DOCUMENT RESUME

ED 188 381 EC 124 250

AUTHOR Redden, Martha Ross; And Others
TITLE Science for Handicapped Students in Higher Education: Barriers, Solutions and Recommendations.
INSTITUTION American Association for the Advancement of Science, Washington, D.C.
SPONS AGENCY National Science Foundation, Washington, D.C.
REPORT NO AAAS-Pub-78-R-2
PUB DATE 78
NOTE 94p.; Photographs may not reproduce well.
AVAILABLE FROM The Office of Opportunities in Science, American Association for the Advancement of Science, 1776 Massachusetts Ave., N.W., Washington, DC 20036 ($3.00 each including postage and handling)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Accessibility (for Disabled); Attitudes; *Disabilities; Environmental Influences; Hearing Impairments; *Higher Education; Physical Disabilities; Postsecondary Education; *Science Education; Science Interests; Science Programs; Visual Impairments

ABSTRACT

The monograph summarizes the findings and recommendations of a conference on the involvement of handicapped students in higher education science. Handicapped and nonhandicapped students, faculty, student services personnel, administrators, and scientists participated in the sessions. Six categories of barriers were identified: attitudinal, informational, environmental, communication, academic, and financial. Each category was examined for solutions as well, including seeking mentor support to combat lowered expectations, providing disabled students with access to available information, promoting architectural access, using interpreters and note takers, encouraging flexibility in scheduling to complete science tests and projects by handicapped students, and making the financial aid office at least programmatically accessible to disabled students. A final chapter outlines recommendations regarding information dissemination, use of human resources, development of new resources and training strategies, precollege science education, career education and counseling; and campus strategies and accommodations. (CL)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

ED188381

SCIENCE for HANDICAPPED STUDENTS in HIGHER EDUCATION

by
Martha Ross Redden
Cheryl Arlene Davis
Janet Welsh Brown

American Association for the
Advancement of Science
1776 Massachusetts Avenue NW
Washington, DC 20036

AAAS OFFICE OF OPPORTUNITIES IN SCIENCE

In January 1973, the AAAS Board of Directors established the Office of Opportunities in Science, the major purposes of which are:

*to increase the number of women, minority and handicapped persons in the natural, social and applied sciences;

*to increase the kinds of opportunities available to these groups; and

*to increase the participation of minority, women and handicapped scientists and engineers in policy-making, advisory and managerial positions.

To fulfill these purposes, the OOS is involved in many programs and activities. It functions as a clearinghouse on information on women, minorities and the handicapped; it acts as a liaison with other professional organizations to help coordinate equal opportunity efforts; it works with the Scientific Manpower Commission on problems dealing with the recruitment, education and utilization of women, minority and handicapped scientists; and within the AAAS it encourages the increased participation of these groups and the consideration of issues concerning them in all programs and activities of the Association.

Under the guidance of its Advisory Committee and Panels, the Office has developed numerous programs to implement its objectives, including three ongoing projects. The Project on Native Americans in Science is investigating the problems and developing strategies for improving the science education and opportunities available to Native Americans. It is also developing programs on ethnoscience and ethnomedicine, and on altering the attitudes of the general public and educators that are detrimental to Native American progress in technical fields.

The Project on the Handicapped in Science seeks to improve the status and participation of handicapped scientists and to improve science education available to handicapped youth. An ongoing activity is to make professional meetings completely accessible to the physically disabled. Other activities include: the compilation of a resource directory of handicapped scientists and guide for its use by project directors; a study of handicapped scientists' coping strategies; a multi-state lecture tour by a deaf physicist serving as a role model for handicapped students, parents, teachers and counselors; a study and conference on barriers to post-secondary science education for handicapped students, and a newsletter, Access to Science, in conjunction with Tufts R and T Center.

The Project on Women in Science seeks to increase the numbers, status and opportunities for women in the sciences. A year-long study on the Participation of Women in Scientific Research has been recently completed, culminating in an extensive report soon to be published. An Inventory of Programs in Science and Mathematics for Women will catalogue existing programs that encourage women to enter the sciences and mathematics.

OOS welcomes ideas, suggestions and help from all who are interested.

SCIENCE FOR HANDICAPPED STUDENTS

IN

HIGHER EDUCATION

Barriers, Solutions and Recommendations

by

Martha Ross Redden
Cheryl Arlene Davis
Janet Welsh Brown

cover - design and layout by Janette Alsford Owens

Office of Opportunities in Science
American Association for the Advancement
of Science
1776 Massachusetts Avenue N.W.
Washington, D.C. 20036

AAAS Publication 78-R-2

Third Printing, October, 1979

The project "Barriers Obstructing the Participation of Handicapped Students in Post-Secondary Science Education" and this publication were supported by the National Science Foundation, Grant No. SMI77-19910. The authors are solely responsible for the contents of this volume.

CONTENTS

ACKNOWLEDGEMENTS I

INTRODUCTION 1

CHAPTER I 1
The Problem. 1
Selection of Conference Participants 2
Conference Organization 4

CHAPTER II BARRIERS. 6
Types of Barriers 6
Attitudinal Barriers 7
Lowered Expectations 7
Categorical Thinking 8
Reluctance to ask and answer questions 8
Attitudes About Accommodation to a Handicap 9
Assumptions of Inferiority 10
Assumption of Responsibility 10
Spread of Effect 10
Stereotyping 10
Science and Mathematics Phobia 11
Informational Barriers 11
Access by Disabled Students to Available Information . . . 12
Lack of Information 12
Inadequate Dissemination of Available Information 13
Environmental Barriers 13
Building Access 14
Location of Equipment and Bench Controls 14
Labelling 14
Unadapted Work Stations 14
Safety 14
Laboratory design pertaining to the Needs of Handicapped Persons 14
Field Study 15
Communication Barriers 15
Communication Barriers for the Deaf 15
Communication Barriers for the Blind 16
Communication Barriers for the Speech-Impaired. 17
Academic Barriers 18
Inadequate preparation in Mathematics and Science 18
The Inadequate Preparation of Faculty in Adaptive Techniques 18
Testing and Evaluation - a Multifaceted Barrier 18
Faculty Inaccessibility 19
Financial Barriers 19

CHAPTER III SOLUTIONS 20

Solutions to Attitudinal Barriers. 20
Approaches to Lowered Expectations 22
Approaches to Categorical Thinking 22
Dealing with Reluctance to Ask and Answer Questions. . . . 23
Changing Attitudes about Accommodation to a Handicap . . . 23
Dealing with Assumptions of Inferiority. 23
Dealing with the Assumption of Responsibility. 24
Counteracting Stereotyping, Spread of Effect 24
Dealing with Science and Math Phobia 25
Dealing with the Idea that Teaching the Handicapped Takes Extra Time and Trouble. 25
Solutions to Informational Barriers. 25
Providing Disabled Students with Access to Available Information 25
Filling the Information Gap. 25
Ways of Disseminating Available Information. 26
Solutions to Environmental Barriers. 27
Building Access. 27
Labelling Difficulties 27
Adaptation of Work Stations. 28
To Improve Safety. 28
Solutions to Communication Barriers. 30
Deaf Students 30
Blind Students 30
Speech-Impaired Students 32
Solutions to Academic Barriers 32
Inadequate Preparation in Mathematics and Science. 32
Adaptive Educational Techniques. 33
Testing and Evaluation 33
Access to Faculty. 34
Solutions to Financial Barriers. 34

CHAPTER IV RECOMMENDATIONS, STRATEGIES, AND A CHARGE 35

Recommendations 36
Information Dissemination. 36
Use of Human Resources 36
Development of New Resources and Training Strategies . . . 37
Impact on Pre-College Science Education. 37
Career Education and Counseling. 38
Campus Strategies and Accommodations 38
Strategies 39
The Task Force 39
Clearinghouse of Information and Technical Assistance Network 41
A Charge to Groups and Individuals 42
Institutions of Higher Education 43
Professional Associations. 43
Consumer Organizations of Handicapped Persons. 44

Government Agencies 44
Congressional Committees. 45
A Final Charge to Action. 46

APPENDICES

Appendix A, Participants, Conference on Barriers to Handicapped Students of Science at Colleges and Universities 47

Appendix B, Working Group Assignments 53

Appendix C, Conference Schedule 55

Appendix D, Student Questionnaire Used to Solicit Data For the Study. 57

Appendix E, Selected Publications of Consumer Organizations of Handicapped Persons 59

Appendix F, Organizations of and for the Handicapped. 62

Appendix G, Bibliography. 63

ACKNOWLEDGEMENTS

The authors of this report wish to express their profound gratitude to the many individuals who contributed to the success of this project. Our debt is greatest to the conference participants, who gave to this effort with great generosity their time, experience and insight. We are grateful to them for sharing with us their unique perspectives as scientists, science faculty, counselors, administrators and students. A special thanks is due to those who so thoughtfully reviewed the initial draft of this report and offered their comments and revisions.

We also want to thank the handicapped college students who shared their experiences in science with us by their participation in our survey, as well as the many academic scientists who took the time to identify them and encouraged them to write and call us. The detail they provided on the questionnaires has enriched the information in this report. Our appreciation also goes to eight hundred handicapped scientists, who as our AAAS resource group during the past three years, have informed us and continually increased our awareness of the barriers facing handicapped individuals who choose to study science and pursue scientific careers. The wealth of material and insight that they provide improves the quality of all that we do; their continuing guidance and support are invaluable.

Our special appreciation must be extended to Mark Ozer, who graciously volunteered his time to train the discussion leaders and serve as conference facilitator. We are especially grateful also to three people whose presentations did so much to set the tone for the conference: Eunice Fiorito, Special Assistant to the Commission, Rehabilitation Services Administration, U.S. Department of Health, Education and Welfare; Raymond Lifchez, Associate Professor of Architecture, University of California, Berkeley; and Irving K. Zola, Professor of Sociology, Brandeis University, Waltham, Massachusetts. Their respective contributions on consumerism, environmental design, and the sociology of disability provided much insight into the issues of handicapped individuals pursuing higher education in science.

We extend our sincere appreciation to the many people who worked so diligently throughout the June conference. They include the oral and manual interpreters whose skills assured the full participation of hearing-impaired conference participants. To these interpreters - Mike Hartman, Ginny Lewis, Don McGee, Larry Miller and Joseph Rosenstein - we are most grateful. For individual presentations and group discussions alike, they performed at their usual high standard over unusually long periods of time and throughout the most demanding kinds of discussions. We are most appreciative also of the contributions made by the discussion leaders - Helenmarie Hofman, National Science Teachers Association; Edward Keller, Professor of Biology, University of West Virginia; and Virginia Stern, AAAS staff - and by the rapporteurs who, with great diligence and care, recorded the ideas of the working groups. The latter include Michele L. Aldrich, Diane DiQuinzio, C. June Maker, and James F. Sattler, all AAAS staff. We thank other AAAS staff members, Karen Ehrlich, Lorraine Stillwell, and Wayne Fortunato-Schwandt, for their handling the myriad of details associated with the conference and give a special thanks to the tireless, conscientious AAAS staff people who worked so hard on the production of the final report, that is, to James F. Sattler, Lorraine Stillwell, Janette Alsford Owens, and Karen Ehrlich.

Finally, we want to note our great indebtedness to the National Science Foundation for recognizing the need to explore the subject matter of this report and making it financially possible for us to do so. The authors, of course, are solely responsible for the findings, opinions and recommendations of this report, but we warmly appreciate the support, advice and assistance of Foundation staff.

Martha Ross Redden
Cheryl A. Davis
Janet Welsh Brown

CHAPTER I

INTRODUCTION

THE PROBLEM

To be handicapped and yet obtain a quality science education appears to require a certain kind of personality structure and a set of circumstances which are, if not entirely favorable, at least not inhospitable. No handicapped student finds it easy; those who succeed must continually cope with, overcome, circumvent, push against, and sometimes simply endure barriers. Because handicapped people are justly sensitive to being excessively praised or criticized for traits having nothing to do with their professional achievements, we do not wish to portray these people as awe-inspiring but it must be acknowledged that those who "make it" in science demonstrate considerable resilience and strength of determination, as well as the basic requirement of a high aptitude for scientific inquiry.

Since the Project on the Handicapped in Science was initiated early in 1975 by the American Association for the Advancement of Science (AAAS), its major purpose has been to identify barriers to handicapped persons entering careers in science, to collect from handicapped scientists information on their coping strategies in overcoming barriers to their education in science, and to plan strategies for removing the barriers that remain. Over eight hundred disabled scientists have identified themselves to AAAS during the past three years in order that they may assist in this task. Because the training crucial for the development of science careers takes place at the post-secondary level, the barriers to the scientific education of handicapped students must be closely examined and removed. These barriers and the strategies for removing them are the subjects of this report.

The AAAS has gathered data from several sources in order to identify barriers to post-secondary science education and to look at methods for overcoming them. Over the past few months, disabled scientists have been requested to complete a questionnaire which quite fully describes experiences that would lead to identification of barriers and coping strategies. In addition to this questionnaire data, over one hundred disabled scientists wrote at great length of their educational experiences in science to assist Dr. Robert Larsen in preparation for teaching a AAAS Chautauqua-type short course, "The Handicapped Student in the Science Classroom and Laboratory: a Workshop." In addition to this personal data, the project staff has completed an extensive search of the literature to identify articles written by practitioners who had taught handicapped students in their science courses and developed useful teaching strategies. Additional information on the subject is also available through our correspondence and direct communication with handicapped scientists over the past four years. From this data has come valuable information identifying both problems and solutions encountered by students with many types of handicapping conditions. Science faculty have described in detail strategies used in adapting curriculum or lab experiences to offer adequate learning experiences to handicapped students with a variety of disabilities. Handicapped scientists have reviewed the coping strategies they used over the years when they were receiving their education in

Dr. Dennis Maki, a postdoctoral fellow at the University of Michigan, did his graduate work at the School of Medicine, University of New Mexico, in microbiology and immunology. The microscope is lowered and located to provide him and his wheelchair an adequate clearance. Photograph by courtesy of The Arthritis Foundation, New Mexico Chapter.

science as well as those used on their jobs in scientific fields.

