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*Leadership in Standards-Based Education*—Following the lead of Texas and California, 29 states now have or are considering pending legislation mandating that all instructional materials purchased by public schools must be usable by students with disabilities. To address this, WGBH's National Center on Accessible Media (NCAM, #9623958) has produced "Making Educational Software Accessible: Design Guidelines Including Math and Science Solutions." The guidelines provide curriculum developers and publishers assistance in making software-based materials accessible (for example, captioning for deaf students, audio tracks for the blind, or alternate/enhanced operation via both keyboard or mouse). National associations of publishers and librarians have encouraged members to use the NCAM guidelines. Interest in the guidelines has been strong and the Center has distributed them to the Association of American Publishers schools division, the Department of Education's technology projects meeting, and numerous universities, museums, and software companies. Elsewhere, working with the National Science Teachers Association (NSTA), the Education Development Center (EDC, #9800287) has completed a series of contributions to NSTA's *Pathways to the Science Standards* publications. The additional sections intend to provide educators with guidelines for including elementary, middle, and high-school students with disabilities in activities and assessments. Two FY 2000 PPD awards to TERC, Inc. (#0090070, #0095392) will help apply the NCTM standards-based curricula to students with disabilities and will develop the SigningAvatar™ to enhance distance-learning programs.

*Assistive and Augmentative Technologies*—PPD-supported principal investigators have made significant gains in the way persons with disabilities can interact with STEM education materials. These successes include improvements to touch tablets by the City University of New York (#9450166); a force-feedback mouse developed by Automated Functions, Inc. (#9906143); and three-dimensional models to enhance the study and comprehension of chemistry, biochemistry, and the life sciences (Arizona State University # 9610289; San Francisco State University #9800281). Oregon State University and ViewPlus Technologies (#9452881, 9800041, 9976548) developed the Accessible Graphing Calculator, Dots Plus Braille code, and the Tiger Advantage Tactile Graphics and Braille Embosser, which provides blind students with a tactile representation of any graphic developed on a computer. This is the first instance of a tactile graphics printer and was co-winner of the B.F. Goodrich university invention of the year in 1996.

*Improved Educational Tools*—PPD awards have also led to the publication of four mathematics and science books prepared with Dots Plus symbiology as developed at Oregon State University (#9452881). Project staff at the University of Northern Iowa have produced two volumes on *Science Teaching in Inclusive Classrooms* of use to anyone trying to address issues of parity and equity in diverse classrooms (#9988729). PPD awards to Reading for the Blind, Inc., helped to develop new technology to integrate computer files with digital voice recording, ultimately leading to new mathematics and science texts for students with print disabilities (#9610308). PPD awards have also helped to adapt the presentation of calculus to visually impaired students (#9906115).

*Improved Access to STEM Education*—PPD activities have done much to introduce hundreds of students with disabilities to STEM in supportive and engaging environments, including summer science camps (#9550003, 9550064, 9732913, 9800324) and undergraduate curricula such as Purdue University’s model program for engineers with hearing impairments (#9353824). For informal science centers benefiting students and the public at large, the Association of Science-Technology Centers (#9906095) is using PPD support to develop science-center exhibits that are more appealing, accessible, and rewarding for all persons with disabilities.

*Mentoring and Role Modeling*—A multi-year effort by the New Jersey Department of Education (#9906123) has developed a distance-learning project to increase the interest in science and science aptitude for deaf and hard of hearing students in kindergarten through twelfth grade. Duke University (#9800201) is working on a system of tiered mentoring is impacting students through the entirety of the supply pipeline, grade school through graduate study. At Temple University, the “Daughters with Disabilities” project (#9906079) has also succeeded in using role models, mentors, and family support to retain the interest of girls and young women in STEM courses. New Mexico State University’s “RASEM Squared” project (#0124198)—also PPD’s first Regional Alliance award—is currently supporting more than 20 students with disabilities majoring in STEM disciplines. Each mentor is required to have a minimum of three weekly consultations with their mentee— younger students with disabilities (either in high school or lower division undergraduates) who have been recommended by science or mathematics faculty as having particular interest and ability in STEM fields. Befitting the expectations of the PPD Regional Alliance model, RASEM<sup>2</sup> involves commitments from 17 two-year community colleges, 6 four-year colleges and universities, and 9 school district regional center cooperatives in New Mexico; and 2 universities and 2 educational service centers representing school districts in West Texas. The alliance also involves two national laboratories, the statewide agencies serving people with disabilities, and a national organization for the advancement of science.

