Talking About Disability:

The Education and Work Experience of Graduates and Undergraduates with Disabilities in Science, Mathematics and Engineering Majors

EXECUTIVE SUMMARY

Edited by Virginia W. Stern and Shirley Malcom
based on a study by Elaine Seymour and Anne-Barrie Hunter

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Washington, DC

This study was supported by a grant from the National Science Foundation, Directorate for Engineering, "Recruitment, Retention of Students and Faculty with Disabilities in Colleges of Engineering," (NSF Grant EEC-9101122). The opinions, findings, and conclusions or recommendations expressed in this material do not necessarily reflect the views of the National Science Foundation or the American Association for the Advancement of Science.

1200 New York Avenue, NW
Washington, DC 20005

Printed in the United States of America.

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EXECUTIVE SUMMARY

Introduction

Students with disabilities, although often acknowledged as "the largest minority," are still significantly underrepresented in undergraduate and graduate majors in science, mathematics, and engineering (SME) curricula.

At first glance, the causes of this are not unlike those of other underrepresented groups: the reasons lie in the structure and culture of SME teaching, not in the inherent difficulty of these disciplines. What distinguishes the persisters from those who leave, regardless of their gender, ethnicity or disability, is the development of particular attitudes and strategies.

A strong interest in their discipline and focused career aspirations are characteristics common to successful graduates within SME. Equally significant is receipt of appropriate forms of support and accommodation at critical periods in the early stages of their studies.

On the other hand, there are many unique issues and barriers faced by students with disabilities. The formal and informal systems that govern progress in their discipline do not usually have the flexibility to accommodate the individual requirements of students with disabilities, which often vary even within one disability group. There is frequent tension between the personal characteristics favoring persistence and the cultural and structural barriers to academic progress. The realities of financial survival only exacerbate the issue. Students with disabilities simultaneously demonstrate a high potential for success and a high risk of being lost.

The Study and the Participants

The University of Minnesota was selected for this study because of its strong reputation in science and engineering, and a record of enrolling a significant number of students with disabilities. Within the University of Minnesota, the Institute of Technology (IT) offers degrees in several engineering disciplines, as well as physics, astronomy, chemistry, geology, mathematics, and computer science.

University of Minnesota Institute of Technology students who had registered with the Disabled Services (DS) office of the university were invited to participate in this confidential study. They included full-time undergraduates registered at the Institute of Technology in the fall of 1993 (n=93), and a small random sample of recent graduates (i.e. 2-5 years since graduation) who were working in the Twin Cities area. The total number of participants was 65, 60 of whom were Institute of Technology undergraduates or graduates, and 5 of whom were undergraduates with disabilities majoring in disciplines other than SME.

The University of Minnesota has a national reputation for excellence in serving students with disabilities. All students who register themselves as having a disability gain access through the university's Disability Services (DS) office to a well-established and expanding system of services. These services were developed first in compliance with the federally-mandated 504 Regulations (1977) which required postsecondary institutions to make all programs accessible to qualified students with disabilities. This office continues to provide reasonable accommodations, in accordance with the Americans with Disabilities Act (1990).

The students participated in interviews and focus groups, varying in length from forty-five to ninety minutes. Interviews were conducted in the style of a focused conversation.

Choice of an SME Major

The predominant motivation mentioned by every IT undergraduate with a disability was a strong liking for science, mathematics, computer science, or engineering and/or a strong preference for a career base in these fields. Motivation by intrinsic interest was much stronger amongst the IT undergraduates with disabilities than among SME majors in general in a previous study (Seymour & Hewitt, 1994). Undergraduate students with disabilities were clearer about their educational and career objectives than the general sample of SME majors.

As shown in the 1994 study, entering an SME major largely for reasons of intrinsic interest was the best predictor of persistence. This helps explain why SME undergraduates with disabilities may be more likely to persist despite barriers which students without disabilities do not have to overcome.