In spite of the fact that the information gathered was detailed, explicit and usable by other persons facing similar problems, there remained questions. "Could the same solutions developed for one blind student apply to all others?" "Could the strategies developed at one university be used at all others?" "Are questions of laboratory safety resolved simply because the record has been satisfactory in a few isolated cases?" "Are there barriers faced by persons with certain types of disability that cannot be overcome as they relate to science education?" "Who is responsible for making the decisions concerning science program access for disabled students on a campus?" "How can the information available be disseminated to the key persons responsible for providing access to science?" "How can counselors be made more aware of the opportunities in scientific careers for handicapped persons?" "What administrative changes are necessary in colleges and universities to assure access to science?" "How can communication be improved between disabled students and science faculty?"

The unanswered questions seemed to deal with issues that crossed lines between the various groups responsible for providing science education to disabled students at the post-secondary level -- disabled students, science faculty, administrators, counselors, and disabled scientists. The AAAS Office of Opportunities in Science with support from the National Science Foundation brought together representatives of these various groups to confer on the yet unanswered questions. As far as can be determined there had never before been assembled a group of people representing all the components necessary in order to overcome the barriers to post-secondary education in science for handicapped students. This conference was asked to identify barriers and solutions, then make recommendations for institutional change and responsibility to assure that the strategies developed by individuals might be disseminated and institutional remedies taken to assure access to science education to the largest possible group of handicapped students. This monograph summarizes the findings and recommendations of the conference and, in addition, the results of our related surveys and research of the literature.

SELECTION OF CONFERENCE PARTICIPANTS

To provide the breadth of experience necessary for this conference, five general criteria were applied in the selection process.

Role group. Conferees were primarily affiliated with one of five broad academic or professional categories: handicapped students, handicapped scientists, administrators, faculty, and handicapped student services personnel. This last included vocational rehabilitation counselors, as well as on-campus service delivery persons. By so doing, the perspectives of the major constituencies involved in the educational transaction were all represented in the conference.

Handicapping condition. Every effort was made to represent four general categories of functional impairment, with no regard whatever to diagnostic labels. These were: visual, auditory, lower limb, and upper and lower limb, rather than blind, deaf, cerebral palsied, post polio, etc. When considering barriers and solutions it is far more useful to look at the functional aspects than the medical definition or label of a disability. For example, adjustments are made because a person does not see as well as others, or that a student cannot reach the standard

lab bench because he/she uses a wheelchair, not simply because the student is blind or paralyzed from a spinal cord injury.

Area of scientific interest or expertise. Conference organizers sought to achieve a mix of persons whose interests included the natural sciences and the social sciences. Special interest was extended to disciplines requiring laboratory, clinical, or field work, and every effort was made to select in addition to the able-bodied science faculty, disabled scientists who represented the wide range of disciplines as well as persons with the four basic categories of handicapping conditions.

Nature of the institutions of higher education. Participants were sought from large schools and small ones, from those with long-existing programs of support services for handicapped students and from those where there were none. Several conferees were from technical schools, some from small liberal arts colleges, others from large public and private universities. Since there is some disagreement as to what can and should be done to provide formal services for handicapped students at colleges of different sizes (and endowments), it was necessary to reflect the concerns and capabilities of diverse institutions.

Ability to contribute. Conference participants were selected carefully from persons who had demonstrated in the past a willingness to analyze barriers, develop solutions and bring about institutional change. The science faculty and administrators selected had not necessarily had prior experience with handicapped students, but each was selected because of his/her past leadership in a university or a particular field of science. Disabled persons were chosen whose physical handicaps combined with their areas of scientific interest or expertise to make them uniquely capable of addressing the inevitable question of how one with a particular handicap can study or practice professionally within a certain scientific area -- e.g., "how does a blind person study biology?" Others were invited because of their experience in implementing a 504 transition plan*, delivering support services, and teaching handicapped students; and some because they had particular experiences in adapting educational methodologies to the needs of one or more handicapped students. To some extent, this factor was assessed by reputation, by personal discussion, and by written evidence of interest. Occasionally, it was based upon the unique combination of handicapping condition and area of interest alone.

Using these criteria, the participants chosen included sixteen handicapped students, fourteen faculty, six student services personnel, four administrators, and sixteen scientists. Several handicapped scientists were faculty, and some among administrators, student services personnel, and faculty were handicapped. Of the total group of conference participants, thirty-five were disabled persons and twenty were able-bodied persons. Organizers strove not for rigid separation, but for role group representation, and when any were significantly more comfortable with one role than another, some shifting about was permitted. The goal, in

---

* Section 504 of the Rehabilitation Act of 1973 requires that institutions of higher education which release federal funds develop a transition plan for making their programs and facilities accessible to qualified handicapped students, faculty and employers.

any case, was not for quantitative, but qualitative analysis of the barriers and a joint effort to develop strategies for overcoming them.

CONFERENCE ORGANIZATION

The organization of the conference was designed to meet two major goals. The first one was to generate information that would be of use to the general community of science educators and handicapped persons and also to those particular persons who participated in the conference. The information was to be generated in answer to the questions as to barriers, successful solutions and recommendations for future action by target groups. The second goal was to encourage communication among participants from the various groups and backgrounds as examples of what might happen on any campus where a similar variety of persons live and study together.

The conferees' collective examination of the information put together during the preconference period and their exchange during the conference of experience across fields, types of educational institutions, places of employment and types and severity of handicaps was planned to allow them to identify and delineate the significant barriers to the handicapped and to develop a set of experimental strategies for their removal. We expected to find that science faculty and handicapped students can share quite different perspectives on the problems and solutions and that exploration of those differences would provide clues and ideas about the necessary strategies that can be employed. Having different perspectives on the nature and sources of some of the barriers, we anticipated that the recommendations of each major group and the merging of these groups represented at the conference would offer, in effect, an agenda for action -- a plan for work to be done not only with, but by each group.

Three questions were asked of the participants: what are the barriers? what are some successful individual solutions? what are the institution actions necessary to eliminate barriers? The focus was on the experience of those coming to the conference in terms of how they have managed to overcome barriers and on their sharing such experiences among the different groups represented, to lead to plans for action to be initiated by the individuals in their own home settings as well as by government agencies, universities and scientific societies.

In answering these three questions, the procedure was to have the different groups represented -- administrators, science faculty (including handicapped and able-bodied persons), handicapped students, counselors (most of whom are handicapped) meet initially and at the end as separate groups. For the main portion of the conference the planning groups were blended -- representing all the particular constituencies in each working group. Each of the blended groups worked independently, but reported to the entire conference the end of each stage so that the entire conference gained from the thinking of each of the groups. The final product of the conference was sets of recommendations in the form of plans for implementation by those involved as well as ideas for others. The activities carried out during the conference were intended to initiate a process of sharing information as to successful experiences that will provide a basis on which to build in the future. The conference also produced ideas as to resources and ways to individual resourcefulness. It was not seen as an occasion for airing complaints without seeking solutions, or of confrontation without consensus.

The specific techniques used to achieve these goals were (1) involvement of the participants in brainstorming in answer to each of the successive questions; (2) selection (evaluation) of the ideas generated; (3) synthesis by the group of clusters of related ideas. The process of brainstorming, selection and synthesis was the method used to set the goals of each of the role groups represented. The product was the answer to the questions stated above plus an increased awareness of the process followed answering those questions.

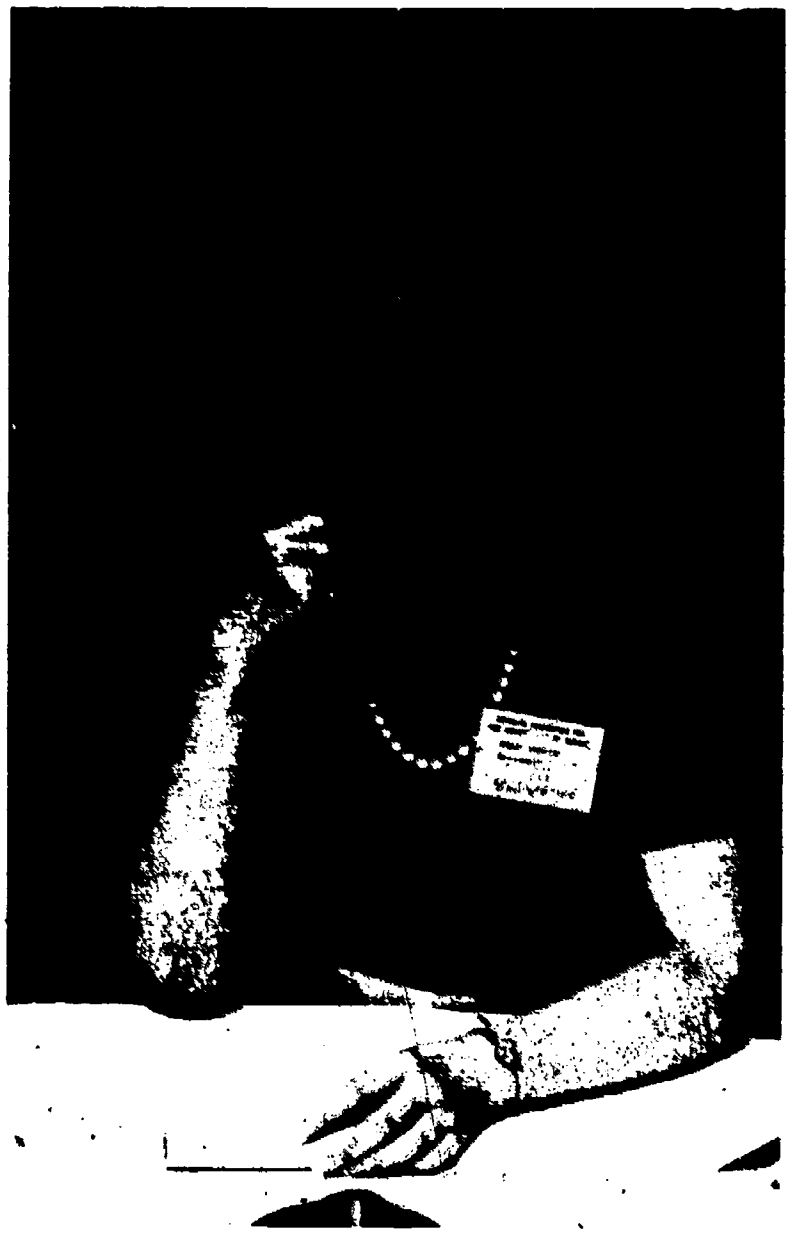
Mark Ozer, Professor, George Washington University School of Medicine, served as facilitator for the conference. Discussion leaders were Helenmarie Hofman, National Science Teachers Association; Ed Keller, Professor of Biology, West Virginia University; Virginia Stern and Cheryl Davis, AAAS staff members. The rapporteurs were Dianne Diquinzio, law student at the George Washington University; June Maker, Michele Aldrich, and James Sattler of the AAAS staff.

The conference participants were also asked to spend the time between workshop sessions discussing barriers and solutions on an informal basis. Thus, throughout the conference, the mode of interaction was reinforced. In addition to the workshop sessions and informal sessions, held primarily around coffee breaks and meals, there were presentations that dealt in a broader way with the issues of barriers. At the opening session, Eunice Fiorito, past president of the American Coalition of Citizens with Disabilities (ACCD) and now Special Assistant to the Commissioner of the Rehabilitation Services Administration, U.S. Department of Health, Education and Welfare, spoke to the group on the value of consumer participation in attacking barriers to education and careers in science. At a luncheon session, Raymond Lifchez, Professor of Architecture at the University of California, Berkeley, spoke concerning the relationship of the environment to the handicapped person functioning within it, especially the ways in which each must adapt to the other. As the dinner speaker, Irving Kenneth Zola, Professor of Sociology at Brandeis University, presented a paper on some sociological aspects of disability. Throughout the conference, there was feedback from the workshop groups to the total group, followed by a wrap-up and evaluation of goal attainment and a total conference evaluation in the five role groups.

The interpretive text which follows is the responsibility of the authors, who have summarized the analysis of the various workshop groups from the workshop notes of the rapporteurs. Every attempt has been made to include the thinking of all conference participants, but this report represents the combined findings of the conference, surveys of students and scientists, and a search of relevant literature.

FACES FROM THE CONFERENCE

Dr. E. Stephen Halpert, psychiatrist, Veterans Administration Hospital, Tampa, Florida.



Dr. Nansie Sharpless, Associate Professor of Psychiatry (neurochemistry), Albert Einstein College of Medicine, Bronx, New York.

CHAPTER II

BARRIERS

There are only a few types of barriers to post-secondary education in science for handicapped students, but these have many different manifestations. Some that relate to architectural configuration and scientific equipment design are visible and understood without great difficulty. Many others, often devastating in their effect on a handicapped individual, are invisible and unnoticed unless an effort is made to recognize and comprehend them. This chapter identifies and discusses the ramifications of types of barriers. Many of these have been elucidated by conference participants, while some have been extracted from surveys of students and scientists.

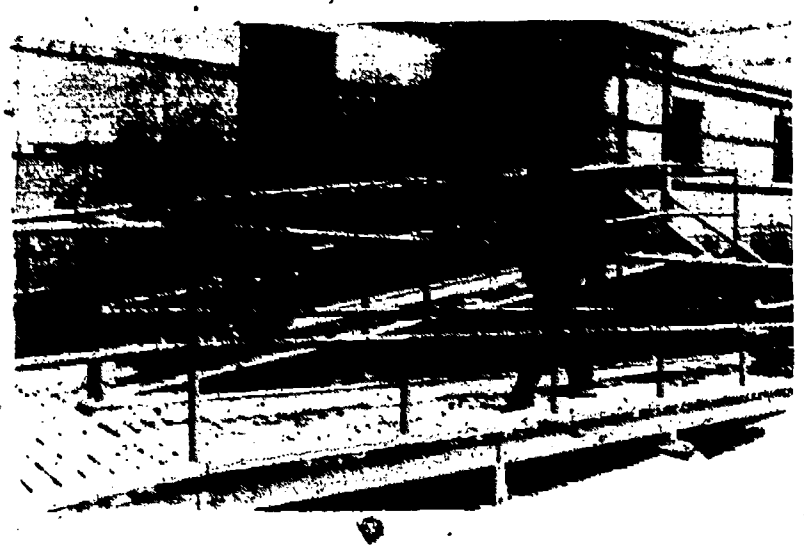
The barriers explored in the next few pages should not be read without also reading other portions of this report, because doing so can create an erroneous impression that barriers so pervasive cannot be overcome. Through strenuous effort and persistence, some people have managed to overcome each of the known barriers to science education. However, the number of handicapped scientists is few and the burden to resolve barriers has historically been placed upon the shoulders of the handicapped persons, their families, or an occasional professor who was willing to exert the extra effort to accommodate a handicapped student. With the signing of Section 504 of the Rehabilitation Act of 1973, colleges and universities receiving federal money must now do their part to remove barriers. Therefore, this chapter portrays the barriers. They may seem overwhelming, but as this report will show, individual persons can overcome barriers, once the problems are confronted, strategies developed to resolve them, and faculty and institutions are willing to implement those strategies.

