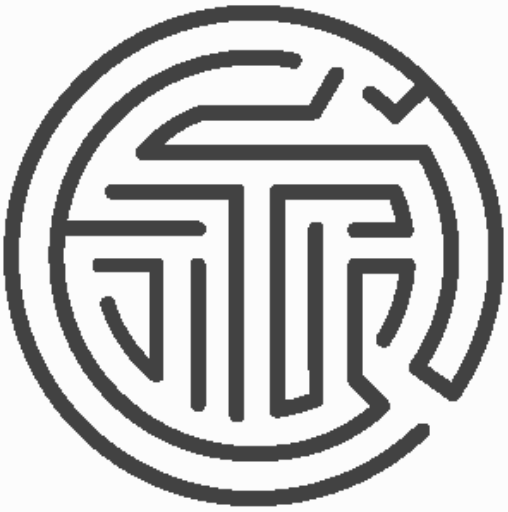
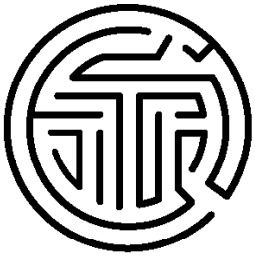


PROMOTING ASSETS AND ACCESS: REFRAMING THE STANDARDS TO INLCUDE ALL STUDENTS

FINAL REPORT TO THE NATIONAL SCIENCE FOUNDATION

NSF AWARD #9800287

CENTER FOR CHILDREN & TECHNOLOGY



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NSF AWARD #9800287

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INTRODUCTION

Standards-based reform is bringing increased rigor and quality into mathematics and science education, but, for a variety of reasons, these improvements have not been fully available to students with physical, developmental, and learning disabilities. This limits participation and achievement in science and mathematics by students with disabilities, and denies the scientific and human enterprise their talents and contributions. Both our reform rhetoric and the health of science demand that high-quality education be available to all students, so exclusion of whole groups from opportunities to excel is not an issue of equity but rather a failing in our definitions of excellence.

The Promoting Assets and Access Project was designed to promote high-quality mathematics and science education for students with disabilities in grades K-6. To this end, we worked closely with individuals and organizations involved in school reform and advocacy, including the standards committees, to examine the standards and make recommendations for how they need to be modified to reflect the contributions and assets that disabled students bring to the learning process. We also developed, implemented, formatively evaluated, and disseminated model activities and materials that illustrate the achievement of national mathematics and science standards by students with disabilities in general education settings. This report describes our efforts and reports our findings on the program's effectiveness.

GOALS AND OBJECTIVES

The purposes and goals of the Promoting Assets and Access Project were closely aligned with the strategic and organizational goals of the National Science Foundation (NSF). In its strategic plan for fiscal years 2001-2006, NSF committed itself to three key outcome goals, including the development of "a diverse, internationally competitive and globally engaged workforce of scientists and engineers, and well prepared citizens" (NSF, 2000). The Promoting Assets and Access Project contributed to this goal by working to increase the participation and advancement of people with disabilities in science and mathematics at the K-6 level in an effort to improve their opportunities to lead productive lives in an increasingly technology-based society and to increase their participation in the science, technology, engineering, and mathematics (STEM) workforce. Research indicates that the number and type of science and mathematics courses taken are positively related to students' achievement in and pursuit of science and mathematics courses at higher grade levels (Oakes, 1995). Specifically, the Promoting Assets and Access Project engaged in laying the groundwork for improving the mathematics, science, and technology skills for students and teachers at the K-6 level by:

- Increasing the awareness and recognition of the capabilities of students with disabilities on the part of practitioners, policy makers, and the general public;

- Developing and adapting techniques, materials, and curricula for teaching science and mathematics that are appropriate for students with and without disabilities;
- Improving the preparation of pre-service and in-service teachers to teach science and mathematics to a student population that is diverse in capabilities and needs.

Our approach was based on the following key elements:

A focus on all disabilities

Following the Individuals with Disabilities Education Act (IDEA) (1997), we defined disability broadly to include mental retardation, hearing impairments (including deafness), speech or language impairments, visual impairments (including blindness), serious emotional disturbance, orthopedic impairments, autism, traumatic brain injury, other health impairments, specific learning disabilities, and developmental delays. Our project activities were designed to promote the inclusion of children with different kinds of disabilities rather than just a subset, such as children with mild and high-incidence disabilities. We were concerned about a hierarchy of disabilities that exists throughout the educational system, that privileges students with certain disabilities over others. Implicit in data collection practices and explicit in the tracking systems is the belief that some students simply cannot learn certain kinds of material because of their disability. It may be justifiable to conclude that students diagnosed with mental retardation or other types of developmental disabilities may have different capacities for grasping higher-level cognitive tasks; however, more often it is low expectations and entrenched notions rather than accurate assessments that limit what students are taught and expected to know. This is particularly true for children with physical and sensory disabilities whose intelligence falls in the "normal" range but who are nevertheless often excluded from educational opportunities and from data collection about participation and achievement.

A focus on the assets that people with disabilities bring to science and mathematics

The Promoting Assets and Access approach was built on an "asset' model of disability, where the experience of disability is seen to inform mathematical and scientific understanding rather than as a deficit that must be compensated (Rousso, 1997). The asset model recognizes that people with disabilities have unique skills and experiences relevant to mathematics and science that can enhance their achievement of the standards and contribute to a more inclusive formulation of the standards themselves, if such assets are recognized and utilized by educators. A growing body of literature is documenting the significant contributions that scientists and mathematicians with disabilities have made in their disciplines (e.g., American Association for the Advancement of Science, 1996; Lang & Meath-Lang, 1995; Rousso, 1997). This literature suggests that assets can come from a variety of sources: family and cultural background and attitudes, experience and exposure, inherent talents, interests, and skills, and the disability experience itself, which can

give a student a unique take on the world and a set of attitudes and skills that can be very beneficial to learning, particularly in mathematics and science. The latter may include, for example, creative problem-solving derived from the disability-based need to do things in nontraditional ways, the vision that comes, for example, from seeing the world in a seated position for wheelchair users, or from literally not seeing at all. For instance, wheelchair users who experience movement through rolling may develop a different, fruitful understanding of concepts such as gravity, speed, friction, and circumference compared to those who walk. The disability experience may also produce an aptitude to challenge the norm/myth of total independence. People with disabilities may work interdependently with great effectiveness and often have a strong ability to persist despite barriers, the result of successful survival in an unwelcoming world designed around the needs of non-disabled people.

A focus on early intervention

The focus in this project was on Grades K-6. A number of considerations led us to focus on the elementary school years. First, the groundwork for all further learning is laid in these years. When students with disabilities are denied opportunities to learn at the outset, they can continue in the pipeline only through extraordinary effort. If students do not participate in sorting objects and learning about patterns, they are immediately disadvantaged in mathematics, and more abstract concepts such as number, even and odd, algebraic functions, or rationales for plant and animal categories have no concrete precedents in their learning. Second, students' experiences in the early years decisively determine whether or not mathematics or science is something they like and can or cannot do. Third, it may help to prevent gaps in achievement between students with and without disabilities. Without intervention, these achievement gaps become increasingly more pronounced as students continue through an inequitable system. Once gaps emerge, educators are more likely to assume that they result from students' deficiencies and are more tempted to resort to remedial approaches to address performance differences. Addressing performance differences before they form and grow larger will make it easier for educators to build on students' strengths.