## Going Forward: A Look to the Future

As a part of the preliminary effort to develop the FY 2001 budget request to Congress, the NSF Assistant Director for EHR asked the PPD Senior Program Director to prepare plans for expanding PPD in FY 2001. The result was a multi-year PPD Phase II plan to promote increased participation of students with disabilities in STEM education and career opportunities. A series of programmatic activities that could not be initiated within the existing budget constraints was drafted. The proposed activities include:

- Support of renewals for exemplary demonstration and enrichment projects;
- Outreach to community colleges to promote participation of students with disabilities in STEM<sup>6</sup>;
- Research on why a high number of STEM majors with disabilities change majors during their undergraduate years;
- Initiate efforts in retaining interest in STEM by students with disabilities during their undergraduate years by providing faculty and counselors information on improving participation by diverse populations;
- Analysis of science and mathematics teacher-preparation curricula and certification programs to identify means by which to prepare future teachers for diverse populations of students; and
- Research on ensuring accessibility of distance education-based STEM instruction.

The various and diverse successes of PPD projects are at once the program's greatest triumphs and its greatest challenges for the future. Increases in both the number and quality of proposals being submitted is unquestionably the most significant consideration for the program's administrators, particularly if near-level funding is continued. The increased numbers of quality proposals submitted to PPD obviously necessitates increased scrutiny of the work being proposed in order to ensure that it is not duplicative of past efforts.

Looking to the future, PPD will continue to focus on a Regional Alliance strategy. Projects such as RASEM, which spans numerous communities in the U.S. Southwest (#9550064 and #9800298) have increased access and representation of persons with disabilities at the middle-school, high-school, and collegiate levels, reached out to women and minorities, and garnered state and corporate funding support toward long-term institutionalization.

<sup>6</sup> This was achieved, in part, with an assistive-capacity building initiative in PPD targeting community colleges in FY 2000. Of 9 applicants, 5 awards were granted—to Yavapai College (AZ), County College of Morris (NJ), Landmark College (VT), Springfield Technical Community College (MA), and to a network of community colleges led by Western Michigan University (MI).

As suggested above, the projects supported by PPD in the past decade reflect not only the prevailing education policy and climate of the era, but also some outstanding exemplars of “what works” in modern pedagogical practice for all students, irrespective of ability. Increasingly, providing equitable access for students with disabilities is seen not as an additional “obligation” but as a measure for making STEM education more accessible, engaging, and inspiring for everyone. The relatively recent consideration of diversified presentation and consideration of alternate learning strategies have necessarily been addressed by students with disabilities, their teachers, families, counselors, and mentors all long. Given this, the practices and lessons learned from PPD awardees become excellent models for defining what works, what doesn’t, and where convention can be improved. As one example, we mention the ongoing research on making the Internet accessible to a broader audience and how that audience prefers to interact with web-based content. The number of people needing assistive tools to see, hear, touch, interact with, and move within their world is tomorrow’s pool of potential end-users for the research and education innovators working with persons with disabilities today.

No one intentionally seeks to *exclude* students with disabilities from the full benefit of the educational experience, but too many systems still fail to realize the proven mechanisms for *including* them. With the majority of states now enacting or considering legislation requiring all educational materials to be fully accessible to students with disabilities, we can expect an increase in the amount and diversity of educational products available to address these guidelines. The human intellect and compassion required for utilizing these resources in the most effective manner has never been more obvious or more crucial. Enhanced communication among awardees and between awardees and the broader academic and public communities is also encouraged. In the interest of increased self-sufficiency, future proposals should be guided toward investigating and possibly allying with existing resources and institutions to maximize the outcomes of the existing knowledge base.

While the impact of PPD has been significant, its mandate is far from being fulfilled. As in many (indeed most) areas of STEM education, the particular needs of women, American Indian/Alaskan Native/Pacific Islanders, and rural- and urban-based student populations are not being addressed relative to the representation of these groups in the general student population. We have previously described these individuals as the “minorities within the minority” of students with disabilities, strongly conjecturing that the successful efforts of the research and education communities need to be redoubled and better adapted in these areas.

The preparation of this report has provided the opportunity to take a much-needed overview of PPD's accomplishments during its first decade. From such a perspective, the impact of the program is clear: The diversity and utility of products, training materials, education research and other mechanisms for making STEM education more inclusive of students with disabilities is readily apparent. Equally apparent is that, with the availability of more funds according to the above recommendations, so much more could be done in the future.