TYPES OF BARRIERS

The conferees in working groups identified six discrete categories of barriers. Despite some overlap, no one of these types can be subsumed under any other. They are attitudinal, informational, environmental, communicational, academic and financial.

Attitudinal barriers. These arise from fear, lack of knowledge about handicapped people and their capabilities, stereotyping, and the myths which are so pervasive in our culture that they often go unrecognized as such.

Information barriers. This category includes obstacles which develop from a lack of knowledge about the resources and methods by which barriers to science can be overcome, and lack of adequate means to provide available information to persons whose handicap prevents them from receiving information by usual methods, e.g., reading for a blind person. Frequently, people do not have enough information to know what questions to ask or where to get information. Often information is available, but not stored or disseminated properly. At other times the information simply does not yet exist in usable form.



Dr. S. Phyllis Stearner, shown here, was instrumental in the effort to make Argonne National Laboratory accessible. A van with lift transports mobility-impaired employees from one building to another. Ambulatory persons too can use a ramp.

Environmental barriers. These are problems of accessibility to buildings and science laboratories, safety and equipment design and, in addition, development of laboratory-design guidelines.

Communication barriers. These are impediments to a student's receiving, sending, or processing information and the problems that other people have in sharing information with people who have impaired hearing, speech or sight.

Academic barriers in science. These involve problems necessitating adaptations of educational technique, testing for competency, aptitude and achievement, and amount of time permitted to complete tests, projects, and course work.

Financial barriers. This category refers chiefly to costs incurred by individuals or institutions in overcoming the other barriers, or in getting their education in science in spite of the extra expenses incurred because of the disability.

ATTITUDINAL BARRIERS

The most limiting barriers and the hardest to combat are those defined as attitudinal. Handicapped persons recall this type of barrier often: "The unspoken actions most often block us.....It's the psychological barriers that are the strongest..... After the professor changed his mind about my capabilities, all the course modifications were made easily."

The phrase "attitudinal barriers" is sometimes equated with prejudice and discrimination. Often associated with prejudice and discriminatory treatment, attitudinal barriers refer to a broad constellation of seldom admitted stereotypes, fears and anxieties, values, myths, and ideas which intrude upon and adversely affect relations between handicapped and non-handicapped individuals. Powerful and self-perpetuating, they are instrumental in determining the roles which handicapped persons fill in our society. Since attitudinal barriers often provide the basis for other barriers, the importance of recognizing them in their many manifestations must be emphasized. They are insidious and pervasive, affecting all aspects of daily living for the handicapped, education, occupation, recreation and the full range of human activities. They are especially important to understand in an area such as science education where, until recently, little attention has been given to their effect in determining whether or not handicapped persons will have good access to that area or to the scientific professions.

Lowered expectations. Few people have realistic expectations of handicapped persons. Usually, academic expectations are lower than for the able bodied. Conversely, expectations for characteristics such as ability to cope with stress, patience, maturity are often higher than for the able bodied. The assumptions underlying both sets of expectations are probably unwarranted. Consequently, many handicapped people do not themselves develop high aspirations involving science, and, of those who do, their objectives are often considered "unfeasible" and "unrealistic" by parents, teachers and counselors. One conferee reported that several of his handicapped classmates during their high school years were constantly enjoined by their counselors to "face reality", advice which appeared to mean that they should lower their aspirations so as to coincide with those of the counselor. (Often such expectations are that the handicapped child will live at

home with parents, be a lifelong recipient of assistance and work little, if at all.)

The effects of lowered expectations can be severe. One consequence may be actual exclusion from science courses by faculty; one conferee reported that an organic chemistry professor refused to teach his class if she were in it. Refusal of vocational rehabilitation agencies to pay tuition for handicapped students wishing to major in science was experienced by several conferees; many, including individuals involved in counseling or providing support services to handicapped students, knew of others who had also been refused. A major effect of lowered expectations is passivity and defeatism in the student; although it may start in lower academic levels it achieves its zenith in high school and college.

Categorical thinking. In effect, this amounts to stereotyping; for example, the idea that blind people, by virtue of being blind, are unable to do physics; that wheelchair users, by virtue of being wheelchair users, are unable to study organic chemistry; and that handicapped persons, regardless of the nature and severity of their impairments are unsafe to themselves and others in laboratories. This type of thinking develops from lack of experience, misinformation or judgements based on biased data. If one blind student is unable to pass a physics course, the cause is often thought to be his/her blindness rather than lack of preparation, aptitude or interest in the subject.

This is similar to the stereotyping of women and minorities. What is particularly dangerous about categorical thinking is that it results in categorical exclusions. The ability of science faculty and others to engage with the handicapped student in a creative problem-solving approach regarding a disability facilitates course participation, yet the tendency to categorize impedes its development. Moreover, categorical thinking, as several conferees make extremely clear, continues from the undergraduate level into graduate school, professional training, career counseling, and job seeking. The faculty member who holds stereotypic ideas about handicapped students is likely to reflect the same attitudes revealed in the classroom in his/her recommending handicapped students for placement in graduate programs or in accepting a handicapped person as a teaching colleague.

Reluctance to ask and answer questions. Faculty faced for the first time with a handicapped student may have no idea how that person functions. Too often, faculty and administrators hesitate to ask questions about the ability of a student to function in tasks related to the classroom and laboratory. Most science faculty have not known enough handicapped people to have become comfortable about asking such questions as, "How do you manage to pour liquids or measure when you can't see?" Hence the questions usually go unasked and the faculty member guesses and thus usually underestimates the handicapped person's ability. The burden has usually been on the students to anticipate and answer such questions. Students sometimes hesitate to anticipate questions -- perhaps, in part, for fear of raising issues which have not yet been resolved, fear of bringing up a doubt that the teacher has not yet thought of, or because having to answer questions in extremely sensitive areas is an onerous occurrence for them.

It is reasonable to ask a severely disabled wheelchair-user how he/she manages specific tasks in a laboratory. For instance the question "How do you reach the equipment?" is legitimate especially if the purpose of the inquiry is to

to accommodate, rather than challenge, the individual. A non-legitimate question is one that solicits irrelevant personal information, e.g., "How do you get dressed?" or even, "How did you become disabled?" The student may react with resentment, since such questions, even if asked out of concern, are not in good taste. The faculty member should be guided by the assumption that personal and irrelevant questions which would annoy non-handicapped students are equally likely to annoy handicapped students.

Questions about a handicap may be asked legitimately only under certain circumstances. Certainly they can be asked by a faculty member or an administrator after a student is admitted to a course or program in order to determine what assistance will be necessary for the student to function adequately therein. What is not permitted under law is any inquiry pertaining to the handicap prior to admission, except in rare circumstances.* This rule requires that the handicapped students be judged for admission on their qualifications to meet course or program requirements rather than on their disabilities. However, campus administrators should publish an announcement to all students at admission that would encourage admitted handicapped students to begin immediately making the appropriate faculty and staff aware of any adjustments that need to be made that may take time to arrange.

Attitudes about accommodation to a handicap. Students are often reluctant to ask for accommodations, e.g., reader services, extra assistance handling laboratory equipment, or a lowered laboratory table, even when badly needed. Even though campuses are required by law to furnish them, many feel that to do so would call attention to the handicap, which is undesirable for those who are trying to minimize its more obvious effects. Some may successfully improvise their own accommodations, while others would benefit greatly from assistance from faculty or a student support services program. Without this assistance, some among the latter may not survive academically without appropriate accommodation. In a laboratory where an accommodation is needed to allow for individual experimentation and observation, assistance may be critically important; without it, the student may fall ever further behind.

The faculty often assume, when seeing such a student, that because of the handicap, the student must be incapable of doing certain tasks necessary for course completion. Some have reported that it is not their responsibility as college-level educators to initiate inquiries about a need for accommodations. They expect the matter to be handled by a special services or vocational rehabilitation counselor. Others may be uncomfortable with the subject and choose to push the matter aside. Still others, even if asked by the student for some accommodation, may refuse outright, thinking the student is asking for unfair advantage.

---

* See American Association of Collegiate Registrars and Admissions Officers and American Council on Education, Recruitment, Admissions, and Handicapped Students. (Washington, D.C., Office for Civil Rights, U. S. Department of Health, Education and Welfare, 1978.)

Students, faculty, administrators, and others, each for their own reasons, demonstrate attitudinal problems in connection with "reasonable accommodations," problems which can seriously interfere with an education, especially in science. The accommodations which most students need are minor, can be arranged with little or no inconvenience and can make the difference between academic success and failure. Some are discussed in the next chapter.

Assumptions of inferiority. Many persons with physical handicaps report being treated as if they were children or, worse, as if their intelligence were deficient. The experience of being patronized is common to most handicapped individuals, as is that of being spoken about in the third person, e.g., asking the lab partner of a blind student, "Has she finished the assignment?" rather than asking the blind student herself. The assumption that a handicapped person is not able to think or act as maturely as other students can make it truly difficult for some science faculty to assume competence in that student. It is the barrier which underlies the frequent observation made by handicapped people, especially prior to their acquisition of professional status, "I must prove myself again and again!"

Assumption of responsibility. A major factor in excluding handicapped people from activities is the assumption that the non-handicapped bear a responsibility toward the handicapped for protecting them from even the possibility of harm. This attitude was expressed by the professor who said, "How can I allow a person already crippled and in a wheelchair to risk his life further handling chemicals when he can't escape as quickly as others in case of an accident?" Because the management of risk is so vital to an education in science and because the extent of risk facing the handicapped tends to be vastly overestimated by the non-handicapped, this barrier plays an important role in the undereducation and underutilization of handicapped people, especially in laboratory courses.

Spread of effect. A person unable to walk unaided may be regarded as unable to speak or write adequately. A person who is deaf may be considered unable to think adequately. Remember the term "deaf and dumb" formerly used to identify persons who could not hear. A blind person may be treated as if also deaf. Persons often raise their voice when speaking to a blind person. When one ability is lost the loss of other abilities is also attributed.

Stereotyping. From literature, films, television, written and oral history, people all develop stereotyped images of what handicapped people are like. No one, regardless of one's scientific genius, is exempt. The images of the "mad crippled scientist," Dr. Strangelove, and the helpless blind housewife pursued by smugglers in "Wait Until Dark", all reflect society's image of the handicapped as neurotic, manipulative, and vengeful or -- at the other extreme -- timid, easily victimized, and helpless. Attributions to character are made on the basis of type of handicap, which comes to serve as a metaphor for personality -- an inaccurate one.

Science and mathematics phobia. A number of disabled student service program directors have noticed that some handicapped students exhibit a tendency to avoid courses in science and mathematics because they are considered "too hard" for them. In a way, the courses are sometimes too difficult for a number of students who have gone to special schools or segregated classes in which science and mathematics have

been given little or no attention. One scientist reports, "I was told deaf people have trouble learning mathematics, that there was no need for me to take it in high school." A blind statistician reports that he was in eighth grade before he had a teacher who bothered to explain mathematics concepts or who seemed to expect him to learn the subject. He cites that experience as the turning point in his life.

The idea that teaching the handicapped takes extra time and trouble. Many teachers believe that teaching handicapped students calls for so much additional effort and time on their parts that they will neglect the other students in their classes. This belief can establish a pattern of avoidance which, at lower academic levels, manifests itself in the alacrity with which an instructor relegates a student to a "special class". At the college level, where there is no special class to which an instructor can resort, the avoidance may be more obvious. As one biology professor said, "If I'm going to have to change every laboratory exercise in order to accommodate a blind student, I'll never cover the material required during this semester." This person later remarked on how little adaptation was necessary and that most of the changes he did make probably made things clearer for everyone else in the class.

INFORMATIONAL BARRIERS

Informational barriers to adequate science education for handicapped students fall into three general categories: blocks to access to information caused by disability related problems, e.g., use of library materials by blind persons or wheelchair-users; lack of information to help from college staff understand handicapped persons and how to accommodate to their needs, e.g., how to arrange for laboratory experience to be appropriate for deaf students; and inadequate dissemination of available information, e.g., making available to all science faculty the strategies found successful by others who have taught handicapped students.

Like attitudinal barriers, those involving information cut across all other barriers. After a graduate student who uses a wheelchair explained to his new chemistry professor how laboratory adaptations had made his full participation possible and, further, that his grade point average was 3.9, the overprotective attitude and fears for safety seemed to disappear. In another incident, identification of an alternate entrance to a building made removal of an architectural barrier unnecessary.

Access by disabled students to available information. If all the journals needed for a wheelchair user to write a report are stored on a shelf too high too high for her to reach, that information may as well not have been stored. If a blind graduate student cannot find a reader who has scanning skills, the vast amount of material usually covered by this study method will be lost. If interpreters skilled in translating technical lectures are not available to deaf physics students, they will have to find other methods of dealing with lectures. Methods used by able-bodied students and teachers to exchange information may sometimes become barriers to handicapped students receiving that same information.

Removal of a barrier for one student may in fact build one for another, replacing visual cues with voiced ones may help a blind student, while further limiting one who is deaf. However, it is more often that in the process of

removing an informational barrier for handicapped students that information becomes more available for other students. This has been particularly true when strategies for better access to library materials were developed and made available to all students. The materials were used more by the entire student body because it gave everyone alternatives to accessing information.