RESEARCH AND EDUCATION ACTIVITIES

To accomplish our goals, we carried out the following activities:

Background Research

To inform the design of the curriculum guidelines and units as well as our work with professional organizations and policy makers, we engaged in a number of research activities, including a review of mathematics and science standards and curricula, classroom observations, literature reviews, and interviews with teachers.

Review of standards and curricula

We reviewed science and mathematics and standards and curricula that have been developed for general and special education populations. Our analyses focused on identifying the access barriers that the standards and curricula might create for students with disabilities as well as on identifying the strengths of students with disabilities in relation to these standards and curricula. We reviewed the following standards documents:

- Standards for School Mathematics (NCTM, 1989);
- Draft version of the Principles and Standards for School Mathematics (NCTM, 1998);
- Final version of the Principles and Standards for School Mathematics (NCTM, 2000);
- Benchmarks for Science Literacy (AAAS, 1993);
- National Science Education Standards (NRC, 1996);
- A selection of state standards.

The elementary science and mathematics curricula and instructional guides that we reviewed included:

- Access Science
- Everyday Mathematics
- Full Option Science Study (FOSS)
- Investigations in Number, Data, and Space
- MathWorkshop
- Math Trailblazers
- Playtime Is Science for Students with Disabilities
- Science Activities for the Visually Impaired/Science Enrichment for Learners with Physical Handicaps (SAVI/SELPH).

The review of these curricula included an examination of materials for teachers and students available in print and on the web. Whenever possible, we also visited inclusion and special education classrooms in local schools where these curricula were being used.

Literature reviews

We conducted literature reviews around two major bodies of knowledge. First, we examined the literature by and about disabled STEM professionals to help identify specific approaches and contributions to STEM disciplines that might be related to their disabilities. Second, we reviewed research on science and mathematics teaching and learning by students with various kinds of disabilities as well as by non-disabled students, to help identify the needs and strengths of different students in relation to specific mathematics and science learning goals. Another goal was to identify teaching approaches and strategies that have shown to be successful for students with disabilities. As part of this review we examined research on science and mathematics learning by visually-impaired and blind students, hearing-impaired and deaf students, learning-disabled students, students with developmental disabilities, students with cognitive disabilities, students with physical disabilities, as well as nondisabled students.

Interviews with teachers

To better understand the needs of teachers regarding the inclusion of students with disabilities in standards-based education, we conducted small-group interviews with 20 elementary, middle, and high school level science teachers and learning specialists. The teachers came from two different school districts: an urban, predominately Hispanic school district in New Jersey, and a suburban predominately white school district in New York. Our focus in this study was primarily on science education. Interview questions probed for teachers' awareness and perception of national science standards, their current practices in teaching science to students with disabilities, their experience with implementing standards-based education with students with disabilities, and the kinds of materials and professional development opportunities that would support them in their efforts.

Informing the Work of Standards Committees and Policymakers

Throughout the project, we collaborated with a variety of individuals and organizations engaged in developing and revising national standards and policy. Our purpose was to raise awareness about the capabilities and needs of students with disabilities in science and mathematics, to help identify exemplary practices, and to suggest how standards and policies may need to be modified to help ensure that students with disabilities receive a high-quality mathematics and science education. At the beginning of the project, we anticipated devoting only a small proportion of our time and resources on this activity. However, in response to invitations to inform and respond to important national policy initiatives (e.g., the revision of NCTM standards, the establishment of a congressionally mandated initiative to create a more diverse U.S. workforce in science, engineering, and technology, and the reauthorization of the Individuals with Disabilities Education Act) we

ended up shifting our emphasis and spent more time on this activity and less time on the development and research of curriculum materials than initially planned.

National Council of Teachers of Mathematics (NCTM).

At the invitation of NCTM's Standards 2000 Writing Committee and in collaboration with our consultants, advisers, and teachers, we organized and conducted a detailed review of the Principles and Standards draft. Based on this review we submitted a written response with recommendations to NCTM. The response included a section with general comments about the inclusion of students with disabilities in standards-based mathematics education as well as specific suggestions for revising the introductory chapters (chapters 1 and 2) and the chapters focusing on the elementary grades (chapters 3 and 5). Among other things, our recommendations highlighted the need to mention explicitly that students with disabilities are part of "all students" and to recognize that all learners have strengths and weaknesses, whether they have a disability or not. They also stressed the need to emphasize that expectations for students with disabilities need to be raised and to illustrate the kinds of varied supports students with different abilities and disabilities might need to help them achieve the desired learning outcomes. Such supports might consist of carefully selected content, diverse teaching methods, materials in multiple formats, and the use of technology.

Building Engineering and Science Talent (BEST)

BEST is a public-private partnership to develop and execute a national action plan to create a stronger, more diverse U.S. workforce in science, engineering, and technology by increasing the participation of underrepresented groups. BEST was launched in September 2001 to follow through on the September 2000 recommendations of the Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development. BEST is funded by eight federal agencies, including the National Science Foundation. Project staff were invited to participate in one of BEST's blue-ribbon expert panels, focusing on best practices in K-12 education. We worked with BEST to identify benchmarks that matter most to prepare and interest students with disabilities in science and math; identify best practices and effective interventions in mathematics and science for students with disabilities; specify what evidence supports the effectiveness of these interventions; identify the elements that make the interventions work; and identify factors that would facilitate or hinder institutionalization and wide-scale implementation of interventions for students with disabilities.

Technology, Education, and Accessible Media (TEAM) Coalition

The TEAM coalition, comprising more than thirty disability and education organizations, was initiated in the fall of 2001 with funding from Verizon and strategic and substantive support from Leslie Harris Associates (LHA). The purpose of the TEAM coalition is to examine the current policy landscape and develop a consensus on a technology agenda for students with disabilities. Over the past year, a key focus of the coalition's work was to develop recommendations for the reauthoriza-

tion of the Individuals with Disabilities Education Act (IDEA). Project staff worked with the TEAM coalition to help identify disability organizations to participate in this initiative, to plan meetings of participating organizations, to provide information about technology use and best practice in science and mathematics education for students with disabilities, and to suggest how national policies may need to be modified to improve the education for students with disabilities. Our recommendations focused on increasing access to assistive and universally designed technology through research, development, and professional development of teachers and other personnel.

Developing Instructional Materials to Facilitate the Implementation of Standards-Based Education for Students with Disabilities

To support general and special education teachers in the implementation of standards-based science and mathematics education for students with disabilities, we developed a variety of instructional materials including curriculum and program guidelines for standards-based science education at the elementary and middle school level; curriculum units in science and mathematics for elementary inclusion classrooms; and two workshops designed to help teachers and other practitioners develop universally designed lessons and to use technology to support the inclusion of students with disabilities in general education classrooms. The materials were developed based on existing research and were formatively evaluated through expert reviews conducted by teachers, teacher educators, and researchers.

Curriculum and Program Guidelines for Science

The National Science Teachers Association (NSTA) invited us to contribute to the revised editions of the NSTA's Pathways Guides to the Science Standards (Elementary School and Middle School editions). The NSTA's Pathways books contain guidelines and strategies for teachers to help them move the vision of the National Science Education Standards (NRC, 1996) into practice. We developed two guidelines for science curricula and programs, one for the elementary level and one for the middle school level. The guidelines emphasize general ideas about equity and include practical strategies for implementing these ideas in the classroom. Sidebars contain lists of resources for teaching and learning that are available in print and electronic formats, as well as descriptions of the accomplishments of disabled scientists. The appendices emphasize the idea that equity does not necessarily entail equal treatment, but rather means supporting students to achieve high-level learning outcomes. They also emphasize the creation of inclusive science curricula that build on disabled students' strengths rather than using curricula inaccessible to students with disabilities so that they need special accommodations to be able to participate. Practical suggestions address teaching strategies, assessment, selection of content, and ways that teachers can contribute to the development of programs and systems that support students with disabilities in achieving high-level learning outcomes. Resources include reference to information and materials on accessible science equipment, role models, accessible design of software and web-sites, information about assistive technology, professional development resources, information about test accommodations, and curriculum materials.