The Study Findings

Despite the greater degree of barriers they face, students with disabilities can be regarded as more likely to persist in SME majors than some others. Students with disabilities demonstrate a high level of commitment to their majors; a high degree of intrinsic interest in the disciplines and careers they have chosen; and a high degree of clarity about what they want to accomplish and why.

These students do, however, have significant obstacles to overcome to complete a university SME education. The three major barriers common to SME undergraduates with disabilities are:

- Faculty attitudes regarding certain accommodations
- Some aspects of the financial aid system
- The disability itself and its limitations

Students who are most successful have communicated their needs regarding these issues and /or identified appropriate accommodation and support. These students have developed a combination of persistence, excellent organizational skills, knowledge of assistive technology, and the ability to invoke the necessary support systems or agencies when dealing with barriers. **The most successful scenarios have been when the students, faculty, and support organizations have teamed to address the problems together. It is important to understand that all three members of this team have significant roles and responsibilities in addressing the unique issues faced by students with disabilities.**

Faculty Attitudes Regarding Certain Accommodations

None of the study participants recommended changes in the accommodation system administered by Disability Services (DS). They did suggest that, in many cases, faculty attitudes undermined the system and needed to be addressed.

IT faculty responses to formal accommodation requests from students with disabilities included:

- Discounting the need for accommodation
- Refusing the accommodation as a way to "prepare" the student for "real world" competition
- Encouraging students to drop the class or change majors
- Placing the students in inappropriate testing places (subject to noise or periodic interruptions)
- If the student arranged testing under DS administration, forgetting to send the test, or not communicating changes or errors
- Lowering grades for work done under accommodated conditions

- Insistence on knowing personal details about the disability
- Embarrassing student by talking about the disability or accommodations in front of peers

Study participants perceived, based on faculty responses to requests for accommodations, that some SME faculty "approved" certain conditions as "genuine disabilities" and exercised various degrees of skepticism about all others. The conclusion made by many students is that the rigors of the process imposed on them have little to do with academic issues, but are regarded by faculty as an appropriate way of testing for fitness to belong to the academic and professional communities based on SME disciplines. The essential question raised by many requests for accommodations is, whether in granting it, a student with a disability would be given an unfair advantage over other students.

The Financial Aid System

The main difficulties of students who sought financial aid through the university's financial aid office were the rules, required of all financial aid recipients, that make no allowances for carrying less than a full class load. The nature of the disability, its variability or unpredictability, the effects of particular medications, problems of fatigue, and unexpected crises of mobility and transportation are issues which can make a full complement of classes very difficult or impossible for many students with disabilities. Taking a full load, to qualify for financial aid, very commonly creates a pattern of "incompletes," failures, and temporary withdrawals.

Some students in this study believed they would have spent less time, energy, and money repeating classes, had they been allowed to work at a pace commensurate with the constraints of their disability.

The Disability and its Limitations

People who have little regular contact with disability issues may assume that mobility problems are the dominant type of difficulty experiences by persons with disabilities. Although mobility issues certainly exist, particularly in terms of access to lecture halls, laboratories, field stations, and public accommodations, there are other common situations which cut across the range of disabilities. These common circumstances are less visible and often less acknowledged and addressed, but can be characterized by the following one or more descriptions:

- Disabilities vary over time, in severity and effect, and in ways which are unpredictable
- Unpredictable interruptions can include periods of hospitalization or therapy, which do not necessarily fit into academic calender breaks
- Disruptions can occur as a result of medication or medication changes
- The need to be "pushy" to obtain accommodations can be stressful in itself

The interaction between the disability and its management can produce quite dramatic peaks and troughs in academic performance. Students find they are often unable to take classes which have early morning starts when either the requirements or the effects of medication make it difficult to be fully functional for early morning appointments. Students with spinal cord injuries have regimes which may limit their class schedule. Deaf and hard-of-hearing students, who rely on lipreading or interpreters, often experience eye fatigue in the afternoons.