Lack of information. Until recently, when federal legislation made it imperative that every campus provide access to handicapped students, the need for information on how to do this was not present. Now there is a real imperative to understand the needs of handicapped students wishing to take science, to know when and how to adjust classroom and laboratory experience to accommodate their needs and to know what has worked for others in the past. Only sparse information of this type is available. When available, it is often not in a form that is readily available through the resources commonly tapped by science faculty.

Science faculty often ask, "Is there a manual that describes adaptations needed to teach laboratory sciences to blind students?" or "Where can we order the aids and appliances we are required by law to have to make our laboratories and classrooms accessible to handicapped students?" or "Are there standards for making laboratories accessible similar to those on other building access?" or "Where can I get a manual on technical and scientific signs for interpreting for deaf students to give the interpreters who will be in my classes this fall?" The answer to these questions is either that the information does not exist at all, or, that it does not exist in a form that makes it readily available. This is truly an informational barrier which prevents even those with the best of intentions from carrying out their wishes to provide equal opportunities for handicapped students in their programs.

Conference participants and others have identified several areas where information seems not to exist. There are no handbooks/manuals for faculty that identify the usual aids and appliances used by handicapped students in classroom and laboratory settings and explain how they assist the student to participate on an equal basis with other students. Such a manual could also list sources of such aids and other resources proved in the past to be helpful to others in making necessary accommodations.

There are no available standards or other guidelines for making laboratories accessible to wheelchair users or other persons whose disabilities make use of standard laboratory equipment and furnishings difficult. Questions of safety often stand in the way of making laboratory experiences available to disabled students.

Information as to the actual need for aids unique to accommodation to science curriculum has not yet been generated. Developers of such aids must know the needs of disabled students. The lines of communication between the developers of such technology and the consumers of it -- both the science faculty and the disabled student -- are virtually non-existent.

To summarize, in some areas the information does not exist or is not in usable form, and in those areas the information needs quickly to be developed.

Inadequate dissemination of available information. The difficulty of locating information about the handicapped in science (or even the problems finding out whether a particular set of information does exist) was judged by conference participants to be the greatest informational barrier of all. The conventional storage and retrieval systems of the education world are not yet responsive to requests for information on the education and careers of the handicapped in scientific and technical fields. No government agency has pulled together a quantity of the known data to be helpful to those requesting information and assistance on accessibility to science.

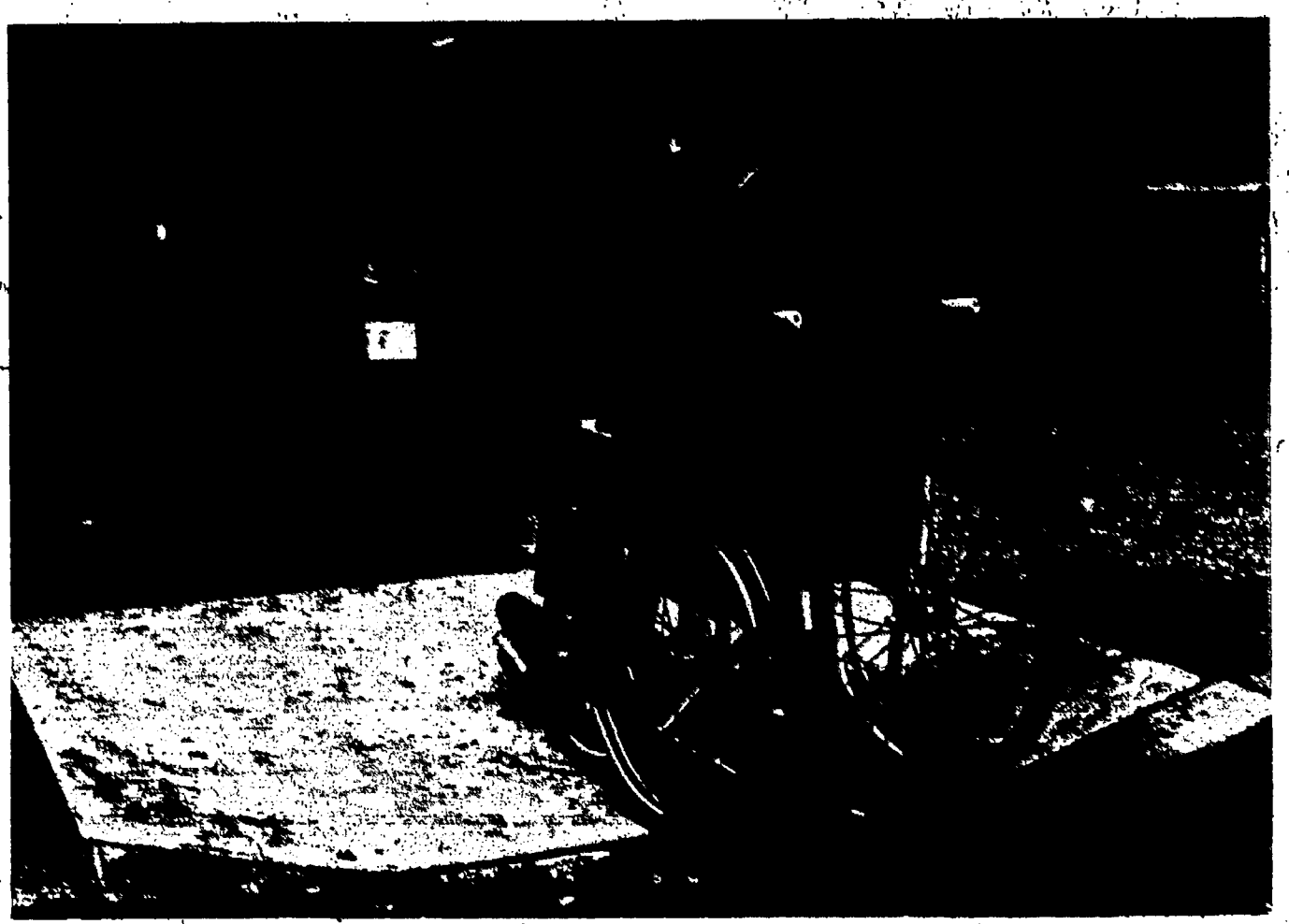
The problem has two aspects. First is the fact that no conventional library or information systems search is likely to turn up very much of what is known to exist. For example, an ERIC search using locators for handicapped students does not turn up information within the science education literature nor does use of locators for science education produce references from the special education file. Articles dealing with these issues that are known to exist in the journals reviewed by ERIC do not turn up in searches.

Second, there is now beginning to accumulate a record of instructive experience not all of which has found its way into the printed word, and thence to the libraries and computerized storage systems. The following types of information are known to exist and need to be made easily retrievable in order to eliminate this informational barrier. Experiences of successful disabled scientists which detail their methods of getting their education and jobs in science; successful strategies used by science faculty to teach handicapped students; lists that describe and tell how to get available aids and appliances proved useful in course adaptation; descriptions of laboratory modifications and available equipment and furnishings found useful; descriptions of testing strategies used successfully to evaluate performance of handicapped students in science courses; and description of resources available in the scientific community that would assist counselors in advising students interested in scientific careers. There is no clearinghouse where this kind of material can be found, except for the efforts being made by the AAAS Project on the Handicapped in Science.

ENVIRONMENTAL BARRIERS

As might be expected, some of the physical environmental barriers concern general access to wheelchair users and visually impaired persons and may call for the assistance of an architect or other specialist in design or engineering problems. Others may be amenable to improvement by minor modifications of procedure or equipment by the faculty or students. The prime characteristic of this category of barrier is that the obstacles are observable and rooted in physical reality. Attitudinal barriers may magnify the perceived dimension of the environmental problem and the willingness to seek a solution, but the solution, when it comes, is a response to a physical situation. The barriers discussed below are representative:

Building access. Concern encompasses access not only to classroom and laboratory buildings, but also to research libraries often housed separately from other library collections. From wheelchair users have come comments about inaccessible building and laboratory entrances, inadequate space to maneuver, benches too high and incapable of being moved, and narrow doorways. A faculty conferee mentioned



A curb ramp makes all the difference.

a situation on his own campus, where a ramp of proper width and suitable grade bottomed out in a landing with a grating that could catch a wheelchair's wheels and tumble the occupant out. The result was that the entrance was of dubious value and safety. Designs, he felt, should be evaluated prior to construction by individuals in a position to catch such irregularities, e.g., wheelchair users. A student cited as a problem the inaccessibility of the stacks in a biology library. Although the staff was willing to retrieve books requested, she was deprived of the opportunity to scan the literature of her specialized field -- neurophysiology of behavior -- at her own pace.

Location of equipment and bench controls. Equipment is reported by many handicapped students and scientists to be difficult to reach and scattered throughout laboratories. One student expressed dismay at the amount of time taken to set up a demonstration because the storage of equipment was poorly planned and placed so many things out of reach. Others report difficulty in reaching bench controls, e.g., faucet taps and burner adjustments. One student, a conference participant, has said that if the controls and equipment had been more favorably situated in her chemistry laboratory, she might not have been required to have an assistant. The need for an assistant, she thought, was more a function of a poorly designed laboratory than of her physical limitation as a paraplegic.

Labelling. Visually impaired students, some of whom are blind, often find that labelling of controls, equipment, storage, safety apparatus, and chemicals is not adequate for their needs. Appropriate identification of materials can promote safer and more independent functioning in the laboratory.

Unadapted work stations. Students work with all sorts of unsatisfactory arrangements, coping with inappropriate heights of work surfaces and even, at times, inadequate clean air. As an example, a wheelchair-using conferee required an assistant the first semester of chemistry, but the second semester was offered a lowered work station. Unfortunately, it was placed in a closet and was not equipped with an exhaust hood.

Safety. Laboratory safety is a major issue and inadequacy for handicapped persons may become a barrier to their entering science programs. This barrier is often largely attitudinal and based on false assumptions of the abilities of disabled students. However, there are safety-related barriers that are physical/environmental.

Such safety equipment as exists is reported as being unusable by some blind and wheelchair-using students. In some cases, it may not have been identified or appropriately labelled. Eyewashers, fire blankets, showers and extinguishers were too often unusable because the controls were too high and/or the directions unreadable. In view of the concerns frequently expressed for the safety of handicapped students and the possible hazards they may present to themselves or others, this continuing lack of real effort to assure use of safety equipment by handicapped persons may suggest that the so-called "safety issues" relates to an attitudinal barrier as much as to equipment. Another safety issue is the lack of alternative warning systems for blind and deaf students.

Laboratory design pertaining to the needs of handicapped persons. Laboratory adaptations must often be individualized to the requirements of each student, but

certain basic dimensional parameters are clearly needed and lacking. The American National Standards Institute, which published the first national accessibility standards in 1961, will be issuing revised standards within several months. These will be based on research performed at the Department of Architecture, Syracuse University. At this time, academic and industrial laboratory design have not been included in the project. This is causing and will continue to cause confusion and lack of adequate attention to this area. Without some basic standards which can be shared on a national level, and without a clearinghouse for information exchange, virtually none of the post-secondary institutions or their architects and planners know what schools have done which kind of adaptations. They are unable, thus, to compare, evaluate and refine designs for laboratories.

Field study. Handicapped students may have less access to field experiences than their non-handicapped peers. This can be a serious problem, for such limitation on educational development hampers professional growth. To faculty, without prior experience with a handicapped student, it may be especially hard to understand the value of field studies in anthropology to a blind student or in geology to one who uses a wheelchair. The value of such field studies is apparent, however, to the blind anthropologist and the wheelchair-using geologist. Exemption from field experiences is a barrier faced by many students. Many disabled scientists report that professors were much more willing to substitute classroom-based experiences or exempt them entirely from field work requirements than to use the effort and creativity required to make the field experience available under adapted conditions. Faculty is often more protective of handicapped students than their able bodied peers. Again an attitudinal problem may be unnecessarily bolstering an environmental barrier.

COMMUNICATIONS BARRIERS

In some ways, the communications barriers relate to those of attitude and information. Although related, however, they cannot be subsumed fully under either category. They relate to specific obstacles to receiving and giving information of hearing-impaired, visually-impaired, and speech-impaired individuals. Communication barriers introduce complexities into the learning and teaching processes because some disabled persons must have assistance in order to receive visual or auditory messages, and some require assistance in order to give information either in written or verbal form. The disabilities that inhibit communication have been the most misunderstood and have caused some of the most damaging misconceptions about disabled people, e.g. calling deaf persons "deaf and dumb", or judging a person severely impaired by cerebral palsy to be retarded because of poor speech or lack of speech. The following are major communication barriers that relate to science education.

Communications barriers for the deaf. Because intelligence is commonly judged by verbal facility, faculty, like many other people, have difficulty in judging a person with impaired speech, be it from deafness, palsy, or other cause, to be an intelligent rational being. Deaf people have often been termed "deaf and dumb". Ostensibly, "dumb" means that the deaf individual is mute or voiceless, which is rarely the case. However, the word "dumb" casts aspersions on the intelligence of deaf people, and it is rightly resented by them. Many deaf persons do have unusual speech, and it often takes an effort for others to learn to under-

stand the speech of deaf persons. The attitudes people hold about the hearing-impaired, the difficulties which arise in lectures and conversation, and the problems associated with notetaking and other activities result in a number of possible problems for deaf students seeking higher education. When studying science, there are additional problems. Following are some specific examples:

Breaking into seminar discussions and providing comments in a timely manner is extremely difficult for a person depending on lip reading or sign language. People often talk at once rapidly, contradict and support one another, and like so many people, the participants may cover their mouths, mumble, smoke, and so on. This makes lip reading, even by the most skilled, nearly impossible.