Curriculum Units in Mathematics and Science

We developed four curriculum units (two for mathematics and two for science) to illustrate how curricula can be designed to facilitate the inclusion of students with disabilities in standards-based science and mathematics education. Together, the curriculum units span grades K-5. In designing the curriculum units we built on the existing research base on effective instructional practices for students with disabilities and utilized a universal design framework. The curriculum units are built around learning goals derived from national standards in mathematics and science (NCTM, 2000; NRC, 1996). The content of the units focuses on concepts and skills that are foundational for science and mathematics learning (e.g., the representation of number, problem-solving, observing natural phenomena). The units incorporate multiple instructional approaches, a variety of instructional materials, and technology to support students with different abilities and disabilities to achieve shared, standards-based learning goals. Suggestions for assessing student learning are included as well. The curriculum units will be included in a book to be published by the International Society for Technology in Education (ISTE) in 2003.

Workshops for Teachers

We developed two workshops for practitioners to support their efforts to use technology to include students in standards-based science and mathematics education, to facilitate the implementation of the universally designed curriculum units we developed, and to promote the use of the universal design framework in teachers' ongoing lesson planning.

Workshop on using technology to support learners with special needs

This two hour hands-on workshop was designed to introduce participants to different kinds of assistive technologies and universally designed software tools. In addition, participants learn how to evaluate web sites for accessibility and how to customize commonly used productivity tools such as word processors (e.g., Microsoft Word) and web browsers (e.g., Netscape and Microsoft Explorer) to meet the needs of users with different abilities and disabilities. We have conducted this workshop as part of meetings and conferences (see list of presentations in Appendix 3). The workshops were attended by more than 60 teachers and teacher educators.

Lesson-planning workshop

We developed this two-day in-service professional development course to help elementary school teachers build skill and confidence in developing inclusive lessons and lesson sequences in science, mathematics, and other curriculum areas. The workshop utilizes demonstrations, hands-on experiences, discussions, and design activities to help participants learn about the universal design framework for developing inclusive lessons. Participants first examine sample lessons from curricula developed for a general education population, and identify the accessibility challenges these lessons present for students with various disabilities. They then participate in and analyze a universally designed curriculum unit. In the context of this unit, they explore multiple pathways to accomplishing selected learning goals, and examine the contributions of physical, sensory, and

cognitive experiences in the development of the specific skills and concepts involved. The workshop culminates in participants' utilizing the universal design framework to design lessons for their own specific classroom contexts. A pilot version of the workshop was offered as part of the New Perspectives Program at Bank Street College of Education in the summer of 2002 and was attended by six teachers.

Dissemination

Dissemination has been central in this project. Our efforts have been directed at informing others about our work, raising awareness of the contributions of disabled scientists and mathematicians to their disciplines, providing information about how to ensure that standards will be inclusive of students with disabilities, and supporting teachers in the implementation of the standards with students with disabilities. We have made special efforts to reach a mainstream, general education audience through our dissemination activities, including teachers, teacher educators, policy makers, researchers, and the general public. The products we developed include

- Guidelines for developing accessible science curricula and programs;
- Examples of universally designed curriculum units;
- Papers and reports.

To ensure their accessibility to the broadest possible audience, the products are available in multiple accessible formats including print, Braille, and digital format. Dissemination methods included workshops, presentations, and publications (see Appendix 3 for a detailed list of workshops, presentations, and publications).

Project Evaluation

Evaluation research was conducted by project staff with input from project consultants and members of the advisory board. It consisted of the following four components:

- Documentation and formative evaluation of project activities. We took extensive notes of meetings and contacts with national organizations, and worked with project advisers and consultants to assess whether project activities are effective for accomplishing our goals.
- Formative evaluation of curriculum materials. We engaged teachers, teacher educators, and researchers in reviewing the curriculum units and guidelines we developed and revised the materials based on their suggestions.
- Evaluation of the impact of our work on policy makers. We followed and documented the work of collaborating organizations (NCTM, TEAM coalition, BEST) in relation to the inclusion of students with disabilities. We also analyzed the NCTM Principles and Standards document to determine the extent to which the recommendations from our review of the draft version were incorporated in the final version. The purpose of this analysis was to document the impact of our

review on the standards writers, and to obtain formative information about our strategies for communicating with policy makers.

- Documentation and formative evaluation of our dissemination and outreach activities. We documented the number of participants in our workshops and presentations and, whenever possible, had participants complete written evaluations.

Development

To help ensure the continuation of the work begun through this project we developed and submitted proposals around the following three strands of work:

Teacher Preparation

In collaboration with Bank Street College of Education we developed a project to improve preparation of teachers for serving students with and without disabilities within a standards-based mathematics curriculum. Building on the lesson study approach and utilizing the case method, the goal of this project is to develop five modules of professional development materials. Each module will consist of at least two three-hour multimedia case studies of teaching events involving students with disabilities in mathematics classrooms as well as activities that guide users in their interaction with the case materials. A proposal was submitted to NSF's Teacher Enhancement Program.

Instructional Materials Development

Another follow-up project is designed to further increase the availability of mathematics curriculum materials for grades PreK-5 that facilitate the achievement of standards-based learning outcomes by all students, including those with disabilities. The project utilizes a universal design for learning (UDL) approach and builds on the curriculum design process developed as part of the Promoting Assets and Access Project to develop, implement and evaluate five prototype curriculum modules for elementary mathematics classrooms. The modules will build on the strengths of students with disabilities and incorporate multiple, research-based pedagogical strategies to support individualized learning. The project involves close cooperation with curriculum developers who are currently developing new standards-based mathematics curricula and who are revising existing curricula, to contribute to their efforts and to share our modules, findings and an annotated guide of our design process. A proposal for this project was submitted to NSF's Instructional Materials Development Program.

Universal Design Research and Action Agenda

In collaboration with AAAS, the CPB/WGBH National Center for Accessible Media (NCAM), and the Center for Applied Special Technology (CAST) we have developed a proposal to convene experts in universal design, representatives from universities and K-12 schools, and STEM professionals. Our purpose is to develop a national agenda for research and action on improving K-12 mathematics and science education for students with disabilities. We have submitted proposals for this project to private foundations.

FINDINGS

The activities of the Promoting Assets and Access Project produced insights about key conditions that help to ensure that students with disabilities will receive a high quality science and mathematics education. Specifically, the project contributed to our understanding of

- How standards need to be revised to insure the inclusion of students with disabilities and reflect their contributions and strengths;
- How curricula for general education inclusion classrooms need to be designed to ensure their accessibility to students with disabilities;
- What kinds of support teachers need to facilitate their efforts to include students with disabilities in standards-based science and mathematics education.