To avoid a poor attendance record or grades which underrepresent actual knowledge and ability levels, some students with disabilities try to schedule classes in the time slots when they will be have the most energy. However, when a required class or lab is only offered at one particular time, this may be impossible.

Students with disabilities cope with the variability of their circumstances and the need to pace themselves by pre-planning and a high degree of organization. Those incidents which were harder to cope with were close deadlines, unscheduled tests or assignments, and sudden changes of syllabus or venue. **What the students found to be the most successful strategies was when they were able to clearly communicate their individual needs to faculty members and have those needs respected and met. This included cooperation with accommodations, classes which were well structured, and the ability to get class materials ahead of time.**

Other Disability-related Issues

•Many students had problems with the physical lay-out of the classrooms. Sitting for long periods and seeing the board clearly enough were issues for some. For hearing-impaired students, room acoustics, seating in class, and the teacher's delivery and accent all affected how much of the lesson could be heard.

•Some aspects of lab work presented challenges for students with dexterity limitations or prosthetic hands

•Although campus buildings were wheel-chair accessible, the long distances between buildings and the occasional locked elevator posed barriers to students with mobility impairments.

•For those who could not drive, the public transportation system dictated the class schedule. Where possible, students with disabilities organized a complex system or rides and emergency back-up arrangements.

Attrition and the Stop-Go Phenomenon

Although the attrition rate of students with disabilities appears comparable with those of students of color, there are major differences. The "attrition" of students with disabilities is often temporary, more of a stop-go pattern to their progress rather than an abandonment of their education or their field.

Approximately one-third of the IT undergraduates with disabilities reported feeling sufficiently discouraged to consider leaving either their major or the institution. The issues which prompted these projected moves out of the Institute of Technology were not the same as those which prompted switching to non-SME majors among undergraduates without disabilities in the 1994 study. Four related issues recurred in the explanations of undergraduates with disabilities who were considering leaving or who had left:

- Financial problems
- Intermittent troubles due to disability
- Accumulation of "incompletes" in record, related both to the disability and financial difficulties
- Accommodation difficulties

Most students with disabilities resumed their studies once a specific disability set-back and or their financial situation had improved, or they were able to address problems with their academic record. This is not, however, a pattern indicated in the SME attrition rates of students of color, women, or white males. Because time out of school was reported by the undergraduates with disabilities themselves to be, typically, one semester, **the overall time taken to complete IT majors (i.e. a little over 5 years) is similar to IT majors without disabilities.**

Disability as a "Disadvantage of Time"

Coping with time-related problems was a universal feature of the experience of all study participants. It distinguishes their circumstances from those of other SME majors, is a facet of every type of barrier they encounter, and transcends differences of students with disabilities of different types. One way to understand the commonality of students with disabilities in SME is to see them as students who are "time-disadvantaged."

The time issues which participants raised were of five broad types:

- problems of pace
- speed of learning, comprehension, and recall
- temporal disruptions in physical and mental functioning
- time-related educational needs
- time expended in coping with difficulties raised by their disabilities

Because SME faculty have traditionally made the execution of particular learning tasks to particular standards in particular time-frames the criteria for academic success (as opposed to demonstrations of knowledge and comprehension in other forms), the **slower pace** at which students with many types of disabilities must work becomes a critical disadvantage.

Students with learning and other neurological disabilities usually do not learn in the same way as other students and must find **alternative way to absorb and apply class materials**, all of which takes longer than working by so-called standard learning methods.

Students who have a **temporary set-back in physical or mental functioning** due to the fluctuations of their disability or the side effects of necessary medication may lose a morning, a day, or a week of productive study and have to exert double effort to catch up and stay level.

Basic educational requirements and activities of daily living take more time. Students with mobility and visual impairments need extra time to get to and from campus or from class to class. Students with learning disabilities can require more than double the time to complete a reading assignment. Students with hearing impairments must find a TDD pay phone to make a telephone call from campus, or use the TDD relay, which takes more time. Low-vision students read assignments with magnification devices; this takes longer to read each page. Students with asthma must adjust their schedule to demands of medication and energy. Students with diabetes cannot work overtime in a lab if that causes them to miss medication and/or meals.

