exchanges in the community. Although Suburban School was public, it often had fund-raising events at which parents contributed both time and money. Many families also supported science learning through volunteer assistance on field trips and on organized activities during and after school. The butterfly garden that parents created in collaboration with the fifth grade gifted program was an example of the parent-led beautification projects that unfolded during the year of our visits to the school.

Our research centered on student performance on three science tasks: weather phenomena, simple machines, and buoyancy. All of the participating Suburban School students had prior experiences related to these tasks. They often spoke about family trips to museums and other science-related events. They also talked about their computer games, and about projects they were making with science kits and equipment at home. Both the students' personal lives and their school experiences contributed substantially to the students' knowledge base for learning science. In the process of performing the tasks, students also told personal stories about what they had previously done or learned. They talked about watching weather reports on television, and making reports and class projects about hurricanes at school. They associated these experiences with the formation of a hurricane and a tornado (in research task 1). Most students had used tinker toys or Logo-Lego sets at home, had played on a see-saw, and associated these experiences with the concept of a lever (experiences related to task 2). The students understood the concept of buoyancy through learning to swim and from riding in boats and other water vehicles (experiences related to task 3).

The school's instructional environment. Suburban School was a new modern facility with the latest equipment. From its inception three years earlier, the school had been designed to serve as a model in educational innovation. Teachers had been specially selected because of their commitment to the philosophy of the school as a center of discovery. Teachers and administrators were proud of the school and welcomed opportunities to discuss their programs and to share information about instructional practices.

Support for science learning was evident throughout the school. The school's red, white, and blue colors, for example, lent a patriotic tone to the school's theme of space exploration. The colors and space exploration images were emphasized in the clothing of the administrators, teachers, and students. These vivid colors and images were also echoed in the signs and pictures throughout the school. Terms related to the space exploration theme were also noted in the names of facilities, such as "mission control" (the central office), the "galley" (cafeteria), and the "discovery center" (library). Together, these sights and signals provided a school unified in its endeavor to engage students in science learning.

Instructional support for language development occurred in several ways. All students identified as limited English proficient (school district term) participated in the English to speakers of other languages (ESOL) program. Native speakers of Spanish could also participate in the bilingual curriculum content (BCC) program.

Science instruction was assured through a departmentalized program. Two specially trained science teachers served the school, one at the primary and the other at the intermediate level. The primary teacher traveled to K-3 classrooms with a cart filled with materials, a ``science lab on wheels," as an administrator described it. Young children could often be seen flying kites and airplanes, taking measurements around the campus, and making observations as they engaged in activities out of doors as well as within their classrooms. The intermediate science program was led by a bilingual science teacher proficient in English and Spanish. The science classroom of tables and chairs was located next to the a computer lab and a large, well-stocked storage room filled with science equipment.

Teachers' and administrators' perceptions. As part of our research with fourth- and fifth-grade students, we interviewed the teachers and administrators to determine their perceptions and beliefs about science learning. The interviews focused on two questions: (a) Do students who are considered culturally and linguistically diverse have more difficulties learning science than typical mainstream students? and (b) What can schools do to promote scientific and technological literacy for all students, including those considered to be culturally and linguistically diverse? Teachers and administrators were encouraged to elaborate on their responses and to share their personal beliefs and insights.

The value of science instruction was emphasized throughout the interviews. "Science," several teachers affirmed, "is a topic that is open and available for all students." An administrator noted, "Science is a vehicle for encouraging learning. It's a love for our children, as it can be for all students."

In response to the first question, teachers and administrators emphasized that culturally and linguistically diverse students should not have any greater difficulties than typical mainstream students. Both the teachers and the administrators voiced the strong opinion that, in spite of differences in language and culture, there were no real achievement differences among ethnolinguistic groups. Respondents were consistent in their view of the importance of treating all students equally. "Schools have the responsibility to ensure that all students have the opportunity to learn," was a statement echoed by many teachers. One questioned, "Why would any particular group of students be better at science than any other group?" Another wondered, "If a student doesn't perceive himself or herself as different, then is there really any difference? All of the students here are treated the same. Many are achievers, no matter what their language or ethnic background."

Some teachers said that if there were science achievement differences, these resulted from families' economic opportunities rather than students' inherent abilities. Lack of experience and exposure, rather than ability, made the difference in achievement, according to these teachers. Several teachers commented that where differences were observed, it was the monolingual children who tended to be less motivated and less curious than the culturally and linguistically diverse students.