Developing Standards for All

National science and mathematics standards include a strong commitment to provide all students with opportunities to attain high levels of scientific and mathematical literacy (AAAS, 1993; NCTM, 2000; NRC, 1996). Our analyses of the standards and the research literature revealed that integrating considerations about students with disabilities more deeply throughout the standards could strengthen this commitment. Specific suggestions for standard writers are to:

- Emphasize that students with disabilities are part of "all students" and explicitly acknowledge that students with disabilities have traditionally been underrepresented in science and mathematics programs and careers.
- Acknowledge heterogeneity among all learners. In the standards, the phrase "all students" tends to suggest that "all children" are essentially the same in development, experience, and prior knowledge, as well as the same in the ways in which they learn most effectively and easily. If instead the standards acknowledge the range, variation, and diversity among "all children," then it becomes easier to talk about students with disabilities in concrete terms without their being the only special group singled out for attention and assistance.
- Acknowledge the heterogeneity among students with disabilities. It is also important to recognize that a number of different disability types are covered by the phrase "students with disabilities." More than 5 million students, about 10% of the school-age population, have disabilities and qualify for special education services. While children with disabilities have things in common, it is important to keep in mind that they are also a very heterogeneous group. Each disability brings its unique set of strengths in relation to science and mathematics. Even within a particular disability group there can be a large degree of variation in the kinds of talents and needs an individual has.
- Emphasize high expectations and explicitly acknowledge that students with disabilities are one of several groups for whom expectations need to be raised. Low expectations have traditionally been one of the major barriers to participation and achievement especially in mathematics and science for students with disabilities.

- Emphasize that high expectations need to be coupled with strong supports that will enable students to accomplish the desired learning outcomes. Provide concrete examples of such supports throughout the standards.
- Emphasize the need for varied approaches to teaching and assessment. Explicitly describe in multiple contexts the need to provide a diversity of teaching strategies, materials in multiple formats, and multi-sensory presentations of information.
- Illustrate how science and mathematics content can be connected to the prior knowledge, experiences, and interests that students with disabilities bring to the classroom.
- Emphasize active engagement with science and through various means, including manipulatives, technology, personal involvement, or collaborative problem-solving. A common misconception about students with physical, sensory, or attentional disabilities is that they cannot handle manipulatives or technology as they might "break " the equipment, or might be too "distracted" by it.
- Emphasize providing students with opportunities to communicate through various means and of supporting students in the use of language to talk and write about mathematics and science.
- Emphasize integrating universally designed technology to facilitate the development of science and mathematics concepts and skills of all students and the use of assistive technology to enhance the participation of students with disabilities.
- Embed recommendations about including students with disabilities in the context of other relevant policy and law. National science and mathematics standards, with their emphases on promoting high standards for all students, are consistent with legislation that affect students with disabilities, such as the Americans with Disabilities Act (ADA), the Individuals with Disabilities Education Act (IDEA), and the No Child Left Behind Act (NCLB). The NCLB is explicit that students with disabilities and diverse learning needs are part of the definition of "all students." And both IDEA and NCLB require the participation of students with diverse learning needs in assessments, including providing accommodations and adaptations to enable their participation. These students' results must be considered in the planning of curriculum by the school districts and in reports made to the state. It is therefore essential that all efforts be made to ensure that students with disabilities have the opportunity to master the same curriculum as their counterparts. The standards could be more explicit in making connections to specific mandates of the law.

Through our work with national organizations we learned that there is a strong commitment and interest on part of standards writers and policy-makers to include students with disabilities. At the same time, these organizations have a great need for information about the capabilities and needs of students with disabilities in relation to science and mathematics as well as for information about instructional practices that are effective in supporting students with disabilities in achieving high-quality learning outcomes. The responses of the NCTM standards writers to our

recommendations indicate that certain ideas may require considerable rethinking and are not embraced automatically. Our analyses of the NCTM standards indicated that while many of our suggestions were incorporated into the Principles and Standards document, a few were not. Most notably, the final version of the standards reflects a view of disability as a deficit, describing strategies for accommodating students with disabilities so they can participate in a curriculum that may otherwise be inaccessible to them. This contrasts with the asset perspective of disability that we emphasized in our review, and with our suggestion to create and use curricula that build on every student's strength from the outset. Another idea omitted from the final version of the Principles and Standards document relates to the curricular sequence in which mathematics is taught. Emphasizing that the development of math concepts and skills does not always follow the same order for every child, we had suggested allowing for more variability in the sequence in which different math concepts are being taught. The final draft of the Principles and Standards document, however, emphasized teaching and learning mathematics in a fixed, predetermined order.

Designing Accessible Curricula

Our review of existing science and mathematics curricula revealed that most existing general education mathematics and science curricula and materials have not been designed to support the attainment of high-quality standards-based learning outcomes by students with disabilities alongside their non-disabled peers. While exceptional work has been done developing standards-based elementary school mathematics and science curricula for a general student population, these efforts have given limited attention to incorporating content, instructional strategies, and materials that have been shown to support students with disabilities. Even though existing curricula tend to emphasize work in small groups and the use of multiple approaches to solving problems, instructional activities, materials, and products within a given lesson are often not differentiated based on individual students' needs and strengths. Options for individualizing learning are often limited to providing vocabulary support, extra practice, and enrichment activities. Different groups of students end up working on the same problems using the same materials and the same activity. For instance, to learn about the relationship between different geometric shapes, a lesson may involve small groups of students filling outline drawings of geometric shapes using pattern blocks. Following this activity, students may be asked to record their observations and findings in writing. While this is a valuable activity for some students, it excludes students who cannot see or visually process the outline drawings because of a visual impairment or learning disability. It also excludes students who may be unable to manipulate the pattern blocks because of a physical disability or difficulty with fine motor control, and those who have difficulties expressing their thoughts in writing. Students may fail to achieve the desired learning goal not because they are incapable of learning about the relationships between geometric shapes, but because the activity presented is inaccessible for them.

Our classroom observations and interviews with teachers indicated that making the content, activities, and materials of these curricula accessible to students with disabilities after the fact places a

considerable burden on classroom teachers. Often, teachers must go to great lengths to adapt existing curriculum materials for students with disabilities—something they do not feel well prepared for, and adaptations tend to be insufficiently challenging to students with disabilities and to socially isolate them from their nondisabled peers. According to a recent national survey (Maccini & Gagnon, 2002), general and special education teachers identified the lack of adequate materials as a considerable barrier to successful implementation of standards-based mathematics education for students with disabilities. For teachers to develop curriculum adaptations locally, without benefit of broad experience and research, is expensive and inefficient. Moreover, rarely is knowledge about how to do these adaptations aggregated, and the adaptive design system does not get transferred into the general practices of curriculum design. Clearly, as the number of students with disabilities who are educated in the general education classroom steadily increases[1], so will the need for general education teachers to have adequate curricula, tools, and resources to serve them.

Research can serve an important role in the design of accessible curricula. There now exist a small body of literature that can guide the selection of content, materials, and teaching strategies to support a diverse group of students in attaining standards-based learning outcomes. One strand of literature is documenting the contributions that people with disabilities have made to science and mathematics (e.g., Lang & Meath-Lang, 1995; Rousso, 1997), facilitating the identification of specific topics for study. Research also can help identify the kinds of instructional supports that facilitate the participation of students with disabilities in learning environments built around more general problem-solving scenarios and constructivist frameworks (e.g., Bley & Thornton, 1995; Giangreco, Colninger, & Iverson, 19989; Karp, 2000). For instance, students with severe speech, hearing, vision, and cognitive impairments will succeed in mathematics when given supportive instruction in classroom that focus on understanding. For example, blind and visually impaired students benefit from opportunities to explore visual concepts and materials through tactile, kinesthetic, and auditory means (Cox & Dykes, 2001). Deaf and hearing-impaired students benefit from opportunities to engage in cognitive, challenging word problems and instruction in analytic problem-solving strategies (Kelly, Lang, & Pagliaro, in press). Students with certain kinds of learning disabilities benefit from using graphic representation and visualization when solving problems (Jitendra, 2002; Winebrenner, 1996). Technology, in particular, has a key role to play to make the kind of problem-based learning that national standards call for accessible to students with and without disabilities (e.g., Rose & Meyer, 2000; Pugach & Warger, 2000; Woodward, Gallagher, & Rieth, 2000). Multimedia tools, simulations, and large authentic science data sets available on the Internet are just a few examples of technologies that provide for multiple forms of student expression and engagement, support the visualization of mathematical concepts and operations, scaffold problem-solving, provide immediate feedback, and make information available