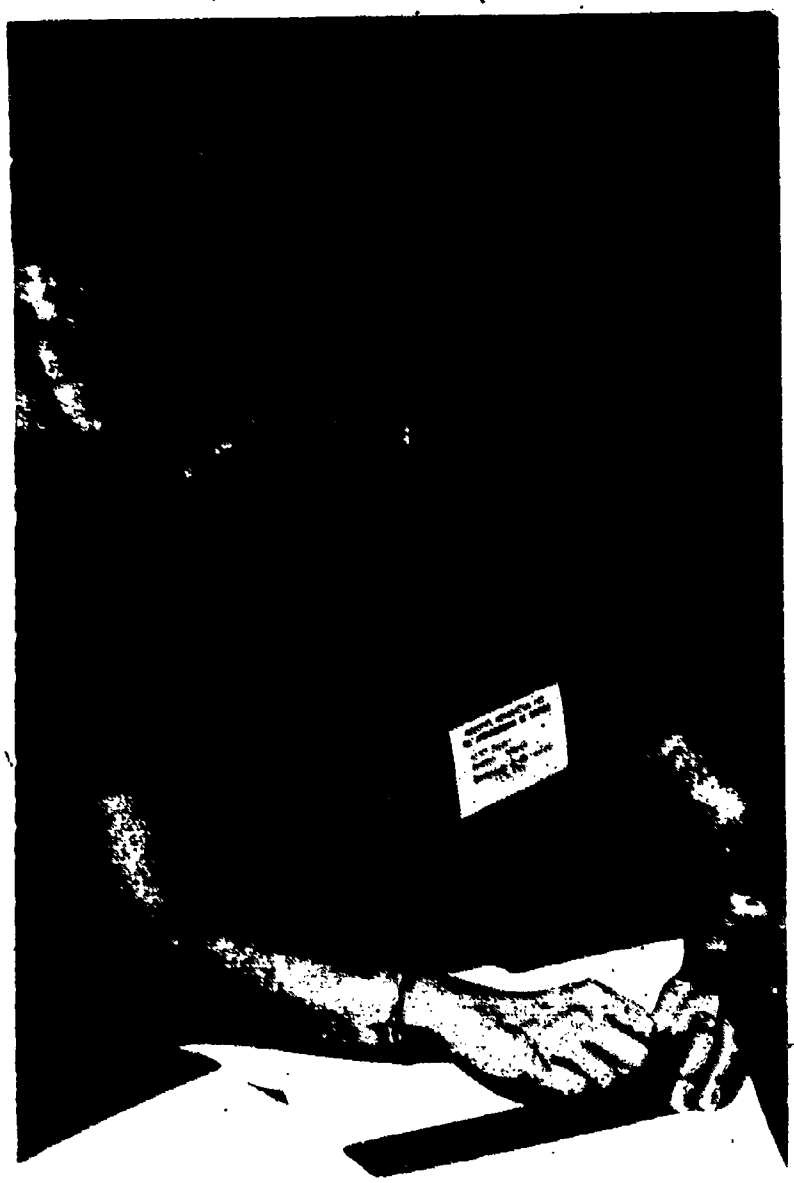
The effort involved in talking and either lip reading the spoken word or attending to a sign language interpretation of it all day can make a deaf person hesitant to exert any more energy to explain the requirements for improving comprehension. Such requirements are often very simple, such as asking the person to speak more slowly, use a chalkboard or visual cues, etc. Rather than continuing to call attention to oneself the hearing-impaired person may pretend to understand. It takes a person with a strong self concept to keep reminding persons to be more considerate of his/her needs. These types of situations handled improperly can build serious barriers to communication.

The deaf student may lose a sense of continuity in the flow of discourse, unless questions asked by the students are repeated by the professor. When all eyes face the front of the room, the other students cannot be "heard" by the deaf student. One conferee reported that he often "hears" (lip reads) the professor's answers, but is unable to place the answer in the proper context, not having "heard" the questions.

For similar reasons, when a professor faces the chalkboard while writing on it, he becomes virtually impossible to lip read.

Watching laboratory demonstrations and following the instructor's speech at the same time is extremely difficult. Further, a deaf student may miss what the professor said in a lecture or in the laboratory because he/she was speaking too rapidly, facing the blackboard while talking, or mumbling. In addition, faculty often talk about topics which are not in required textbooks or other written class materials, and if a deaf student misses them in lectures, there may be no alternative source of that information. In addition, note taking becomes particularly difficult when one must lip read or attend to sign language. These factors may leave the deaf student at a disadvantage as compared to hearing students, especially when the unheard, unnoted material shows up on tests.

Communication barriers for the blind. Blind students have reported difficulty keeping up with the latest scientific literature when it is not available on tape or in Braille. With relatively little scientific literature taped or brailled, blind students of science must pay inordinate amounts for readers and must find people who can read scientific literature comprehensibly and who will know enough about the subject in question to assist in research. Even with adequate readers, this is a less than satisfactory arrangement. Blind conferees indicated clearly that they would be much more comfortable doing their own research than depending upon readers. They believed also that this barrier should yield to



Sometimes laboratory equipment must be adapted for use by blind persons. Dr. Ira Cochin (above l.) and Mr. William Skawinski (r.), of the New Jersey Institute of Technology, are both blind and have developed a number of adaptive devices to assist Mr. Skawinski in his field, chemical engineering. Here they are shown modifying a spectrometer.

Often, however, the need can be met by readily available devices, such as the Braille slate used by Ms. Kathy Susany (l.) to take notes at the conference. Many techniques used by blind persons can be readily improvised from common materials, such as raised line drawings and mesh graphs.

current or soon-to-be available technology. Knowing this, the lack of access to the current literature was especially vexing to them.

Computer technology is not adequately accessible to blind students and scientists. Much of what would assist blind individuals has already been developed. It is not, however, coming into use as quickly as desired and is largely unutilized by postsecondary institutions for use by print-handicapped (persons who cannot read print) individuals in scientific applications. One blind student who was recently awarded the doctorate in physics at Stanford University, for example, used an interactive computer terminal - kept in his apartment - with output in Braille. This is only one of the approaches possible today, and yet astoundingly few blind students have access to the sophisticated equipment which would so facilitate research.

In addition to the problems blind students have taking in information, there are the problems they have with written assignments. There is a great deal of emphasis in higher education on the ability to write one's ideas clearly. Essay tests are the only type given in some classes. Other problems arise from dependence on the written word, e.g. simply leaving a note for an absent professor. Of course blind students have alternate methods to produce written assignments such as preparing tapes to be transcribed or dictating essays. However, blind students have reported that some professors do not want to allow any change from the set procedure.

Most assumptions of the inability of blind students to benefit from laboratory experiences are myths. There is an attitude common to educators and many counselors that many fields are closed to blind individuals because knowledge gained through experimentation or demonstrations in laboratories cannot be communicated adequately to a blind person. Such laboratory techniques may require modifications but they can often be done with a little effort and ingenuity. Others require special devices or equipment that allow the blind person to understand the demonstration. Modifications may be relatively simple, such as use of raised line drawings, which can be made by a lab partner as easily as any other type of drawing. It may involve using photosensors to note change in color intensity of a substance and set off an auditory response in the sensor.

Communications barriers for the speech-impaired. The problems of the speech-impaired individual are several. The uninitiated find impaired speech both difficult to comprehend and--because of the effort required--anxiety producing. The listener may feel tempted to give up the attempt quickly or, equally bad, try to anticipate what the person is saying and complete his or her sentences. In addition, many people underestimate the intelligence of a speech-impaired individual. Not all cerebral palsied individuals have speech impairments, but some report that they have been presumed to be mentally retarded and treated as such. In the classroom situation, they report that teachers never recognized or called upon them. On the other hand, teachers report that they may find themselves unable to prevent such a person from heavily monopolizing class time. The quality of speech in deaf or cerebral palsied individuals varies tremendously, but all such people note that one great vexation is the listener who pretends to understand while his or her eyes

reveal perfect incomprehension. The discomfort inherent in such interaction can result in patterns of avoidance. When the avoiders are faculty and fellow students, this may significantly impede the informal intellectual exchange that is so important a part of professional development.

ACADEMIC BARRIERS

These barriers relate to flaws in the student's academic preparation, pedagogic techniques, testing, and methods by which handicapped students may function in the classroom, in the laboratory, and in related activities. Following are some representative barriers discussed by the conferees.

Inadequate preparation in mathematics and science. The single most important academic barrier is inadequate preparation in mathematics and science. One conferee reported that although his own preparation was satisfactory - not having been handicapped until college, he had not been in a special school - handicapped classmates, especially those who had not been mainstreamed, looked upon science as something impossible for them to consider. They had taken little or no science, knew little about it, were afraid of it, and generally exhibited a high degree of "science phobia" and "math anxiety". While this barrier is caused by conditions which pre-date the student's entry into a college life, ways of compensating for inadequate preparation are surely not confined to the elementary and secondary level.

The inadequate preparation of faculty in adaptive techniques. For the most part, science faculty do not understand how individuals with different handicapping conditions can best observe and work with materials in laboratories. Few have experience in presenting phenomena in ways that visually and aurally handicapped students can appreciate. What alternative techniques, for instance, can be substituted by a blind student for identification of substances by color? Most faculty report some difficulty even in understanding when such modifications may be needed and when they are not.

Testing and evaluation - a multifaceted barrier. The most appropriate means by which to test, especially in relation to laboratory work, may not be clear. Competency being tested may be of a task which the student is physically unable to perform. The question arises for faculty of evaluating meaningfully the results of such testing when the testing methodology varies from the standard.

The student may require additional time for taking a test, especially in situations where the physical impairment limits the student's ability to write quickly, hear questions given orally, or read questions. When an examination is delivered to a blind student orally, the student does not have the advantage of being able to re-read the questions as non-handicapped students can. If the exam is taped, the student may lose time rewinding the tape and finding the place to begin the question again. In the laboratory context, many faculty express uncertainty as to when a student ought to be allowed latitude in time and how much extra time to permit to complete projects. More time may be essential for some students to complete lab demonstrations or other projects. The problem comes down to a recognition of potential need for time, flexibility, and realistic arrangements which do not threaten seriously to upset a reasonable time frame for the completion of the entire academic program.

Good readers and note takers may be difficult to find; their schedules need to be juggled, and that may include the adjustment of test schedules as well as the length of time allowed for the test.

Faculty inaccessibility. Many faculty offices, laboratories and conferences are located in inaccessible places, where doors, steps, and turns represent barriers. Faculty may also be deemed inaccessible if necessary assistance in orientation, interpretation, and other services are lacking. All of these need frequently to be arranged in advance, and some of them may be difficult to arrange in a timely manner.

FINANCIAL BARRIERS

Academic institutions and handicapped students may both be confronted with financial problems as more and more students take advantage of study in science. The resultant problems may be felt most severely in regard to the science disciplines where costly issues of equipment or laboratory design may be most striking.

Financial aid to handicapped students may be limited. Often it is assumed, for example, that state vocational rehabilitation (VR) agencies will pay tuition and other expenses when, in fact, agencies up until now have placed various limitations upon the kind of programs for which they will fund a client. Some limitations are peculiar to the agency, others to the individual counselor. Many handicapped scientists and some aspiring students today have been denied tuition monies by VR because the scientific career in which they expressed interest was deemed "infeasible" or "unrealistic". Ultimately, this may be attributed to a lack of information by VR counselors about the fact that handicapped persons can and do enter scientific careers. It must be recognized that lack of VR funding represents a serious financial barrier for many. Even though some handicapped do not utilize VR for college, it remains for others a principal means of funding.

From state to state there may be considerable variation in what VR is willing and able to pay. It is nearly a universal truth, however, that VR will pay for graduate study only under rare and highly exceptional circumstances.

Some handicapped scientists and students have had necessary aids or devices purchased for them by VR agencies or by agencies serving blind persons. Others have been less fortunate. The VR agency is guided by a basic policy which has the potential for major financial repercussions for colleges and universities. This policy requires that a VR agency seek alternative funding resources before paying for goods and services for its clients. The college itself constitutes such a resource, for goods and services essential to a disabled student, including interpreter services. For students the VR system may offer hope for financial assistance, but that hope may have strings attached.

For the college, the strings are many, and the hope for financial assistance is bleak. As the colleges and universities complete their transition plans under Section 504, they must contend with costs for environmental modifications and services. Yet, to date, there are virtually no special funding sources on which to draw.

CHAPTER III

SOLUTIONS

Having identified some extremely critical barriers, it is tempting to race ahead of the agenda to develop long-range solutions, plans and recommendations for dealing with barriers at an institutional and organizational level. In this chapter an effort is made to describe the ways of coping with barriers on an experiential level, to discuss not what we should do, but what has been done that seems to have worked. An exploration of individual efforts to resolve barriers suggests ideas some of which can be applied at the institutional and programmatic level. It must be remembered that this chapter does not and is not intended to serve as a mandate for action. Instead, it provides a sense of what people have done already and what should be considered in developing a strategy. Actual recommendations for broad action are found in the next chapter.

SOLUTIONS TO ATTITUDINAL BARRIERS

Approaches to lowered expectations. One student has spoken of the importance of getting advice and support from other handicapped science students in such areas as mutual tutoring, advice on information-gathering techniques, and discussions of legal rights. Students often find that such interaction makes them more cognizant of the needs and interests of students with other disabilities, as well as making them better able to articulate their own coping strategies. Thus, they are enabled to perceive themselves as growing more effective in meeting their needs.

Other students have found meeting with disabled scientists to be of inestimable value. A student beginning college wrote that until he had met a deaf physicist, he did not know that deaf people could go into science. Now he could affirm his strong desire to study chemistry and his hope to enter that field. Both faculty and handicapped students should be provided with opportunities to meet with handicapped scientists, engineers, and doctors. They can provide valuable service as role models to students and, in addition, demonstrate to faculty and others the high capabilities which handicapped individuals may bring to science.

Another type of assistance of significant value in raising the expectations of students is mentor support. The handicapped student often finds, before and during college, that no one appears to expect anything of him or her. This may lead to a constructive drive to prove those low expectations wrong, but may also--and this is probably more often the case--lead to resignation. To feel that a respected scholar believes in and supports you is a luxury that more people should have; for the handicapped, as for women and minorities, it can make a critical difference.

This mentor relationship can develop between a respected science professor and the disabled student. Recently, another sort of mentor relationship has begun to develop between disabled scientists who bring students to work with them in their labs. Two such programs were initiated during the summer of 1978. Dr. Phyllis Stearner, biologist at Argonne National Laboratory has had two deaf science students

working with her on research in the effect of radiation on the cardiovascular system. Dr. John C. Seidel, research scientist at the Boston Biomedical Research Institute, has provided a similar experience for David Young, a chemistry student who is a quad. They are working together in biochemistry research. Opportunities for such laboratory experience are rare for disabled students and particularly valuable in providing real work experience under the direction of an experienced and competent scientist who has also overcome barriers that the student is facing as a disabled person.