The importance of considering students' learning needs, especially the development of English language proficiency and science vocabulary, was noted by some teachers. One teacher observed, "Students may have difficulties with the words, the terminology. New words can be hard to remember. Some students have difficulty pronouncing science terms. Others may not feel comfortable using words that are unfamiliar to them." Many of the teachers praised the bilingual science teacher for her efforts at making instruction meaningful and accessible for the students. As a footnote, several teachers added that because science was difficult for them, they were pleased with the departmentalized science program where they were relieved of the responsibility for teaching science.

With regard to what schools could do to promote scientific literacy for all students, teachers and administrators emphasized active student engagement, especially with hands-on activities. One teacher summarized his belief about the importance of active engagement: "The kids need good hands-on stuff. You do it in a fun kind of way and they don't have to know that you're doing it." Along with hands-on activities, several teachers expressed the need for providing activities that were relevant to students' daily life. One teacher noted the importance of making science practical: "Give students things to do at home, not that they have to go out and buy, but that they can make, like cakes, where they can apply their knowledge."

Although the value of hands-on activities was the most dominant suggestion for promoting science learning, teachers also talked about the importance of establishing a non-threatening learning environment. They discussed a number of other suggestions, such as the value of working in small collaborative groups, beginning science instruction at the pre-school level, focusing on language development, and developing thematic units. Several emphasized the need to promote new ways of thinking. One said, "Students need to learn to ask questions and to find out why things are the way they are. They need to get their minds in thinking mode and develop higher level ways of thinking. They need to be inquisitive and not just try to find the right answer."

The bilingual science teacher shared the views expressed by other teachers about the importance of active engagement, the fostering of curiosity, and the development of higher order thinking skills. She also added a note of concern over her own limitations at not being fully proficient in the scientific terminology needed to effectively discuss science concepts in Spanish. Because all her training and professional development in science education had been in English, she felt limited in communicating science concepts in Spanish. She added that she also lacked instructional resources in Spanish and was always looking for ways to up-grade the resources she had.

One teacher illustrated how she used problem-solving activities to link science instruction, reading, and mathematics through the use of the computer. This teacher declined to participate in the departmentalized program and sought to provide her students with in-depth instruction in her own classroom. Another teacher commented on science instruction beyond basic activities. This teacher emphasized the importance of a comprehensive program designed to build on students' prior knowledge:

> When you take the time to develop the concepts and the activities that support learning over time, all students, particularly those who may have a difficult time with the language or with traditional approaches, are able to follow along. When more direct associations are made between previous and current instruction, then there are more opportunities for learning.

Summarizing science learning at Suburban School. This school was located in a community of diverse ethnolinguistic groups. Many of the elements identified as necessary for effective instruction (Edmonds, 1990) were in place within this school. In emphasizing the importance of academic achievement, the school had a theme and central focus that communicated high expectations and personal involvement in learning. The administration and faculty communicated positive attitudes about the value of cultural and linguistic diversity. Students were actively engaged in the learning process. Family and community involvement was high. Instructional programs supported learning in English and in Spanish. Sufficient resources were available to support general instruction and to emphasize science learning.

Despite having many of the characteristics of an effective school (Edmonds, 1990), most teachers at Suburban School did not differentiate between interesting activities and a comprehensive program for developing scientific literacy. While talking about the importance of meeting the educational needs of all students, little science instruction was directed toward students from non-Spanish backgrounds who were developing proficiency in

English. In spite of efforts to promote effective science instruction, the school could not be characterized as fully engaged in promoting scientific literacy.

Urban School's Efforts at Promoting Science Learning

Urban School was located in an area of rapid growth in an older, once solidly middle class part of the city. The area in which the school was located had become home to newly-arrived immigrants and working class groups. The school was bordered on one side by a major interstate highway that produced high levels of noise and dust. On the other three sides it was surrounded by modest homes and multifamily complexes.

According to district demographic data, the more than 1,500 students in the school were 95% Black and 5% Hispanic (school district data). Although the district and the state did not differentiate among African-Americans, Haitians and other Caribbean-origin students, our observations revealed the presence of diverse ethnicities within the school. Students came with a range of proficiencies in standard English, Black English Vernacular, Caribbean English, Haitian Creole, Spanish and other languages.