[1] Approximately 5.5 million students between the ages of 6 and 21, representing 12% of school population, have disabilities (U.S. Department of Education, 2000). Between 1986 and 1996 the percentage of children ages 6-21 with disabilities who were educated in the general education classrooms increased substantially, by nearly 20 percentage points (NCES, 1999b). In 1996, 45% of all children with disabilities were predominately educated in general education classrooms, 29% in resource rooms, 22% in separate classes, and 4% in separate facilities. Despite variation in magnitude, participation in general education classrooms increased for students with all different types of disabilities, including students with learning disabilities, speech and language impairments, visual impairment and blindness, hearing impairments and deafness, orthopedic impairments, serious emotional disturbance, mental retardation, autism, and multiple disabilities.

in multiple accessible formats (print, Braille, images, speech-output, etc.).

It is important to note, however, that the research literature in this field is still in its infancy, and little information is available, especially on science and mathematics learning by students with low-incidence and more severe disabilities. Similarly, explicit writing by and about STEM professionals with disabilities that connects their disabilities to their contributions and approaches to science and mathematics is still relatively scarce. Clearly, more research is needed in these areas.

Through our literature reviews, interviews and observations of teachers, and our curriculum development activities, we were able to identify and test the feasibility of an approach to lesson planning and curriculum design that is responsive to the various needs and strengths of diverse learners. We have found that a universal design framework holds considerable promise for integrating instructional approaches that have been found effective in supporting students with disabilities in achieving high-quality learning outcomes in mathematics and science. "Universal design" is a new approach to curriculum design and technology integration (e.g., Bowe, 2000; Orkwis & McLane, 1998; Rose, 2000). The universal design approach uses the flexibility of computers and the Internet to design tools, educational content, and instructional approaches that support individualized learning. According to the Council for Exceptional Children, "universal design means the design of instructional materials and activities that makes the learning goals achievable by individuals with wide differences in their abilities to see, hear, speak, move, read, write, understand English, attend, organize, engage, and remember. Universal design for learning is achieved by means of flexible curricular materials and activities that provide alternatives for students with differing abilities. These alternatives are built into the instructional design and operating systems of educational materials—they are not added on after-the-fact." A universally designed curriculum facilitates the inclusion of students with disabilities in all aspects of the learning experience (content, methods, assessment, materials). UDL expands opportunities for all learners and strives for greater educational impact, thereby increasing the capacity of general education to address student diversity.

The use of multiple instructional strategies responsive to individual differences in learning is supported not only by research on science and mathematics learning by children with disabilities (e.g., Jackson, Harper, & Jackson, 2001), but also by cognitive research examining mathematics learning by children without disabilities. This research has shown that strategy use in arithmetic problem solving varies not only with age, but often also between children of the same age (Bransford, Brown, & Cocking, 1999; Cooney, Swanson, & Ladd, 1988; Siegler, 1996). Even the same child given the same problem on two different days may use different strategies (Siegler & McGilly, 1989). When solving an addition problem such as 4+3, five-year-olds may count from 1, retrieve answers from memory, or count on from 4. The new understanding of children's strategic development has led to the creation of new instructional approaches (e.g., reciprocal teaching, communities of learners) that recognize and build on children's knowledge and use of diverse strategies (Bransford et al., 1999).

The impact of universally designed curricula in science and mathematics has not yet been directly measured. However, researchers and educators have postulated a number of benefits of the uni-

versal design approach. An important goal for future research is to test these hypotheses. Proposed benefits include: supporting teachers in their efforts to provide all students with a standards-based education and providing them with effective, research-based tools and approaches to support students with disabilities; helping students with disabilities attain high-quality learning outcomes in science and mathematics; and improving science and mathematics learning for all students. The reason universal design promises to benefit all students is that instructional strategies and approaches found to work well for students with disabilities also work very well for students without disability. For instance, providing explicit strategy instruction, an instructional method shown to be very successful for students with learning disabilities (Giangrecco & Doyle, 1999; Karp, 1999), can be of great help to students without disabilities as well. Nondisabled students, who for a variety of reasons (e.g., absence due to illness, transfer from a different school) may lack a particular skill needed to solve a given problem (e.g., how to compute the average), will benefit from the teacher's explicit review on how to approach a data analysis problem requiring this skill. In addition, the use of multiple, alternative pathways to teaching particular concepts will help deepen children's content knowledge. For instance, exploring the concepts of number and quantity through non-visual means (e.g., counting and exploring sounds, counting and exploring movements such as the number of steps climbed on a stair) will not only benefit blind students and non-visual learners, but will also help all students to uncover new aspects and relationships relating to these concepts (e.g., more, less, cardinality) that previously may have gone unnoticed.

Teacher Preparation

In addition to standards that are inclusive of students with disabilities and curricula that are accessible to them, another key element in supporting students with disabilities in achieving standards-based learning outcomes is adequate teacher preparation. Our research with teachers revealed that teachers often feel ill-prepared to implement standards-based science and mathematics education for students with disabilities. The research literature is consistent with our findings. According to a recent survey of a nationally representative sample of public school teachers conducted by the National Center for Education Statistics (1999a), only 21% of teachers who serve students with disabilities reported feeling very well prepared to address the needs of these students. Among mathematics teachers, the percentage was even lower. Only 19% of teachers whose primary teaching assignment was mathematics indicated feeling very well prepared to teach students with disabilities. Not surprisingly, a recent analysis of data collected by the National Assessment of Educational Progress (NAEP) indicates that in math, the least common topics for professional development are those dealing with special student populations, such as those with limited English proficiency or special needs (Wenglinsky, 2000). Lack of preparation is an issue for both general and special education teachers. While special education teachers have expertise in disability and individualizing learning experiences, they are often less familiar with most recent reforms in the teaching and learning in mathematics. By contrast, general education teachers tend to be more familiar with current issues in mathematics teaching and learning, but they are

often less familiar with the needs and strengths of students with disabilities and how to individualize instruction based on students' needs and strengths.

Clearly, there is great need to broaden the preparation and professional development of teachers. Our own research and research conducted by others (e.g., Giangreco, Cloninger, & Iverson, 1998; Karp, 2000; Mastropieri, & Scruggs, 1992; Wade & Zone, 2000) have helped to identify key competencies that teachers need to help students with disabilities succeed in a general education setting. Among other things, teachers need to know how children with different kinds of disabilities develop and learn; how to analyze students' needs and strengths; how to use a variety of instructional approaches (e.g., explicit strategy instruction, coaching, cooperative learning, inquiry-based learning); how to make decisions about and manage multiple instructional strategies; how to adapt curricula and activities and design effective lessons; how to identify, develop, and utilize appropriate resources and materials; how to formally and informally assess student learning; how to seek assistance and guidance from specialists and other resources; and how to work with specialists and families. The National Council for Accreditation of Teacher Education (NCATE, 1998) acknowledges these competencies by emphasizing that elementary school teachers need to understand how elementary students differ in their development and approaches to learning, and create instructional opportunities that are adapted to diverse learners.