Other types of personal support can also prove important, especially for a handicapped student who has not adapted to an adventitious disability. Dr. Stephen Halpert, a psychiatrist who is a quadriplegic described the profound positive support of the dean of his medical school. After a traumatic injury during the beginning of his years as a medical student, the dean had said to him "when you come back..." rather than, "if you come back." He had assumed that no one believed he could come back. When the dean and another administrator spoke in terms of time, not condition--when he returned, not if he returned--it helped sustain him in the belief that he would return, as ultimately he did.

Such experiential sharing provides three major benefits: 1) the handicapped scientist or engineer may be able to share practical information with students and faculty about adaptations that have or have not been necessary in order to participate in course work and practice his/her chosen profession; 2) the handicapped students are offered a role model to strengthen their own confidence in their ability and their aspirations; 3) career guidance and vocational rehabilitation counselors, who should also meet handicapped science students and scientists can better judge the "feasibility" of science careers for handicapped individuals and more intelligently advise, direct and support the student.

To vitiate the effects of lowered expectations among counselors in state VR agencies, several improvised techniques appear to have been utilized, ranging from negotiation between student and counselor to circumvention of the system. Some disabled students seek to educate the counselor about career options in science, discussing the specific physical tasks required by the particular discipline desired and offering concrete ways the client can cope. Others major in a counselor-approved area, making sure to garner sufficient credits in science courses as to leave their options open for graduate study to be funded by sources other than VR. Still others forsake the system altogether to seek alternative forms of financial assistance.

A disabled scientist who recently received a Ph.D. in microbiology from Columbia tells of his struggle to receive approval from his rehabilitation counselor for his career goal to enter biology. His counselor insisted that a major in business was much more practical and would not approve a career goal that required graduate education to fulfill. Since he was completely dependent on the VR system to finance his education he agreed on the major in business while pursuing a double major in biology. He was able to maintain a grade point average that made scholarship money and work/study grants available for graduate study.

Some vocational rehabilitation counselors engage independently in activities which can raise their expectations of some of their handicapped clients. They meet with scientists and faculty to determine the nature of essential tasks,

discussing them with the client. They contact handicapped consumer organizations; they, or individual members, have valuable information which makes a science-related goal seem more feasible. They contact federal agencies, such as the National Science Foundation, the Rehabilitation Services Administration, or the President's Commission on Employment of the Handicapped and professional scientific societies for career information.

The AAAS Project on the Handicapped in Science is working with a number of professional scientific societies such as the American Chemical Society to link the counseling capabilities in the societies to VR counselors and their clients who are considering scientific career goals. Often counselors and disabled students need more information about the variety of career choices within a particular scientific discipline; future job possibilities in that field, and schools that offer the particular program for completion of career goals. This type of career counseling is available in many societies and the commitment has been made to making it available to disabled students, counselors and science faculty.

Some students and scientists have overcome attitudinal barriers simply by sharpening their personal negotiations skills. The barrier may persist, but the effects can be reduced, say some, by polite persistence and compromise, where compromise is not damaging. One student, a paraplegic, originally faced great resistance by a chemistry professor. Although she did not feel the need for one, she accepted an able-bodied assistant the first semester. The second semester, her capacities better known and understood, she felt freer to insist upon an adapted work station.

Approaches to categorical thinking. Exposure to disabled people, working in scientific professions, areas where the handicapped are unexpected, can do much to challenge the stereotypes which limit and often exclude the handicapped. This has been done by having disabled people speak to faculty, to students, to counselors, administrators, and the families of disabled people. It can be done best in small group discussions because the element of personal contact is critical for success.

During the 1977-1978 year Robert Menchel, a deaf physicist, was given leave from his position as senior physicist at the Xerox Corporation to travel across the country speaking with handicapped students, their teachers, parents, counselors and others interested in education. His year's work was certainly worthwhile in its own right, but even more important is the model it set for other disabled scientists to share their experiences in similar groups in their communities. Over 500 disabled scientists have expressed a willingness to participate in such activities. Surely as these persons interact with decision makers, categorical thinking will begin to deminish.

Another helpful approach is for a science instructor who is not disabled, but who has taught a handicapped student, to share that experience with faculty who do not have such a body of experience to draw upon. This type of activity has been accomplished very effectively by Dr. Teodoro Halpern, professor of physics at Ramapo College in New Jersey. He devised a system to allow a visually impaired student to actively participate in class. He has written of his experience and shared it with several publications that reach other science professors.

Dealing with reluctance to ask and answer questions. A handicapped person can deal effectively with such reluctance by an assertive approach. Dr. Anne Swanson, research scientist, has described the following approach for coping with initial interviews. Upon being introduced, she began in a pleasant and matter-of-fact manner, "You're probably wondering how I work at a lab bench; well, here's what I do," and then she would explain the ways in which she had adapted her work station to her needs, explaining the auxiliary device which she had designed and had built. She added that the usual effect of such forthright discussion was two-fold: 1) it put the interviewer immediately at ease; 2) it not only satisfied the interviewer of her ability to manage in the lab but brought her added points for the obvious resourcefulness and creativity which she had exhibited. In effect, this approach gives the responsibility to the handicapped student for directing the behavior appropriate to both parties involved in the interaction. It both requires and builds self-assurance.

A chemistry professor reports that he worked things out with the student and advises others to listen to the handicapped and to their suggestions. An instructor can and should feel free to voice concerns when they are germane to his/her discipline. As in any discussion on a possibly sensitive subject, it is reasonable to speak with the student privately. One possible approach is for the faculty to say, "I am concerned about how you will be able to do thus-and-so in the laboratory setting. I wonder if you have done it before and whether you can shed some light on it. I haven't had a person in a wheelchair (or with a visual impairment, etc.) in my lab until now." This is a perfectly legitimate expression of concern and unfamiliarity which does not sound like - and is not - a challenge to the student.

Changing attitudes about accommodation to a handicap. Probably the most effective method of removing this barrier is to remove the mystery of "aids to accommodate" by providing the professor with illustrations or better yet, actual examples of such aids. Also helpful would be a resource directory of available aids. It is a usual occurrence that when a professor begins to discover aids that allow material to be learned by a different mode than usual that he/she becomes fascinated with its use. After that resistance to aids is diminished. In fact, often the professor becomes so intrigued by such aids that there is a danger he/she will insist a disabled student use accommodations not actually necessary or advisable. Another useful approach is to have faculty meet with handicapped science educators who have taught handicapped college students or other resource persons such as handicapped student services directors. These people can discuss the genuinely minimal nature of most accommodations and the immense difference they make to academic success. They can also supply information on where and how these accommodations may be secured if not available on the campus.

Dealing with assumptions of inferiority. Like so many other attitudinal barriers, exposure to successful disabled colleagues and peers is one of the best ways to attack the assumption of inferiority. It is difficult to look down, for example, on a deaf scientist like Dr. Myron Weinberger, who supervises a research team of more than thirty people or confront the deaf chemist, Dr. John Cornforth, who recently won the Nobel Prize.

In order to combat this barrier and similar ones, AAAS actively encourages the full participation of disabled scientists in activities in the science community. Since the initiation of a barrier-free annual meeting in 1976 over two hundred disabled scientists have attended each subsequent meeting. As these scientists have become more active in the Association and in their disciplinary societies, they are no longer seen as crippled or sickly, but as colleagues competent in their fields.

Dealing with the assumption of responsibility. The faculty in charge of a laboratory session is responsible for the safety of all the students, but is not more responsible for the one who is handicapped. The most reasonable approach is for faculty and student to discuss performance skills and deficits and cooperatively determine which activities will be "hands-on" and which will call for the physical aid of an assistant. Where there is disagreement, it may be possible to demonstrate a physical skill in question in a non-hazardous setting. Both the science faculty and the student may benefit in making a determination, in some instances, with the aid of student support service personnel and/or even occupational therapist. The latter resources may have constructive ideas which may make the apparently unperformable performable. In any case, the faculty must remember that the responsibility must be shared.

Counteracting stereotyping, spread of effect. A variety of techniques and resources are available to students, faculty, administrators, and student support services personnel. The visits of "role model" scientists already discussed can be of inestimable value. Some student support service programs have held "handicap awareness days" which far transcend the usual concept, in which people without disabilities "try on handicaps" to "see how it feels." For example, one such program has gathered and made available quantities of non-stereotyping factual and fictional literature about the handicapped and brought in handicapped speakers working in a variety of professional areas. Students and state or local handicapped organizations also have met with state vocational rehabilitation agencies, with varied success, to talk over issues of job stereotyping and routinized treatment of clients.

Probably the best way to break down the stereotypes is through exposure. This can be done most effectively through interpersonal discussion, but there are audiovisual materials which can also be helpful. Career educational materials for the handicapped, recently developed by an NSF-funded project* attack several barriers simultaneously; they offer information, they can raise expectations of and about the handicapped, and--equally important--they depict handicapped persons in an astonishing variety of non-traditional scientific positions. These materials are geared primarily to the pre-collegiate level, but can be used effectively for awareness type activities on the college level as well.

---

*Neil H. Buyer, Science Career Information for the Physically Handicapped Individual. Thomas County Schools, Thomasville, GA 31792. 1978

Stolle, Joanne, Career Guidance Information Especially Designed for the Needs of Deaf Students. (Philadelphia. Research for Better Schools, 1977).

Dealing with science and math phobia. Programs have been developed to overcome science and math phobia. None has been developed specifically for the handicapped; for the most part, such specificity is not desirable, but it is highly important that handicapped students know about and can access these programs early in their academic careers.

What must be considered with the handicapped is that many of those who have attended special schools or classes are inadequately prepared in science and math--a fact not always apparent. One student, for example, had studied algebra for three years in high school and maintained an A average. However, the records did not reveal that those three years consisted of the first semester of a first year algebra course, repeated interminably. She was unprepared, rather than unable to cope with college level mathematics, which left her with a fear of science courses requiring math.

Dealing with the idea that teaching the handicapped takes extra time and trouble. Faculty must be able to exchange experiences of teaching handicapped students and share them with those who have not yet done so. The most effective way to overcome this barrier is through experience, either direct or vicarious. Reading of such experiences can also be helpful; presently such material is difficult to locate--an informational barrier to be discussed in the next section.

SOLUTIONS TO INFORMATIONAL BARRIERS

Providing disabled students with access to available information. Library systems have long been providing services to blind and physically handicapped individuals. Only recently have campus libraries initiated some of these methods to make their resources fully accessible to disabled students. Ramps have been built, card catalog drawers have been lowered, aisles have been widened and assistants have been trained to retrieve material still unaccessible. Some libraries have developed a system to provide reader service, on call, and special private rooms to allow for reading or tutoring. Additional audio tapes or video materials such as film strips have been secured. Books transferred to tape, braille or large print are ordered in advance on request of visually impaired or learning disabled students.

One strategy used and highly recommended is organization of a committee made up of library staff and disabled students to advise on necessary accommodations.

Filling the information gap. During the past year or so projects have developed that have begun to develop the missing information to allow for more rapid and effective removal of barriers to science education for handicapped students. A few examples will illustrate these efforts.

Dr. Robert Larsen, a chemist at Argonne Laboratory taught an AAAS Chatauqua-type short course, "The Handicapped Student in the Science Classroom and Laboratory." This course was one of a series of courses offered to science faculty each year as a sort of inservice trining. In preparation for the course, Larsen asked the disabled scientists in the AAAS Resource Group to share with him their experiences in receiving their education in science. Over one hundred persons responded. From this information Larsen developed his course. Fifty science professors from across

A well organized work space is essential, especially for severely physically disabled students and scientists, as David Young demonstrates. With mouthstick, he operates telephone, calculator and typewriter.

the country took the course. It is being expanded and offered again in the 1978-1979 circuit.

Higher education and scientific societies are being encouraged to offer workshops/panels at their conventions that provide information to faculty on access to science education. Such panels were arranged and presented by disabled scientists and students during the past year at the annual meetings of the American Association of Higher Education, American Institute of Biological Sciences, National Teachers Association and the AAAS.

Access to Science is a newsletter which was initiated last year by AAAS and Tufts Regional Rehabilitation and Training Institute. Its purpose is to provide information and resources to science faculty, counselors and administrators that would allow them to improve access to science education for the handicapped students.

During the past year AAAS Project on the Handicapped in Science has interviewed in-depth nearly two hundred disabled scientists who received their education after becoming disabled to learn their coping strategies. A report of this study will supply further information to educators.

Ways of Disseminating available information. The growing group of concerned scientists and educators who are putting their efforts on access to science for handicapped students are aware of the need to publish information and to get it into the standard channels of information. Professional periodicals for science educators are beginning to carry articles regarding the handicapped. For example, the editor of the Journal of Chemical Education, reported that that journal is developing articles on teaching chemistry to students having several types of impairments, drawing on the experience of disabled graduate students in chemistry. The March 1978 Biology Teacher carried an article, "Achievement in Biology by Handicapped Scientists" in their career education issue. It is encouraging that the editors of the scientific periodicals that reach science faculty are accepting the responsibility for accessing the needs of their readers and arranging for articles to be written that address those needs.

Dr. Robert Larsen's short course in laboratory modifications is being disseminated through the NSF supported Chatauqua-type short course program. A number of schools and design consultants are beginning to work on adoption for laboratory and bench designs and as that becomes available its dissemination is crucial.

The AAAS Project on the Handicapped in Science has undertaken a clearinghouse effort to fill the information gap and assist educators and handicapped students and scientists who need information that is not available elsewhere. From its Resource Group of Handicapped Scientists and the Directory of theirs soon to be published, it is possible to identify scientists whose experience will be instructive to others. In a similar way, completion of the AAAS Inventory of programs in science for handicapped students will make possible the identificatior of pre-collegiate science education experience that is instructive to others.

The demand from handicapped students and scientists for information and resources and the need of educational institutions and faculty for assistance will grow and continue for two or three years until the experience is more widespread and the information readily available from standard sources. In this interim period the clearinghouse activity needs to be sustained at the AAAS or elsewhere--just as technical assistance on admissions, accessibility, counseling and other special services is available through the higher education associations with support from HEW Bureau of the Handicapped, Office of Civil Rights, Bureau of Higher and Continuing Education, and private foundations such as Kellogg. The great additional advantage of such a centralized clearinghouse is that the pattern of requests is itself informative, telling us what the areas of greatest need are and in what areas information still needs to be developed. Insights such as these are evident throughout the present document.