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**PPD Sponsors and Principal Investigators by State, 1991-2001**

*States listed in order according to total program funds received; sponsors and current project PIs listed alphabetically.*

State	Sponsors and Principal Investigators (# of PPD Awards)
1. WA	University of Washington – J. Ray Bowen (2), Denice D. Denton (1)
2. NJ	County College of Morris – Judith Kuperstein (1) Foundation @ NJIT – Howard Kimmel (2) New Jersey Department of Education - Karen Noble (1) Recording for Blind, Inc. – John Churchill (1) Rutgers University New Brunswick – Yakov M. Epstein (1), Sami Kahn (1)
3. NM	New Mexico State University – Douglas J. Gillan (1), William C. McCarthy (2), Enrico Pontelli (1)
4. MA	CAST, Inc – Amy Rubin (1) Education Development Center – Babette Moeller (1) Springfield Tech Community College – Jack Barocas (1) TERC, Inc. – Cornelia C. Tierney (1), Judy Vesel (1) WGBH Educational Foundation (2) – Geoff Freed (1), Lawrence R. Goldberg (1)
5. OR	Linn Benton Community College – Carolyn Gardner (2) Oregon State University – John A. Gardner (4)
6. DE	University of Delaware – Kenneth Barner (2)
7. NY	CUNY Research Foundation – Michael E. Kress (2) Educational Equity Concepts – Barbara Sprung (1) Girls Incorporated – Heather Johnson Nicholson (1) NY Hall of Science – Alan J. Friedman (1) Rochester Institute of Technology – Harry G. Lang (2)
8. ND	University of North Dakota – John Backes (1), Sue A. Schmitt (1)
9. DC	American Association for Higher Education/TLT Group – Steven W. Gilbert (3) American Association for the Advancement of Science – Virginia W. Stern (6) Association of Science-Technology Centers – Sally Middlebrooks (1)
10. IL	University of Illinois Urbana Champaign – Reginald J. Alston (1)
11. MI	Holt Public Schools – Margaret Lamb (1) Space is Special, Inc – Michael E. Kersjes (1) Western Michigan University – Robert J. Leneway (1)
12. AZ	Arizona State University – Anshuman Razdan (1) University of Arizona – David Lovelock (1) Yavapai College – Kenneth D. Abbott (1)
13. ME	University of Southern Maine – Libby Cohen (2), Sharon M. Locke (1)

14. CA	Center for Accessible Technology (1) - Lisa Wahl International Community Auditory - Elizabeth D. Mynatt (1) San Francisco State University - Dennis M. Fantin (1) University of California Santa Barbara - Willis D. Copeland (1), Reginald G. Golledge (1)
15. HI	University of Hawaii Manoa - Richard L. Radtke (3)
16. NC	Duke University - Olaf von Ramm (1) East Carolina University - David Lunney (1) Shodor Education Foundation, Inc. - Robert R. Gotwals (1)
17. PA	Temple University - Brian Butz (1), Lynda A. Price (1)
18. IA	University of Northern Iowa - Greg P. Stefanich (5)
19. LA	Louisiana Tech University - Paul N. Hale, Jr. (1)
20. VA	Automated Functions, Inc. - Ronald A. Morford (2)
21. CO	University of Colorado Boulder - Lucy Y. Pao (1), Elaine Seymour (1)
22. MN	Winona State University - Joan M. Francioni (1)
23. CT	University of Connecticut at Storrs - Ivar G. Babb (1)
24. MO	University of Missouri Columbia - Gregory Holliday (1)
25. VT	Landmark College - Richard Grumbine (1)
26. IN	Purdue University - Lyle L. Lloyd (1), Phillip C. Wankat (1)
27. GA	Georgia Tech Research Corp (GIT) - John Goldthwaite (1), Karen Milchus (1)
28. KY	University of Louisville Research Foundation - Patricia B. Cerrito (1)
29. MD	Moneta Development Corporation - Christin W. Everly (1)
30. WV	West Virginia University Research Corp - Edward C. Keller (1)

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Biotechnology Works!: <http://www.usm.maine.edu/~coe/bio/>. (#9800241).

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Center for Applied Technology (CAST): <http://www.cast.org/>. (#9712964).

Center for Assistive Technology and Environmental Access: <http://www.catea.org/>. (#9976086).

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Daughters with Disabilities: <http://www.sistersinscience.org/dwd>. (#9906079).

Disabilities, Opportunities, Internetworking, and Technology (DO-IT): <http://www.washington.edu/doi/>. (#9800324).

Equal Access to Software and Information (EASI): <http://www.rit.edu/~easi/>. (#9906134).

Information Access laboratory: <http://www.ee.udel.edu/InfoAccess/>. (#9450019).

International Community for Auditory Displays (ICAD): <http://www.icad.org/>. (#9729148).

Marie H. Katzenbach School Science Camps: <http://www.njdeafonline.com/ScienceGrant/mksdsciencecamp01.htm>. (#9906123).

Mathematics Accessible to Visually Impaired Students (MAVIS): <http://www.nmsu.edu/~mavis/>. (#9800209).

National Center for Accessible Media (NCAM): <http://ncam.wgbh.org/>. (#9623958).

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