CONTRIBUTIONS

Contributions within Discipline (Science and Mathematics Education)

The principal focus of the Promoting Assets and Access Project was on science and mathematics education for students with disabilities. Our project contributed to this discipline in two major ways:

- By supporting teachers in the implementation of standards-based science and mathematics education through the provision of instructional materials and workshops;
- By providing standards writers and policy makers with information to help make standards and policies more inclusive of students with disabilities and instructional practices that support them.

Supporting Teachers in the Implementation of Standards-Based Education for Students with Disabilities

Through the inclusion in publications of the NSTA and ISTE, our curriculum materials have been and will be able to reach a large national audience of general education teachers. The science curriculum guidelines were incorporated into the appendices of the revised elementary and middle school Pathways Guides and published in 2000. The guidebooks are widely used nationwide by teachers at all levels. NSTA sold more than 47,000 copies of the first edition guidebooks, and so far has printed 10,000 copies of the revised elementary and middle school editions. The invitation to contribute to the Pathways Guides offered an important opportunity to reach and provide guidance to a large audience of general education teachers. The science and mathematics curriculum units to be published by ISTE in 2003, will reach a large national audience of general education teachers as well. We expect our materials to provide information and guidance to teachers on how to include students with disabilities in standards-based science and mathematics education. The workshops and presentations we offered at various venues were attended by a national audience of approximately 350 teachers and teacher educators. They supported teachers in using the materials we developed, developing universally designed lessons and curriculum units, and using technology to support learners with diverse abilities and disabilities. Ultimately, we expect that the support teachers receive through the curriculum materials, workshops, and presentations will contribute to the improvement of science and mathematics achievement by students with disabilities.

Ensuring the Inclusion of Students with Disabilities and Instructional Practices to Support Them in National Standards and Policies

Our work with national organizations has been largely successful in making standards writers and policy-makers more aware of the capabilities and needs of students with disabilities as well as instructional strategies for supporting them. As described in more detail below, our work with

NCTM has contributed to a more inclusive formulation of the mathematics standards. We are collaborating with other organizations whose work is still in progress, and there are indications that these groups have embraced our recommendations and included them in their products.

NCTM

To assess the impact of our work with NCTM we conducted a document analysis comparing the final version of the NCTM Principles and Standards document with the draft and with the comments we submitted to NCTM. This analysis revealed that NCTM included a number of our suggestions in its final version. Our review made general recommendations about including students with disabilities in the standards and specific suggestions to change the wording of Chapters 2 (Principles for School Mathematics) and 5 (Standards for Grades 3 – 5). Major findings from our analysis include the following:

- Changes relating to students with disabilities were made mainly in Chapter 2 (Principles for School Mathematics) and Chapter 4 (Standards for Grades Pre-K-2) of the Principles and Standards document. The changes in Chapter 4 are most intriguing because we submitted no specific comments on this chapter. However, it appears that the standards writers were able to apply our general comments to the standards for this particular grade-span. One of the writers for Chapter 4 confirmed that our suggestions influenced the revisions for this chapter.

- Students with disabilities are explicitly mentioned in the final draft of the standards as a group that has been traditionally underrepresented in mathematics and for whom expectations need to be raised. The draft did not mention students with disabilities at all.

- NCTM refined its definition of equity. The final draft puts more emphasis on equity of outcomes while the draft emphasized equity of treatment.

- The final version of the standards recognizes that "Students with disabilities may need increased time to complete assignments, or they may benefit from the use of oral rather than written assignments." This discussion was not included in the draft. Our recommendations included the following statement: "Students with disabilities – and often students without disabilities – may need more time to accomplish given tasks, participate in assessments, and acquire skills and concepts."

- The final version of the NCTM Principles and Standards often refers to how technology can help students with disabilities gain access to standards-based education. While the draft cites how technology can play a role in achieving equity, students with disabilities were not explicitly referenced.

The results from our document analysis indicate that, to a large extent, our review made standards writers more aware of the need to mention students with disabilities and to shape the standards for mathematics education in the interest of improving the education for students with disabilities.

TEAM coalition

The TEAM coalition developed a set of recommendations for the reauthorization of the IDEA that were made available to members of Congress. The recommendations suggested that the reauthorized IDEA incorporate:

- The concept of universally designed technologies with funding support for research and development of these technologies;
- Expanded personnel training and preparation in the use and implementation of universally designed technologies and assistive technology devices;
- Requirements to ensure the accessibility of both educational materials and IDEA grant deliverables, including print materials, electronic media materials, web sites, videos, software, CD-ROMs, and DVDs.

There are indications that members of Congress have adopted the TEAM coalition's recommendations. One congressional backer is Senator Patty Murray (D-Wash), who serves on the Health, Education, Labor and Pension Committee. In an article published in the online Special Ed Connection (Urbanski, 2002), Senator Murray is quoted as saying that universal design "will help more students with disabilities participate in school alongside their nondisabled peers and receive a high-quality education. Ensuring all children have access to the materials they need to learn is the first step in ensuring no child is left behind."

BEST

Based on our suggestions and those of other panel members, BEST nominated several programs serving students with disabilities to be considered for inclusion in a "consumer guide" of exemplary K-12 programs that serve underrepresented groups. Among these programs are the NSF-sponsored DO-IT program and the Regional Alliance for Science, Engineering, and Mathematics (RASEM). Nominated programs will be evaluated by the American Institutes of Research for their effectiveness.

Contributions to Other Disciplines (STEM Disciplines)

We anticipate that in the long term, the Promoting Assets and Access Project will also make important contributions to science, technology, engineering, and mathematics (STEM) by increasing the number of disabled people entering these disciplines. Nurturing the assets of students with disabilities in the math or science classroom can, in the long run, have a profound impact, resulting in an expanded cadre of mathematicians and scientists with disabilities who bring their unique voices and perspectives into their work and thereby help to transform mathematics and science themselves. Altering our sense of perspective provides additional insights into our understanding, and sound scientific method advises us to look at the world from different angles, to turn questions and ideas upside down, and to verify our observations in multiple ways. Cecily

Selby (2000) has suggested that the nature of discoveries in science is influenced by the nature of the questions asked by the scientist; these, in turn, are influenced by the scientist's unique mind, senses, and spirit. The more diverse the scientists and their sensibilities, the more diverse the questions they ask and the more expansive the field. Hence the need for more people with disabilities in science, and by extension, mathematics, to further broaden the nature of inquiry.

Contributions to Human Resources Development

Through its training and education and outreach activities, the Promoting Assets and Access Project contributed to the preparation of practitioners, including teachers and teacher educators, to support students with disabilities in achieving standards-based learning outcomes in science and mathematics.

In the long term, we expect that our efforts will help to ensure the inclusion of students with disabilities in standards and policies. We also expect that our efforts to better prepare educators to support students with disabilities in achieving standards-based learning outcomes will help to improve the education of and opportunities for these students in science and mathematics. Improved education and opportunities in turn will help to better prepare disabled students for careers in science, engineering, and technology, and to increase the number of disabled people in science and math-related fields.

Contributions to Resources for Research and Education

The work of the Promoting Assets and Access Project has resulted in a number of curriculum resources providing information and guidance that support teachers and teacher educators in their efforts to improve the education of students with disabilities in science and mathematics. We have collaborated with professional organizations such as NSTA and ISTE to make these resources available in print and electronic formats to a large national audience of general educators.