Coping with difficulties raised specifically by the disability can be frustrating and take valuable time away from studies. Prostheses need adjustment; wheelchair batteries need re-charging; new editions of textbooks cannot be recorded in time; interpreters are not available for *ad hoc* meetings; assistive technology of all sorts requires maintenance and the wear-and-tear cycle of technology does not always match the cycle of core classes.

Thus, to be a student with any form of disability almost certainly means needing more time than is normally allowed to do almost anything that the university expects of its students. **The strength of faculty resistance—especially of time-related accommodations—which students of all disabilities and especially invisible disabilities routinely encounter, supports the findings of the earlier, more comprehensive study (Seymour and Hewitt, 1994). Whether SME majors switch or persist, they experience problems with SME pedagogy, curriculum, and student assessment practices shaped by long-standing traditions about appropriate ways to teach. Because particular requests for accommodations are determined by the nature of disabilities themselves, students are, inadvertently, obliged to challenge some of the pedagogical rules which SME faculty see as necessary for the protection of high academic standards.**

Disability Services

To meet the needs of students with all types of disabilities, the University of Minnesota has established a set of policies, processes and services, administered by the Disability Services offices. The system is intended to accommodate whatever disability-related limitations on educational progress which students bring to this office. The assistance of the DS staff is available to all students who register as disabled. Students with learning disabilities and other invisible disabilities may not wish to disclose their disabilities because of real or assumed stigma. However, only students who register with Disability Services can take advantage of the services. It is also true that some students with learning disabilities are not diagnosed until they are undergraduate or graduate students. Typically they have developed their own coping strategies which served them in precollege and college coursework but were not adequate when they enrolled in a more rigorous curriculum.

Services and accommodations arranged by DS which students with disabilities identified as having special value were:

- Pre-registration
- Arranging priority access to particular classes
- Changing inaccessible or remote classrooms
- Arranging services of note-takers, readers, and interpreters as necessary
- Getting text books recorded prior to start of classes
- Arranging special test accommodations involving extended time, quiet location, assistive technology, or readers or scribes
- Helping students withdraw from class if necessary
- Assistance in locating and trying out assistive technology
- Workshops on resume writing and interview techniques
- On-line job search facility
- A regular supportive relationship with specific DS staff members

Of all services listed above, the supportive counseling and the test accommodations were most frequently cited by all students.

The DS office plays a significant role when the students themselves are unable to negotiate a satisfactory solution between themselves, faculty, administration, or outside agencies such as state vocational rehab, and insurance companies.

STUDY IMPLICATIONS BASED UPON THE AAAS EXPERIENCE

Based upon the recommendations of the participants in the study, as well as the accumulated experience of AAAS working with deans and faculty of colleges of engineering, and students with disabilities in all technical fields, the following issues need to be recognized in order to attract and retain students with disabilities in science, mathematics, and engineering:

Individuality of Students with Disabilities

Scientists and engineers with disabilities are a microcosm of society as a whole. Students with disabilities represent all the diversity of the student population — and more, because students with the same disability each have their particularistic functional strengths and limitations. The sample used in this study is not random distribution, so the distribution of disabilities in this sample might not be the same on every campus, nor every school of engineering. The comments made here cannot be assumed to be the point of view of every student with a disability, or even every student of that disability group.

Similarly, students with disabilities, like all students, have different personalities. Although even a minor disability will present barriers and cause frustration, some students have developed such resilience and determination that they plan and persist after every set-back. Some people are optimistic and have a sense of humor; others internalize every hurt and disappointment.

Most students with disabilities, no matter how high achieving, do not want to be looked upon as heroes. They want to succeed like people without disabilities, in professional and in personal life.

