Roles of Professional Scientists and Research Organizations in the Education of Students with Disabilities Preparing to Enter the Science, Technology, Engineering, and Mathematics Workforce

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To many educators and researchers it is sad irony that, despite a growing need for highly skilled workers who can address acute environmental, economic, and health concerns of human society (e.g., Graedel 2001, Varmus et al. 2003), the percentages of U. S. students enrolled in the fields of science, technology, engineering, and mathematics (STEM) have declined since 1975 (Sax et al. 2000). In addition to age-old problems of acute and chronic diseases, poverty, and short supplies of clean water and arable land, society now faces additional problems of energy and natural resource depletion, environmental pollution, and global warming (e.g., Erlich and Erlich 2004). If the educational pipeline to STEM careers is shrinking, where are the legions of trained workers who will solve these problems? There is growing concern that students with interest and potential to succeed are exiting the STEM educational pipeline prematurely, or never even entering it. In particular, students with disabilities tend to be underrepresented in STEM enrollments (http://ehrweb.aaas.org/entrypoint/rr/appendix2.html), even though persons with disabilities are some of the greatest beneficiaries of the results of research in these fields.

Many of the researchers concerned about the future scientific workforce have no formal teaching responsibilities. What role can they play in enrolling and retaining high school, undergraduate, and graduate STEM students? This perspective considers several existing and

potential activities in which researchers can participate to improve the likelihood of success of high school, undergraduate, and graduate students in STEM fields.

Ambassadors of Science. At the high school and public level, researchers often can leverage their effectiveness as "ambassadors of science" by collective, cooperative projects with other organizations that participate in educational outreach. One such project, the SCIENCE (Scientists Cooperating in Enhancing and Nurturing Children's Education) program at CMAVE (Mankin et al. 1996), has conducted activities at science fairs, career fairs, and state fairs, and sponsored laboratory tours and teacher outreach in cooperation with the University of Florida, the Florida Entomological Society, the Alachua County, Florida school system, and school advisory groups. It may be difficult to maintain these projects for long periods due to turnover of cooperators and resources, but the leverage provided by the collective efforts makes them highly worthwhile. A major goal of outreach programs at this level is to ensure that students are aware of the personal opportunities and the variety and societal importance of STEM careers.

Organized Contacts. A traditional way for researchers to make contact with graduate and undergraduate students is through organized scientific meetings, such as seminars, workshops, and conferences. Students benefit from these activities by gaining experience in preparing and organizing information or in conducting research to be presented in a professional format. In addition, participation in technical meetings enhances student awareness of current research opportunities and practices. Students who participate in one or more of these activities are often the most productive early-career researchers after graduation. Many scientists and professional organizations develop and financially support these activities, but there has been limited study of how they might be enhanced to improve their effectiveness.

Numerous research organizations have student-oriented competitions and grants, including several in which I hold membership (Table 1). Two of these, the Entomological Society of America and the Foundation for Science and Disability, have programs designated specifically for students with disabilities (see http://www.entsoc.org/awards/student/beck.htm and http://cmave.usda.ufl.edu/~rmankin/fsdgrant.rtf). The numbers of qualified applicants in these programs are low, however, despite the clear benefits of participation. Although these programs already have high popularity and membership support because of their past successes, professional organizations would further benefit by formally evaluating the effectiveness of their procedures for notifying potential student participants about the competitions, awards and opportunities for professional interaction at annual meetings. It may be worthwhile to offer additional fee reductions or travel grants to minority students and students with disabilities to help increase the proportion of such participants.

Perhaps the most favorably regarded institution-sponsored educational programs involve the employment of high school and undergraduate students as summer interns. Of approximately three hundred persons interning where I have worked over the last thirty years at the Center for Medical, Agricultural and Veterinary Entomology (CMAVE), almost all have obtained professional or teaching degrees, and many have revisited the Center with favorable comments about their experiences. One-on-one experiential activities can be particularly important educational tools for students with disabilities who might be overlooked in a classroom setting. However, it has been difficult to identify and recruit qualified students with disabilities. Successful programs like EntryPoint (http://ehrweb.aaas.org/entrypoint/), organized by the American Association for the Advancement of Science (AAAS), have a network of recruiters to identify students with disabilities who would be potential internship applicants. Other

professional organizations could emulate this approach, or they could provide financial support to expand the numbers of students employed in existing programs.

Enhanced Access to Information. An ongoing debate among researchers, publishers, and governments about Open Access to the research literature (e.g., http://www.nature.com/nature/focus/accessdebate/34.html) has potentially far-reaching educational benefits for undergraduate and graduate students with disabilities. Under Open Access, the costs of publishing research would be borne primarily by the researchers, their home institutions, or granting agencies, rather than by subscriptions, memberships, and direct purchases of research articles, journals, and books. If the issues and costs can be resolved, an increase in open internet access to journals will benefit not only students with disabilities, but also other students who are distant from library facilities, or persons in developing countries who may have difficulty paying required access fees. A rapidly increased rate of internet dissemination of information by publishers, institutions, and researchers is already in progress (Treise et al. 2003). This has led to increased productivity by researchers and more rapid communication of research findings to students and other end users.

The increasing popularity of the internet as a vehicle for science communication is driven in part to the growth of internet search engines, including Google, which tend to assign high visibility to research pages from scientific institutions (Jepsen et al. 2004). The high visibility has led to increased accessibility of scientific content in web pages (see Mankin 2005 and references therein). The costs of producing and disseminating research are reduced, the information is timely, and it can be incorporated easily into institutional long-distance education coursework. Many researchers, particularly in the physical and computer sciences, regularly post preprints and other scientific information on web sites well before the information appears in the formal

literature. Considerable progress has been made in the development and presentation of scientific content for different internet audiences, but many challenges and opportunities remain for researchers and institutions seeking to disseminate this content effectively and efficiently, while ensuring that it is accessible to all persons with disabilities.

Concluding Remarks. Collective efforts by researchers, institutions, and governments are needed to solve a societal dilemma that persons with disabilities, who are some of the primary beneficiaries of research in STEM fields, are some of the least likely persons to enter careers in such fields. These efforts likely involve educational outreach to increase awareness of STEM as a worthwhile career path, development of additional opportunities for experiential learning, and enhancement of access to scientific information on the internet. A successful resolution of this dilemma will provide benefits not only to students with disabilities, but to society as a whole.

References

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Table 1. Examples of research organizations that sponsor student-oriented awards and activities for experiential learning, some of which focus on students with disabilities

Organization	Type of activity[1]	Web site
Acoustical Society of America	F, G, S, SA	asa.aip.org
AAAS	Entry Point, SA	www.aaas.org
American Junior Academy of Sciences[2]	SA	www.amjas.org
American Mosquito Control Association	G, SA	www.mosquito.org
Entomological Society of America	GD, S, SA	www.entsoc.org
Florida Entomological Society	G, S, SA	www.flaentsoc.org
Florida State Horticultural Society	SA	www.fshs.org
Foundation for Science and Disability	GD	www.stemd.org

[1]Nomenclature: F, fellowships; G, grants; GD, grants specifically for students with disabilities; S, scholarships; SA, student awards.

[2]Sponsors student awards at a poster session held at the AAAS annual meeting.