Students' prior knowledge and background experiences. Although most students walked to school in small groups or were accompanied by family members, minimal parental participation occurred at the school. When parents came to school, it was often in response to a request made by the school. Communication with the parents frequently occurred through interpreters, often teachers who were pressed into providing language support services.

Teacher involvement in their students' home environments was noted in a variety of ways. Some teachers talked about visiting students' homes and offering basic necessities, such as clothing and furniture. Others said that they invited students to their homes and invented ways to help the students remain active while staying out of trouble after school.

For some students at Urban School, the process of acquiring academic English language skills included the development of basic literacy concepts. Many of the intermediate students in our research had not had experiences related to the three science tasks used in our study. In fact, some students had only recently entered school for the first time in their lives. Many were limited in their experiences with literacy concepts in any language. Most had not seen satellite maps of a hurricane, and had not watched a weather report on television. Few had seen a see-saw or played with building materials like tinker toys or Logo-Legos. Some could not swim or float, had never been to the beach, or had never been on a boat. Because the science tasks presented novel experiences, the students often expressed appreciation for the opportunities to learn and asked to take materials home to share with their families.

The school's instructional environment. Although the school had an aquatic theme, the presence of a unifying educational force was not a noticeable part of the instructional environment. The school's most prominent characteristics were overcrowded classrooms and hallways, and a general lack of facilities and resources. During the period of our visits to the school, plans were underway to transfer a portion of the students to a new school that was nearing completion.

With regard to the instruction of students who were learning English as a new language, Urban School had both an ESOL program and a BCC program for students whose native language was Haitian Creole. During the period in which we observed in the school, the administration initiated a plan for promoting a Haitian-centric program emphasizing Haitian culture.

Some teachers and administrators were friendly and willing to share their time and insights about what they were doing to promote science learning. Others indicated they were too occupied to engage in discussions. All the classroom teachers in Urban School were expected to teach science. The teachers who met with us used gestures as well as verbal explanations to emphasize the absence of resources and the lack of encouragement for teaching science.

Teachers' and administrators' perceptions. The same two questions were used to interview the fourth and fifth grade teachers and administrators at Urban School. "All students could learn science," and, "Science should be available for all students," were statements made by most teachers. However, while the teachers at Urban School indicated that one group of students should not have any greater difficulty in learning science than another, they qualified their statements in a number of ways. For example, they expressed concern about students who were not proficient in English. Cultural differences also played a role in the ways that students learned, some teachers noted. One teacher said:

> I believe that these students do have difficulties with science. I noticed that when they were doing the writing tests that they had to take in fourth grade, they wrote just the way they spoke at home. This just isn't the way information should be expressed at school.

Another teacher observed, "Students don't always understand what I mean, even though they understand my words." "If students are not used to noticing and talking about the world around them, it's hard to do it at school," another noted. A third said, "If a student never noticed a cloud, or didn't know what a cloud was, it's hard to talk about cloud formations."

With regard to the question of what schools could do to promote science learning for all students, most teachers at Urban School emphasized the importance of hands-on activities. The importance of practical applications, non-threatening environments, and engaging activities were also discussed. In addition, they also stressed the need for English language instruction and vocabulary development.

The teachers at Urban School provided fewer specific examples and less detailed information about what schools could do to promote science learning. Instead, they talked about the limitations and barriers to science instruction. They expressed frustration over the lack of equipment, materials, and supplies, and the restrictions on science-related activities, such as field trips. One teacher summarized the difficulties clearly, "Money, and more money. We need more supplies, more hands-on activities. That means more money." Several teachers also believed that continuing professionalization was important. One emphasized:

> I just wish someone would come here and give us some workshops on teaching science. I'd really like to have someone show us what to do to involve the students. I've noticed that when the students are involved, they learn more. I want to learn how to do that!

Summary of Urban School's efforts at promoting science learning. The instructional environment at Urban School may be typical of many inner city schools. Few of the elements identified as necessary for effective instruction (Edmonds, 1990) were in place within this school. The teachers with whom we spoke were clear that what occurred in the name of science instruction was, at best, limited. Without the support of community and administration, and lacking the resources and professional preparation to implement effective science instruction, the teachers felt there was little they could achieve. Despite clear limitations in science instruction, these teachers expressed attitudes of caring and concern for their students' academic success that went well beyond basic lessons in science they were able to provide.