Another example of dissemination is the fledgling newsletter Access to Science. One conference participant stated that Access to Science, discussed above, had been of great value in learning resources for dealing with architectural and attitudinal barriers, as well as offering useful material on career development. A continuing intercollegiate newsletter could be invaluable in improving the information flow. Another way of disseminating information that is clearly operative is the networks of handicapped students who have themselves started to organize. Although still in the early stages of development, a national organization of handicapped students could function strictly as a rights organization--or it could develop itself also as an inter-campus conduit for information among students and student service programs. As such, it could link students with particular needs to students in similar straits who were further along in resolving them. This could be of great value to students facing not only the interests common to all students, but also to those facing unique issues relating to laboratory and field work and research opportunities.

SOLUTIONS TO ENVIRONMENTAL BARRIERS

Building access. A number of schools have made considerable progress in promoting access to buildings, including their laboratories and research libraries. In many ways they have made great progress in implementing their transition plans. Yet, for too many institutions, the accessibility ends at the laboratory door.

At several institutions, significant efforts have been made to improve the placement of bench controls and location of equipment. Southwest State University, in Marshall, Minnesota, for example, has refined its designs in the course of its campus development. A relatively young institution, it has involved disabled students in the planning process, critically evaluating existing structures to improve newer ones. The campus was built for accessibility, and this extends to the laboratory.

Labelling difficulties have been resolved by visually impaired students themselves affixing braille, large print, or textured labels to equipment and equipment storage areas. Student support services have also assisted in such efforts, as in the case of the University of Wisconsin at Whitewater, where a geology lab was adapted so as to be more accessible to visually impaired students.

Dr. Robert Larson uses a stool mounted on casters for his work in the chemistry laboratory at Argonne, propelled by crutch and cane.

Adaptation of work stations. Work stations have been adapted in a variety of ways, depending on the nature of the impairment for which accommodation is required. An excellent example is that built by the University of California at Davis. Adjustable in height, the bench features a sink on the left and a fume hood on the right. Drawers can be placed with set ups for different students in different classes. The cost was about $3,000, but the bench can be moved from lab and is, the designer says, less expensive than a standard chemistry bench. For some wheelchair-users, such a bench may completely eliminate the need for an assistant and, at the same time, vastly improve safety.

Yet another work bench adaptation is a custom-built raised platform. This unique aid, featuring steps and elevated platform, a small bench to one side and a safety rail was built to the specifications of a handicapped scientist whose short stature does not offer her, even standing, good access to chemistry work benches. The platform is not set upon casters, but slides. A further refinement could be retracting wheels, similar to those on library kickstools. The scientist reports having had several different platforms built for different laboratory situtations dating from student days.

Another student, Jayne Schiff, a paraplegic, reported using a window washer's belt for stabilizing her balance. Hooked to the work bench and encircling her at the hips, the belt enables her to stand at the chemistry bench with both hands free to work. This is an extremely inexpensive solution of value to semiambulatory paraplegics, possibly to some others with balance problems.

A customized study area was developed by a quadriplegic chemistry student which permits him to have all relevant manuals, guides, texts, typewriter, and other materials for his chemistry course spread out and available in a U-shaped arrangement. It is designed for total efficiency and relieves him of the necessity of asking other persons to retrieve materials from drawers, put books onto racks, off racks, etc. The telephone is equipped with a speaker for "hands off" conversation.

To improve safety in the laboratory for students having visual or aural impairments, warning devices should provide for the needs of each. Such devices can be provided very economically. Information on these is available through state VR agencies and organizations of and for deaf or blind individuals. The personal touch should not be ignored; a blind person can always be called by name, and a deaf individual can be touched. Another way to get a deaf individual's attention is to flick the switch of a room's lighting two or three times; this method is contingent on immediate circumstances and, of course, it is important that the hearing-impaired person participate in determining the signal to be used.

Other measures have been taken to provide better for the safety of handicapped students. Written instructions were distributed to hearing-impaired students on the location and use of fire extinguishers, alarms, fire blankets, and emergency showers. Visually impaired students profit by orientation to a laboratory's total layout, including location of exits, obstacles, and all safety devices (which should be labelled both with large print and braille). For the benefit of mobility impaired students, safety equipment should be reachable at

roughly forty-eight inches from the floor, maximum. When the ANSI standards are published, the section on CONTROLS will provide a valuable guideline.

Other types of modifications. Other adjustments for handicapped science students have also been made. For example, the University of Lowell (Massachusetts), St. Andrews Presbyterian College (Laurenburg, North Carolina), and the University of Massachusetts at Boston have all made available tables with adjusting heights for use by students in various science courses. Students may want a table as low as eighteen inches from the floor to enable use of microscopes from a wheelchair. Others will find useful a table higher than standard height for easy use in manipulating switches and dials on electronic equipment.

Physical adaptations of a non-structural nature may be exceptionally helpful for individuals with sensory impairments. For example, audiovisual equipment can be readily applied to the needs of disabled students. Photomicrographic slides can be projected on a wall, as a conferee reported. Their enlarged images are useful both for visually impaired students and severely physically handicapped students who cannot easily look into a microscope. A faculty conferee uses a closed-circuit video set-up to bring the image of the teacher and blackboard in the front of the room closer to the visually impaired student. At Ramapo College, this set-up features an additional capacity; the touch of a switch will exchange the close-up image of the instructor and blackboard for the student's own notes.

Dorothy Tombaugh, a biology teacher, reported a variety of ways to adapt that subject for blind students. Raised line drawings were used to illustrate slides. These are reported as useful for blind students and usable for sighted ones, when done with mixed media. Such an adaptation for teaching biology to blind students requires, in addition to pen and ink, the use of string to outline, for example, cell membranes, and beans for inner structures.

Field adaptations have proven to require special daring and creativity. In order to offer the full range of experiences to a student who used a wheelchair who was attending an NSF summer program in Marine Biology, Dr. Edward Keller, who has an orthopedic disability himself, used marsh fence to cover the sand and allow the student access to the beach.

A geologist who uses a wheelchair spoke of her field experiences and her preference for gathering her own specimens for later analysis in her lab. The pattern of allowing her to make the necessary arrangements and participate in field experiences prepared her well for a profession in geology.

Adaptations necessary for disabled persons to participate in field experiences in anthropology, psychology, social work or health care fields are best worked out on an individual basis. Several disabled persons recounted experiences where field supervisors expressed doubts as to the ability of the person to handle interaction with clients, patients, etc. When the disabled student illustrated how he/she had been successful in coping with similar situations a chance to try was granted. It has often been pointed out by disabled scientists that the field experience was particularly important because it was the first time for many that they had been allowed to meet challenges and even failure, and to learn to depend on their own strengths to cope. Several expressed gratitude to field supervisors who allowed them to try in spite of misgivings.

One conference participant reported that hand-controlled all-terrain vehicles can be extremely useful in the field. Active paraplegics have been using these for some time for a variety of sports activities, including hunting and "hiking." Some are advertised in handicapped consumer periodicals. Institutions purchasing any transportation vehicles for handicapped persons may wish to consider purchasing one. Unconventional vehicles have proven useful on college campuses where the terrain presents unusual difficulties under certain seasonal conditions.

SOLUTIONS TO COMMUNICATIONS BARRIERS

Deaf Students. Hearing impaired students learn best by doing, by observing other students and demonstrations. They cannot lipread a professor and simultaneously observe a demonstration. One conferee stated that she learns best when a whole demonstration can be gone through all at once, but chiefly she observes the other students. One way the faculty can help is to meet the student prior to the lab session to explain any last minute changes. Another is to give the deaf student beforehand a written precis of what will be discussed while the demonstration is performed. Faculty should also ask whether the student wants to work facing away from a window, to work closer to the instructor, or needs better light. If faculty, however, do not ask, the student should be sure to explain what is needed.

Interpreters and note-takers can be invaluable. While professional note-takers are almost never available* many students take good notes and there is no reason why a top student or graduate student should not be able to make carbons of class notes. Jane Reehl, a deaf graduate student emphasizes the importance of communicating by whatever means is available, be it orally, by note or signs - without ever losing patience. To communicate is the main thing, and this may at times require patience. Patience on the part of faculty, as well as the deaf student, goes a long way in promoting good communication. In seminars, it is most helpful for faculty to try to limit excessive cross-talk and to solicit participation from deaf students. This is most important, because many hearing-impaired students are hesitant to jump into a rapidly moving dialogue, especially when doing so might interrupt ongoing discussion.

By repeating a question prior to answering it, the faculty can be certain that all students have heard the question. This procedure is also a useful rhetorical device employed by many, and so the aid it gives to the faculty themselves should be considered. No one expects faculty to face the class every moment, but the more this can be done, the better. When facing and writing on a chalkboard, if the written words conform to the oral, there is no problem. Otherwise, it may be helpful to repeat or clarify the point being made.

Blind students. Most blind students report that the efficient use of reader services is the most viable solution to the management of written materials. As for other experiences that rely strongly on visual clues they feel that knowledge

*Recently an effort is being made to provide this training on some campuses.

of available adaptive devices, information about what has worked for others and problem solving interaction with professors have been helpful in gaining full access to science classes and laboratories. New technology is also expected to be of great assistance to blind students of science.

Existing computer technology can be of immeasurable value to blind and visually impaired science students. Presently, it is inadequately utilized, but it is realistic to hope and work for it to become more available to students and scientists who need it. Steven Machalow, a conference participant proposes that interactive terminals linked to other computers be installed in libraries, with teletype output directly in Braille. The user asks for key words, subjects or authors, and the Current Contents titles or abstracts can be printed out in Braille (similar to the Medline Retrieval System). This avoids storage of Braille transcriptions. Recording can be directly onto tape from the central information storehouse computer without need for human reading onto the tape. Three such terminals are currently available in the United States. The Sagen, a blind conferee stated, is marketed by Telesensory Systems and the LED I and LED 120 are distributed by Trifonations Systems, Inc. In addition to the cost of the terminals, a "Grade 2" Braille translation program is required. Such a program costs anywhere from several hundred to several thousand dollars. While this can fill the needs of Braille readers, many blind persons do not in fact read Braille. His belief, however, is that the majority of blind science students, as well as scientists, are proficient Braille readers, except for some who have lost their vision late in life and others whose tactile skills are poor.

A less costly approach than the interactive computer terminals, this blind conferee suggests, would be to employ "paperless Braille." Paperless Braille is produced by encoding electronic signals on standard C-60 audio cassettes on the market. There are two and a third will be available in October this year. One such machine costs about $2,600, but does not contain a microprocessing unit. The other units contain microprocessors which allow information stored on the cassette to be indexed and quickly accessed.

The storage problem associated with Braille would be satisfactorily resolved by "paperless Braille," since sixty minutes of cassette tape contain 500,000 Braille characters. This is the equivalent of a 200-page ink print volume. This approach may be feasible for publishers to develop Braille materials on request at a very reasonable cost to the blind individual.

Another existing device for those who do not read Braille, or choose not to wait for Braille versions, is the Kurzweil Reading Machine, which scans a printed page and produces synthetic speech, effectively "reading" the page to the user of the machine. This machine is presently available in a number of libraries, schools and rehabilitation centers and will be available soon to individuals.

The equipment mentioned herein is presently available, or very soon will be. The interactive terminal has already been used by several blind individuals, including an individual who has just received his Ph.D. in physics. This equipment can also interface with other standard equipment, such as calculators and typewriters, suggesting further ways to aid visually impaired science students.

Improved communications for blind students can do much to increase the safety and independent functioning of the blind or visually impaired student

Vicki Pasco, a blind student, uses a mesh graph, raised line drawings, and other tools to study biology (Courtesy Dorothy Tombaugh).

Richard Skyer and Linda Ross, deaf students, have a summer work experience at Argonne National Laboratory.

in the laboratory. Dual labelling of materials and equipment, orientation of students in labs, and arrangements for evaluation in emergencies are several ways. It should be remembered that while blind individuals may have special needs, they are not helpless. A blind student who was recently caught in a burning building reported that no sighted person could see in the thick smoke, but he was able to reach safety because he had memorized the building layout and let temperature guide him further. He was the first to exit from the structure, which was totally destroyed, and he was unharmed.

Speech-impaired students. Some students may prove to have speech so impaired that others cannot understand it. In many cases, however, it is useful to listen as though the speaker had a foreign accent. The phonic variations to normal speech are usually consistent, and once the variations are noted as such the speech becomes better understood. For example, one student with cerebral palsy regularly changes plosive sounds to non-plosive, with other distortions as well; his advisor and his friends understand him well, while others are mystified. What makes the difference is exposure. Those who understand him converse with him on a more or less regular basis.

Several students having severe speech problems have found the MCM* of value. This is a portable unit having a keyboard with one or more readout displays, depending on the model. It is more typically used for telephone conversation by deaf individuals, for which TTY's** adapted teletypewriters are also utilized. Colleges should seriously consider having such devices available at critical locations, and they might do well to consider one for the student having a severe speech impairment.

SOLUTIONS TO ACADEMIC BARRIERS

Inadequate preparation in mathematics and science. Handicapped students, like many other students, may be discouraged from developing an interest in science because of "science phobia" and "math anxiety." If they are regarded as simply not capable of "doing" science and math, rather than poorly prepared and/or anxious, little effort may be made to encourage them to study these subjects. Often their fears come from a lack of exposure. Many of the handicapped students who have not been mainstreamed, but instead attended special classes or schools, have never even been exposed to science or math. For a few, mere compulsory exposure early in the course of their postsecondary education may be beneficial. Others can profit from participation in a "math anxiety clinic." Still others need an opportunity for remedial study.

One thing which science faculty have done at schools having a supportive services program for disabled students is to supply handicapped student program offices with science career brochures, materials regarding financial supports for graduate study, and information about science and math clinics available in the area. Science professors have also spoken to these groups and offered their services for academic and/or career counseling. Many students frequent program

---

*Manual Communications Module, produced by Micon, Inc.