Changes in Faculty Attitudes

Misconceptions, fear, and negative societal attitudes about disabilities are reflected in the higher education community just as everywhere else. Faculty need specific assistance in responding. Training and exposure to positive role models would remind them of the need to focus on the ability rather than the apparent limitation of a student. Renowned scientists and engineers like Thomas Edison, Charles Steinmetz, Albert Einstein, Steven Hawking, and Geerart Vermeij are celebrated for their accomplishments, not for their different way of thinking, inability to see, lack of intelligible speech, or crooked posture.

Faculty, however, often focus first on the disability of the student, and this remains dominant in their interactions with the student. They cannot make the conceptional leap to recognize that talent is present and can be developed in a student who is different (Thomas, 1993).

Changes in the Classroom Environment

Some of the problems that students with disabilities experience are related to poor teaching and classroom management. Addressing these must be a shared responsibility, since now the accommodation seems to be often one-sided — all on the students, who must accommodate to meet the traditional expectations. If faculty were more accepting, the development of classroom accommodations could be a mutual challenge to professor and student, and would benefit from joint problem-solving.

Impact of Technology

In the past two decades, nothing has had greater influence on science, mathematics, and engineering (SME) education and career options for students with disabilities than developments in assistive technology. So much of science, mathematics, and engineering is now computer connected, students with any

disability have access to virtually any field. Alternative input to use computers — voice recognition systems, headpointers and switches that work with special scanning software give those with limited mobility keyboard access. Alternative mice, trackballs, and keyboards allow more controlled input with hands or other parts of the body. Alternative output includes voice sythesis systems with screen readers that convert words on the screen into synthesized speech, refreshable tactile displays of braille or graphics, and braille embossers that produce hard copy braille. Recorded texts are now available more quickly through e-text and digitized speech. The ubiquitous use of e-mail has opened communication to all students and faculty, and has become a special boon to students who are deaf. Real-time captioning can make available every word of a professor's lecture Specialized software such as word prediction packages and spell-check assist all students, including those who have learning disabilities.

Some students with disabilities are accommodated with a one-time low technology solution, e.g., raising a table with some wooden blocks under the legs, or adding a piece of non-slip tape to a glass laboratory instrument. Other students, who may be wheelchair riders, and have the arm strength to use a manual wheelchair, are able to preserve significant energy resources for studies by using an electric wheelchair to go distances on campus. For others, many of the hurdles of research are surmounted through the use of the same technology used by all students, which gives them access to the resources of the libraries from a distance, or permits quick and satisfactory appointments with faculty advisors via e-mail.

Faculty, especially faculty in engineering and science, have an opportunity to understand the impact of the technology and encourage its use.

Students with Disabilities are Enrolled in Higher Education

More than 9 percent of college freshmen report having a disability. The percentage of full-time, first time freshmen reporting disabilities has increased significantly since the late 1970s. In 1994, 9.2 percent of all freshmen reported having some type of disability, compared with 2.6 percent in 1978. With such a large and growing population, colleges and universities need to accommodate this cohort in ways not envisioned before (Henderson, 1995).

Post-secondary institutions are also enrolling increasing numbers of non-traditional students, e.g., women returning to the workforce and students of both sexes who seek new skills when their original careers become obsolete. Some of these students became people with disabilities mid-career and need to be accepted and served.

Existence Proofs of Successful Scientists and Engineers with Disabilities

The American Association for the Advancement of Science has worked for two decades with its Resource Group of Scientists and Engineers with Disabilities. Records of the hundreds of individuals in this group are evidence that people with any disability are able to meet the most rigid criteria in every field of science and engineering and hold professional positions in academia, government, and the private sector (Stern and Summers, 1995).

Some faculty will need to readjust their concepts of the academic potential and professional capabilities of students with physical, sensory, or learning differences, and realize that one can have a full professional life using different approaches. The AAAS database of this Resource Group is available for faculty who wish to interact with peers in their discipline who are also individuals with disabilities.