Contributions beyond Science and Engineering

The impact of the Promoting Assets and Access Project goes well beyond science and engineering by contributing to the improvement of the education of students with disabilities across all content areas. The project expanded the views of national leaders in education, increasing their awareness about the capabilities and needs of disabled children, the instructional approaches that serve them, and the need to include students with disabilities in standards-based reform for the benefit of all. The project also contributed to the professional preparation of teacher educators, resulting in changes that broadened the preparation of pre-service teachers to work in diverse and inclusive settings. Finally, we developed a model for creating universally designed lessons and curriculum units along with a workshop that navigates through this model, which resulted in teachers developing universally designed lessons for their own classroom contexts.

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APPENDIX 1: PARTICIPANTS, PARTNERS, AND COLLABORATORS

Participant Individuals:

Principal Investigator: Babette Moeller

CoPrincipal Investigator: Ellen Wahl

Others: Louisa Anderson: Harilyn Rousso; Yolanda George; Patricia Campbell; Nancy Rosenbaum; Patrick Carrigg

Partner Organizations:

American Association for the Advancement of Science (AAAS): Collaborative Research

AAAS provided expertise that informed our two main project activities: The development of inclusive hands-on science and mathematics activities, and the translation of curriculum into changes in the standards. Through its extensive dissemination networks, AAAS helped us to make all products and findings available to a broad national audience.

Other Collaborators:

Project Advisers

Project advisers attended an advisory board meeting, provided advice on the design of project activities, reviewed products, and helped with the dissemination of our products and findings. Several project advisers also contributed to the review of the National Council of Teachers of Mathematics (NCTM) Principles and Standards draft and the appendices for the National Science Teachers Association (NSTA) Pathways to the Science Standards guidebooks. The following individuals have served as our project advisers:

DeAnna Banks Beane, Association of Science Technology Centers

Douglas Clements, SUNY Buffalo

Judith Levy Cohen

D. Kent Cullers, SETI Institute

Joan Ferrini-Mundy, National Research Council

Susan Goldman, Learning Technology Center, Vanderbilt University

Naomi Hupert, Education Development Center

Eric Jolly, Education Development Center

Sami Kahn, Consortium for Educational Equity, Rutgers University

Beth Lief, New Visions for Public Schools

Jan Mokros, TERC

Marty Osman, engineer in retirement

Harold Pratt, National Research Council

Stephanie Robinson, Education Trust

Ellen Rubin, Educational Equity Concepts

Adine Usher, Bank Street College of Education

Gerald Wheeler, National Science Teachers Association

Karen Worth, Education Development Center

Teacher Educators

We have worked with mathematics and science teacher education faculty from Bank Street College of Education to explore how to broaden the preparation of pre-service teacher to help students with disabilities achieve standards-based learning outcomes in mathematics and science.

Stan Chu

Marvin Cohen

Barbara Dubitsky

Karen Marschke-Tobier

Harold Melnick

Linda Metnetsky

Andrea Spencer

National Organizations

We have worked with several organizations involved in national policy initiatives relating to science, technology, engineering, and mathematics (STEM) education to help ensure that students with disabilities are included in these initiatives, and to promote the inclusion of instructional approaches that have shown to be effective for students with disabilities into national policies and standards. Our work with national policy initiatives also served to help shift policy makers' perspective of disability as a deficit to disability as an asset, and to raise awareness about existing inequities and possible remedies in relationship to STEM education for students with disabilities. We have worked with the following organizations:

Building Science and Engineering Talent (BEST)

International Society for Technology in Education (ISTE)

National Council of Teachers of Mathematics (NCTM)

National Science Foundation (NSF)

National Science Teachers Association (NSTA)

Science Education for Students with Disabilities (SESD)

Technology, Education, and Accessible Media (TEAM) Coalition

U.S. Department of Education

Other PPD-Funded Projects:

We have worked closely with three other organizations that house projects funded through the NSF Program for Persons with Disabilities to inform and amplify each other's work. Representatives from these organizations contributed to the review of the NCTM Principles and Standards Draft and the appendices for the NSTA Pathways to the Science Standards guidebooks. These organizations are:

American Association for the Advancement of Science

Consortium for Educational Equity at Rutgers University

CPB/WGBH National Center for Accessible Media

Educational Equity Concepts

APPENDIX 2: OPPORTUNITIES FOR TRAINING AND DEVELOPMENT

The Promoting Assets and Access Project offered a number of training and development opportunities for project staff and project partners as detailed below.

Training and Development Opportunities for Project Staff

Project staff benefited from a number of training and development opportunities provided by the project and the EDC Center for Children and Technology (CCT) where the project was housed. These opportunities helped ensure the ability of staff to carry out the work of the project.

Disability as an asset

At the beginning of the project, Harilyn Rousso, one of our project consultants, led a workshop for project staff examining disability as an asset. Topics included: the contributions of scientists and mathematicians to their respective disciplines; theoretical perspectives; and instructional approaches that built on students' strengths.

Project meetings

Thematic project meetings provided opportunities to train project staff in the evaluation of curricula, instructional materials, and technology for accessibility; developing universally designed lessons and curricula; and conducting the workshops we developed.

Staff meetings

CCT conducts weekly general staff meetings and bi-weekly meetings on diversity and research methods. These meetings provided opportunities for project staff to learn about related work at CCT and elsewhere, to examine issues of equity and diversity encountered in CCT's work, and to receive training in research methods (developing protocols, conducting interviews, organizing and analyzing data, and developing reports).

Interns

The project was able to offer internships to an undergraduate and a graduate student. Interns received training in conducting literature reviews, analyzing documents, and evaluating curricula, instructional materials, and technology for accessibility.

Training and Development Opportunities for Project Partners:

The Promoting Assets and Access Project also offered training and development opportunities to colleagues at CCT and to our partners. These efforts were designed to raise their awareness of the capabilities of students with disabilities, to help them learn about strategies for including these students in standards-based science and mathematics education, and to better prepare them for working with them in the classroom.

CCT staff

We presented information about the Promoting Assets and Access Project and conducted a workshop on using technology to support learners with special needs for our colleagues at CCT.

Classroom teachers

We invited collaborating teachers to contribute to the review of the NCTM Principles and Standards draft and provided them with guidance and support for doing so. While these teachers are experienced professionals, none had previously contributed to a review of national standards. Participating in this review process increased teachers' familiarity with the national mathematics standards and the process of creating standards, and enabled them to share their classroom-based perspectives and concerns with policy-makers.

Bank Street College of Education faculty

We conducted workshops on using technology to support students with disabilities and worked with individual faculty members to help them integrate technology into their graduate courses and to develop technology-supported action research projects for K-8 inclusion classrooms.

APPENDIX 3: EDUCATION AND OUTREACH ACTIVITIES

Education and outreach activities have been central to this project. Our efforts have been directed at informing others about our work, raising awareness of the contributions of disabled scientists and mathematicians to their disciplines, providing information about how to ensure that the standards will be inclusive of students with disabilities, and supporting teachers in the implementation of the standards with students with disabilities. We have made special efforts to reach a mainstream, general education audience through our dissemination activities, including teachers, teacher educators, policy makers, researchers, and the general public.

Workshops

Ba, H., & Anderson, L. (2002). Diversity, education, and technology. Workshop conducted at the *Learners, Laptops, and Powerful Ideas Conference,* Orono, ME, August 14-16, 2002.

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Presentations

Moeller, B. (2002). *Universal design in the science and mathematics classrooms*. Presentation at the Forum on Technology and IDEA, Washington, DC, May 9, 2002.

Moeller, B., Rousso, H., Anderson, L., & Wahl, E. (2002). *Promoting assets and access: Planning inclusive science and math lessons*. Paper presented at the annual meeting of the Council for Exceptional Children, New York, NY, April, 2002.