Summarizing the Similarities and Differences

Returning to the metaphor of a continuum of opportunities for acquiring scientific literacy, these two schools were clearly at different points in their development. Although neither school exemplified a comprehensive effort at promoting scientific literacy, differences between Suburban and Urban Schools in opportunities for science learning abounded. Palpable discrepancies were noted in the ways the teachers and administrators at the two schools discussed science instruction. With regard to differences between mainstream and culturally and linguistically diverse students, Urban School teachers perceived limited English proficiency and cultural differences as reasons for the students' difficulties in science learning, while the teachers at Suburban School did not. Considering ways to promote science for all students, the educators at Urban School were less specific about instruction and less articulate about their own beliefs regarding effective instructional approaches than the Suburban School educators. Some explanations of these differences were clearly related to the instructional environments found in each school setting. The ways teachers were selected for their positions and the ways their efforts at implementing instruction were supported provide other explanations.

In spite of the obvious differences in the two schools, similarities in the perceptions and beliefs of teachers and administrators who participated in the interviews were also evident. Educators in both schools viewed science instruction positively, expressed beliefs that all students could learn science, and emphasized that science learning Opportunities should be available for all students. They agreed on the importance of active student engagement, practical applications in daily life, and authentic, meaningful tasks. They emphasized the need to promote language development during science instruction for all students, especially those from diverse language and culture backgrounds.

Ethnolinguistic background *per se* does not necessarily promote or limit learning opportunities. Effective schools are a reflection of the communities they serve. Language, culture, and socioeconomic status can affect the influence that families and communities are able to exert on schools. As the contrasts between Suburban and Urban School illustrate, a powerful influence for articulating expectations for academic achievement is often eliminated when families are unable to communicate expectations and are unable to contribute substantially to the educational process. However, even under more favorable conditions, conceptualization of instruction as a comprehensive plan that is more than a set of discrete activities is necessary to reach the upper end of the continuum of opportunities for scientific literacy. Active engagement, while important, cannot be a substitute for a sequential plan for developing literacy over time. Linking meaningful instruction across disciplines to promote scientific literacy requires a focus on the general instructional environment as well as specific instructional skills. Toward this end, both schools represent missed opportunities at different points along the continuum.

Achieving the Promise of "Science for All"

The continuum of opportunities for developing scientific literacy is ephemeral, growing and extending as the requirements of society increase. While scientific and technological literacy for all students has become a national priority, the question of how to achieve this goal requires consideration of many aspects of the teaching-learning process. The development of national and state standards in curriculum, instruction, and assessment are important steps in providing the focus for change (Darling-Hammond, 1994). These standards also generate discussion about the procedures to be used in implementing and monitoring the change process.

In recent years, educational researchers in collaboration with practitioners have been building a knowledge base for promoting science learning (American Association for the Advancement of Science, 1993). For students developing English language proficiency while learning academic content, much remains to be learned (Fradd & Larrinaga McGee, 1994; García, 1994; LaCelle-Peterson & Rivera, 1994). However, what is already known can be applied to provide adequate instruction now. Beyond the establishment of goals and guidelines, a great deal must be done to produce important learning outcomes in schools with significant numbers of culturally and linguistically diverse students.

Large scale plans are evolving as vehicles for systemic change in promoting scientific literacy. One example involves Project 2061's effort to address the needs of under-served groups of students in science education reform. Another example involves the National Science Foundation's Urban Systemic Initiative Program to provide assistance in science education innovation for a select number of the nation's 25 largest school districts with high poverty levels.

Changes in the funding and allocation of resources also require school districts to consider ways to ensure that schools share equitably. Recent legal initiatives are forcing policy makers and educators to realize that disparities between urban and suburban schools are no longer tolerable (Bradley, 1994). Rather than waiting for legal remedies, school districts can begin the process of reducing disparities by (a) examining the knowledge base and experiences that students bring to the learning process; (b) considering the knowledge, skills and perceptions of the teachers and administrators; and (c) determining the impact of the instructional environment in promoting scientific literacy. These data sources provide beginning points for harnessing the energies and retooling the teaching-learning process to make science a reality for all Americans. As new programs are implemented, the perceptions of parents, teachers, and administrators can serve as indicators of the success of the change process and as a guide for ensuring that "science for all" becomes more than a pipe dream.

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