"Hidden" or Invisible Disabilities Predominate

Students with hidden disabilities —learning, health, and other— account for more than half of all freshmen with disabilities. The largest growth, both in numbers and proportions, has occurred among students with learning disabilities (National Science Foundation, 1996).

SME faculty may be particularly resistent to students with learning disabilities because of the perception that the department would have to lower its standards in order to accommodate anyone with a "learning disability." The term itself, unfortunately, seems to contradict academic and professional achievement.

When faculty recognize that many students learn in many different ways, this negative bias will fade.

Financial Aid

The financial aid restrictions that impact so severely on students with disabilities who cannot carry a full class load, in every discipline, every semester, are generally established by federal guidelines. Postsecondary institutions are beginning to collaborate to address this issue, so that students with disabilities, who are registered with the disability service office on campus, can be considered qualified for financial aid with a modified schedule of course units.

Changes in Higher Education for Everyone

Institutions of higher education are undergoing profound adjustments in all areas. Many are revisiting the structure of their introductory courses. Others are exploring greater incorporation of technology into their teaching. The role of inquiry and undergraduate research are being reviewed. All are being challenged to connect the disciplines to employment opportunities in the "real world."

As the higher education community goes about its own reform it needs to consider how it responds to the needs of individual students and makes the knowledge and excitement of learning available to all. In that re-invention of teaching and curriculum design, the inclusion of students with disabilities can indeed be seen as an opportunity for creativity and flexibility. Typically, these students have brought innovations to their own environment long before they entered a postsecondary program. Their personal resilience has necessitated alternative approaches to many apparent barriers. Their innovations involve the inclusion of both high and low technology in studies and everyday life, and the use of different styles of learning. The range of life experiences that students with disabilities bring to the classroom and laboratory contribute not only to the education of peers, but potentially to the advancement of the engineering and science professions.

Not all students with disabilities who need science, mathematics and computing courses will seek degrees in these fields. Education in these areas is a significant part of a liberal education for the new millennium. In addition, these courses form a critical gateway to medicine, allied health professions, business, education, law and the social and economic sciences. Lack of access to these courses closes off most of the professional opportunities a students might seek.

The recent experiences of AAAS with an internship program for students with disabilities with business and government reinforce the importance of the perspectives that diverse groups contribute to the workforce. In addition to the talent, skills and creativity that the interns bring they also provide a critical window into the experiences of the customers with disabilities (Hoffert,1998). In a company seeking a competitive edge, "different" can mean "value added."

Meeting the learning needs of individual students does not mean that they are being coddled, just as accommodating their differences does not mean that expectations for them are lower. Including students with disabilities is not charity but rather enabling them to support themselves while contributing to the human resource pool of the Nation.

As these students enter the workforce with invaluable skills we have an opportunity to learn from their successes and build a foundation for utilizing this talent on the basis of case examples rather than case law.

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ABOUT AAAS

The American Association for the Advancement of Science (AAAS), founded in 1848, is the worldís largest federation of scientific and engineering societies. It currently has some 143,000 individual members and nearly 300 affiliated societies and academies of science. AAAS publishes Science, the weekly professional journal, and Science books and Films, a source of critical reviews for schools and libraries.

The programs and activities of AAAS respond to a broad spectrum of scientific opportunities. In addition to its activities to strengthen school science, mathematics and technology education, AAAS programs focus on broadening the human resource pool of scientists and engineers, shaping science and technology policy, promoting the public understanding of science, expanding scientific cooperation in global issues, defending scientific freedom and championing high professional standards.

The Directorate for Education and Human Resources Programs (EHR) seeks to improve the quality of science, mathematics and technology education for all students at all levels; to increase the participation of minorities, women and people with disabilities in science and engineering; and to improve the public understanding of science and technology for all people. EHR programs focus on supporting systemic educational reform by developing models, materials, mechanisms, processes and networks; supporting policies and conducting studies and analyses; and implementing findings as appropriate to accomplish the overarching goalóthat real education means connecting schooling with out-of-school experiences.

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