Moeller, B., Rousso, H., Anderson, L., & Wahl, E. (2002). *Promoting Assets and Access Project*. Presentation at the Project Directors' Meeting of the Program for Persons with Disabilities, National Science Foundation, Arlington, VA, March 2002.

Moeller, B. (2002). *Comments on the Upping the Numbers Report*. National Action Council for Minorities in Engineering (NACME): Upping the Numbers: Using research-based decision making to increase diversity in the quantitative disciplines. Meeting conducted at the Union League Club, New York, January 15, 2002.

Moeller, B. (2001). *Technology and Learners with Special Needs*. Presentation at the EDC/Center for Children and Technology, New York, June 6, 2001.

Moeller, B. (Chair). (2001). *Special Educators for Special Students*. Roundtable discussion conducted at the fourth annual SchoolTech Exposition and Convention, New York City, March 29, 2001.

Moeller, B. (2001). *Technology Serving Learners with Special Needs*. Presentation at the fourth annual SchoolTech Exposition and Convention, New York City, March 30, 2001.

Moeller, B., & Wahl, E. (2001). *Promoting Assets and Access: Creating inclusive science curricula*. Presentation at the Working Conference on Science for Persons with Disabilities, St. Louis, MO, March 21, 2001.

Moeller, B. (2000). *(From assistive technology to a universally designed curriculum: Computer im Einstatz der Schulung fuer behinderte Kinder und Jugendliche in den USA.)* Invited presentation at: Medienkompetenz: Computer in der Jugendsozialarbeit und in derBenachteilgtenfoerderung [Mediacompetency: Computers in social work and education for disadvantaged youth], Bad Boll, Germany, November 26-29, 2000.

Moeller, B. (2000). Towards improving the education of children with disabilities: Challenges and opportunities. In: M. Honey (Chair), *Dealing with Dilemmas: A Tribute to Jan Hawkins*. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA, April 24-28, 2000.

Moeller, B., & Wahl, E. (1999). *Promoting Assets and Access Project*. Presentation at the annual Project Directors' Meeting of the Program for Persons with Disabilities of the National Science Foundation, Arlington, VA, September 29 - October 1, 1999.

Moeller, B., & Wahl, E. (1999). *Moving Accessible Design into the Mainstream*. Presentation at the second annual Expanding CyberSpace Conference, New York City, November 1, 1999.

Project staff also participated in the DisAbility Expo, an Exposition of EDC's current projects relating to disability, Education Development Center, Newton, MA, June 6, 2000.

Other Activities

Because a member of the project staff served on the review committee for the Women, Minorities, and Persons with Disabilities in Science and Engineering: 2002 report, to be published by NSF, project staff were able to contribute information about the achievement and participation of students with disabilities in STEM education and careers.

We have worked with NSTA and Science Education for Students with Disabilities (SESD) to organize presentations by scientists with disabilities at the annual NSTA conventions. We were able to arrange for a presentation by the distinguished evolutionary biologist Geerat Vermeij for the 2002 NSTA convention and by the chemist Judith Summers-Gates for the 2003 NSTA convention.

We have had contacts with individuals at the U.S. Department of Education and initiated a joint meeting of officials of the National Science Foundation and the Office of Special Education Rehabilitation Services (OSERS). The meeting was attended by Larry Scadden from NSF, Judith Heuman, Assistant Secretary of Education, senior program officers from OSERS, and project staff. The purpose of the meeting was to explore how the NSF and the U.S. Department of Education could join forces to promote the inclusion of students with disabilities in standards-based reform in mathematics and science.

We have worked with Larry Scadden from the Program of Persons with Disabilities at NSF to provide input on how the new system of accountability for project performance that is currently under development could be linked to teaching and learning standards in mathematics and science.

We have built relationships with teacher education faculty from Bank Street College of Education to explore how to broaden the preparation of pre-service teacher to better support students with disabilities in achieving standards-based learning outcomes in mathematics and science.

We have collaborated with the Digital Clubhouse Network to co-host the second annual Expanding CyberSpace Conference, held November 1, 1999, in New York City.

We have also had close contacts with three other organizations that house projects funded through the NSF Program for Persons with Disabilities to amplify each other's work: the CPB/WGBH National Center for Accessible Media, Educational Equity Concepts, and the Consortium for Educational Equity at Rutgers University.

APPENDIX 4: PUBLICATIONS AND PRODUCTS

The Promoting Assets and Access Project has developed a numbers of products. To ensure their accessibility to the broadest possible audience, the products are available in multiple accessible formats including print, Braille, and digital format.

Book(s) or other one-time publications(s):

Moeller, B. (in preparation). *National Educational Technology Standards for Students: Resource units to include students with disabilities.* To be published by the International Society for Technology in Education.

Moeller, B., & Rosenbaum, N. (2001). *Promoting Assets and Access: Including Students with Disabilities in the NCTM Standards for Mathematics Teaching and Learning Evaluation Summary*. New York: Education Development Center, Center for Children and Technology.

Wahl, E. (2001). Can she really do science? Gender disparities in math and science education. In H. Rousso & M. Wehmeyer (Eds.), *Double Jeopardy: Addressing Gender Equity in Special Education Services.* Albany, NY: SUNY Press.

Moeller, B., Wahl, E., Campbell, P., Rousso, H., Anderson, L., Bell, N., Jolly, E., George, Y., & Kahn, S., (2000) *Science for All: Including Each Student.* In: National Science Teachers Association (NSTA), NSTA's Pathways to the Science Standards, Elementary School Edition, 2nd ed. Arlington, VA: NSTA.

Moeller, B., Wahl, E., Campbell, P., Rousso, H., Anderson, L., Bell, N., Jolly, E., George, Y., & Kahn, S. (2000). *Science for All: Including Each Student.* In National Science Teachers Association (NSTA), NSTA's Pathways to the Science Standards, Middle School Edition, 2nd ed. Arlington, VA: NSTA.

Moeller, B. (2000). Towards improving the education of children with disabilities*: Challenges and Opportunities.* In M. Honey, (Chair), *Dealing with dilemmas: A tribute to Jan Hawkins.* Symposium conducted at the annual meeting of the American Educational Research Association, New Orleans, LA.

Information about Our Project Has Also Been Featured in the Following Publications

Scadden, L. (2001). Enabling science. *The Science Teacher,* 68(7), 48-51.

The Goodnewsletter: *Science Education for Students with Disabilities,* Fall 2002.

The Goodnewsletter: *Science Education for Students with Disabilities,* 24(1), p. 8.

Welsh, J. S. (1999). A challenging IDEA: Including special needs students. The Annenberg/CPB Project: The Guide to Math and Science Reform. Accessed online at:

http://www.learner.org/theguide/speced.html.

Mosaic (Summer 2000). A newsletter produced by the Education Development Center.

Other Specific Products:

Review Paper

Promoting Assets and Access Project. (1999). A response to the 1998 discussion draft of the NCTM Principles and Standards for School Mathematics. A review prepared for the National Council of Teachers of Mathematics. New York: Education Development Center.

The review was submitted to the NCTM Standards 2000 Writing Committee.

Internet Dissemination:

1) www.edc.org/CCT This web site contains a project summary and contact information for the Promoting Assets and Access Project.

2) www.learner.org/theguide/ This web site houses a searchable database with information on projects, resources, and organizations devoted to reforming K-12 science and mathematics education. Information about the Promoting Assets and Access Project is included in this database.

3) www.learner.org/theguide/speced.html This web page contains an article about IDEA and the inclusion of students with disabilities in mathematics and science education. The article includes information about the Promoting Assets and Access Project.