**Teletypewriter, also by Micon. Both MCM and TTY are sometimes called TDD, Telecommunications Devices for the Deaf.

offices and the availability of such materials and personal interaction contributes to making science and math less forbidding to the handicapped student who needs such encouragement.

Adaptive educational techniques. To assist faculty in adaptive educational techniques, especially in terms of helping them to develop alternative modes of observation and of their encouraging the greatest possible active participation of sensory impaired students, there are already some resources which can be tapped. An example is Dorothy Tombaugh's manual, "Biology for the Blind." Tombaugh, who has taught biology to blind students integrated into the regular classroom setting for some years, provides many helpful suggestions for drawings, charts and graphs, and measuring devices which can be used by blind students--and others. She also describes some ways in which visually impaired students may observe chemical change, grow plants, observe animals, and participate in field trips.

Testing and evaluation. The testing and evaluation of competency of some handicapped students may be similar to that of their non-handicapped peers. For others, however, the methodology of testing and the very definition of competency requires careful reconsideration. Scheduling flexibility for completing tests and projects may prove essential. Students who have severe limitations in their hands or arms and those who are blind or visually impaired especially are likely to need additional time to complete examinations. This should not vitiate the effectiveness of the test which evaluates competence, or achievement. The critical question concerns the definition of competency.

Competency within a discipline must not be confused with competence over the testing methodology. The ability to perform physical manipulations may demonstrate certain competence, but the physical inability to perform them does not necessarily demonstrate a lack of competence. What is important is that the student be able to demonstrate an understanding of theory and methodology, that he/she understand the use of equipment even if unable to use the equipment unaided. Obviously, the student physically able to perform in an active role should be expected to do so. It is a mistake, however, to penalize a severely disabled student for being restricted in the ways of demonstrating mastery of a subject.

The identification of competence with the ability to perform certain physical activities often occurs when faculty identify mastery of a subject with the ability to carry out the duties of their profession. Obviously, they think, a quadriplegic cannot be a bench chemist. However, a quadriplegic can work as a technical writer, edit scientific periodical, or work at a laboratory in an administrative capacity. For none of these types of positions is the ability to perform a titration a requirement.

Flexibility, then, may be required in several areas. The student may need extra time to complete tests and projects. He/she may not be able to perform a titration, but perfectly able to instruct an assistant and explain what happened. He/she may not be able to identify a slide which he/she cannot see, but can feel a three dimensional copy of it made by a lab partner to learn what is there. The test may need to be administered differently from the standard--orally, or on tape, or brailled for blind students, for example. Finally, some

students may find that certain courses are so demanding on their time, for reasons relating to their handicap, that they may require a smaller course load during one or more semesters, which may require extra time permitted for course completion. The objective is not to provide the handicapped student with unfair advantages, but to offer reasonable accommodation. The faculty should be willing to listen to the student and negotiate necessary modifications, but are also advised, where possible, to consult with the student support services program or other persons who have worked with a similarly handicapped student or a handicapped scientist who had similar experiences. No one recommends that all handicapped students be given more time, any more than one would recommend that exceptions not be made when needed. No matter what decisions are made to adjust course requirements, the handicapped student should be expected to gain the same competencies as his/her able bodied peers.

Access to faculty. Finally, it may not be feasible to make all faculty offices accessible at many schools, but this need not prevent handicapped students from having access to the faculty for conferences or other participation in program activities. Alternative accessible sites must be available and meetings at these sites should be easily arranged. The university, faculty, and administrators must all recognize, too, that making special conferences accessible may also include the provision of interpreters for deaf students, since students consultations with faculty are academically related activities.

SOLUTIONS TO FINANCIAL BARRIERS

Handicapped students must have access to the same financial aid materials and counseling as other students regardless of assistance received from VR. At some institutions, the financial aid office is inaccessible. It must be made at least programmatically accessible under Section 504. That is, the services provided there must be available in an accessible location for handicapped students. This may not always require architectural modifications. One school has relocated materials which students can independently consult. Staff offices are still inaccessible, but the staff will meet students anywhere necessary on campus. In addition to the financial aid office, it is important for handicapped students to have access to placement services and participation in work-study programs. This is an area where the administrator plays an important role.

Presently, as college and university administrators are well aware, there is little financial assistance available from the Higher Education Act for removing architectural barriers or providing services such as interpreters. There is, however, technical assistance available. Costs for architectural modifications are one-time expenses. Often, there are ways to provide these modifications in a way which is less expensive than might be believed. Unfortunately, many architects do not understand the intent of 504 and may confuse programmatic accessibility, which 504 requires, with full physical accessibility, which it does not. Due to this continuing confusion, as well as the basis for determining architectural fees for service, administrators should make a special effort to consult with handicapped students, consumer organizations, and VR or other agencies, who can help to determine ways of meeting the need which are still as cost-effective as possible.

CHAPTER IV

Recommendations, Strategies and A Charge

In the previous chapter, we discussed some solutions which have already been used by handicapped students or scientists. Although a number of institutions and individuals have been quite helpful to handicapped students, such efforts will continue to be piecemeal without the development of a strong policy and institutional support consistent with the requirements of Section 504 of the Rehabilitation Act of 1973. This chapter contains the specific recommendations for removing the barriers to post-secondary education in science for handicapped persons, strategies for their implementation and a charge to the groups and individuals whose responsibility it must be to carry them out.

The following recommendations, which are based upon a search of the literature, surveys of handicapped students and scientists, and the input of conference participants, can make a significant difference in improving access to quality science education for handicapped students at the post-secondary level. The recommendations are listed to provide, in effect, an agenda for action by relevant agencies, institutions, professional societies and individuals. The recommendations are not prioritized, since doing so would imply that a recommendation near the top of a list is much more important than one lower down. No such inference should be drawn. All these recommendations will promote the breaking down of barriers to handicapped students in science.

The strategies for implementation of the recommendations were those developed by the conference working groups after consideration of barriers and solutions. The strategies presented here offer plans for immediate action. They outline carefully tasks that can be started right away by institutions and individuals to begin to remove the barriers to education too long faced by handicapped students wishing to enter scientific careers, or merely to take science courses. We hope that these strategies may serve as a model by which individuals or institutions can develop plans to meet their unique needs.

Finally, this chapter contains a charge to those institutions, agencies, members of the U. S. Congress, organizations and individuals who are responsible for bringing about the necessary change that will assure truly equal access to science education for handicapped students. We charge the institutions of higher education where the formal science education takes place; the scientific, educational and counseling associations whose members make up the community of persons most critical to success of the implementation; the consumer groups of handicapped persons; the governmental agencies charged with improvement of education and career opportunities of handicapped persons or with the science education of all students; and the Congressional committees responsible for legislation, impacting on the education and/or rehabilitation of handicapped individuals and/or science education of all persons; and finally, the individuals who, in the end, will carry out any implementation strategies, that is, the science faculty members, administrators, counselors, handicapped scientists, handicapped students, other handicapped

persons, other members of the scientific community, members of the Congress, and professionals who work in governmental agencies.

RECOMMENDATIONS

The recommendations are divided into categories that seemed to fall naturally. These categories are used mainly to assist the reader.

A. INFORMATION DISSEMINATION

- Improve existing information services by checking for inclusion of existing information on science education of handicapped persons.
- Use existing information networks such as journals, newsletters, and meetings of professional societies to disseminate information on science education of handicapped students, and career opportunities in science for handicapped persons.
- Establish an interim technical assistance clearinghouse with hot-line to give on-the-spot advice and referral of resources to persons charged with the science education of handicapped students as a stopgap measure until established channels of information can be updated to include this type of technical assistance.
- Organize campus groups made up of all parties interested and knowledgeable about science education and handicapped students in order to allow for information exchange.
- Prepare and distribute flyers to advertise existing resources; such as the AAAS Directory of Handicapped Scientists and National Federation for the Blind's Handbook for Blind College Students. (See the bibliography in the Appendices.)
- Identify existing science materials, and laboratory equipment and furnishings that may be helpful in accommodating handicapped students.
- Utilize the information, training opportunities and manuals widely available that deal with general barriers, architectural barriers, attitudinal change, understanding disability.

B. USE OF HUMAN RESOURCES

- Use AAAS Directory of Handicapped Scientists to engage speakers for campus activities, professional-oriented fraternities, student groups, professional organizations, and other societies, in order to instruct in accommodation of handicapped students and to raise the audience's expectations of handicapped persons.
- Use handicapped scientists as role models for students in high schools and colleges.
- Enlist economists to develop a monograph on the cost-

effectiveness of providing a good education in science for handicapped students.

- Arrange seminar programs to allow handicapped scientists to give lectures at universities to students, counselors, faculty and other staff in their field of science, and their coping strategies systems of accommodation.
- Seek to improve the image of handicapped persons by using handicapped scientists in media presentations and in textbook illustrations.

C. DEVELOPMENT OF NEW RESOURCES AND TRAINING STRATEGIES

- Train handicapped students and faculty in interactive problem-solving techniques that will facilitate accommodations in science programs.
- Train all science faculty and department heads in understanding legislation for the handicapped as it impacts on science education.
- Develop training workshops and manuals that describe in detail methods of instruction, aids and appliances, and resources available for teaching science to handicapped students.
- Prepare one-page fact sheets, i.e., "What Do I Do If a Deaf Student is in My Class?" Such fact sheets could be developed as a result of such a workshop on the subject.
- Develop sign language for scientific terms and train interpreters in techniques of interpreting technical scientific lectures and laboratory demonstrations.
- Develop standards for modification of science laboratories to accommodate handicapped students with mobility, visual, or auditory impairment.
- Develop audio/visual materials, i.e., films, filmstrips, posters, depicting handicapped scientists to use in workshops on awareness, teaching methodology and for career education.
- Develop a model seminar/workshop presentation on handicapped students in science laboratories and classrooms for use by scientific societies at their professional meetings.

D. IMPACT ON PRE-COLLEGE SCIENCE EDUCATION

- Incorporate into all elementary-teacher and secondary-science teacher training and licensing requirements training in teaching science to handicapped students.
- Mainstream physically handicapped youth for science education from the beginning of their educational experience, and provide necessary services for science teachers.

- Develop materials for younger handicapped students encouraging them to consider careers in science.
- Provide resources necessary to adapt standard science curricula and materials to needs of handicapped students.

E. CAREER EDUCATION AND COUNSELING

- Link counselors to available resources in educational and career guidance in science.
- Develop career education materials that feature disabled and able-bodied scientists.
- Develop curricula for counselor training that addresses special needs of handicapped persons wishing to pursue education in science or scientific careers.
- Provide all counseling and career education materials in form usable by all handicapped students.
- Study vocational rehabilitation counseling and service delivery system for its impact on students choosing to seek scientific career goals.

F. CAMPUS STRATEGIES AND ACCOMMODATIONS

- Establish positive commitment to science education of handicapped students by establishing a committee of science faculty, handicapped students and scientists and other campus staff to evaluate science program and recommendations and strategies for access; monitoring all science programs to insure compliance with Section 504 of Rehabilitation Act of 1973; and preparing an action plan to assure all objectives to provide access are met.
- Recruit qualified high school handicapped students for science programs.
- Allot resources to provide access, especially to laboratories and libraries.
- Develop a strategy to recognize faculty who are particularly creative in removing barriers.
- Work with existing agencies to secure necessary aids and appliances and other accommodations needed for handicapped students to participate as fully as possible in science programs.
- Create regional resource centers to supply necessary aids or adapted materials to science programs to pool existing resources and develop additional equipment and maintain a "hot-line" information service.

STRATEGIES

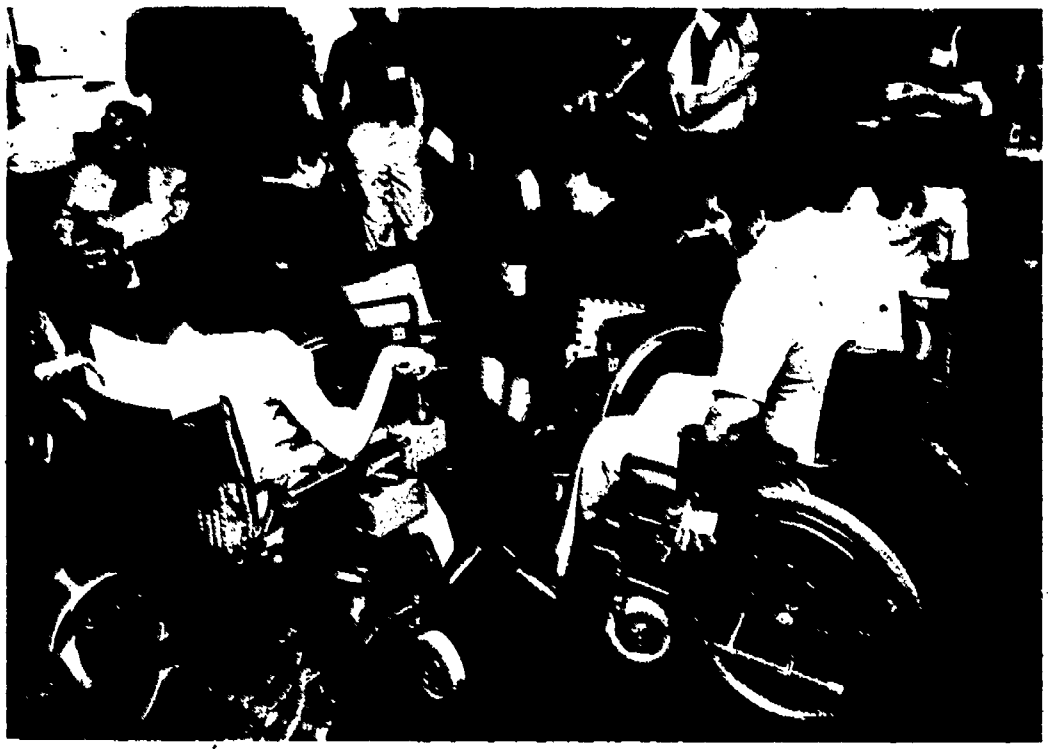
Two major strategies for implementation of the recommendations were generated by conference participants. We present these two strategies with the hope that they will serve as examples of action that may be taken by individuals and groups to eliminate barriers to science education for handicapped students.

The first strategy recommended by one group of conferees is the establishment of an interdisciplinary task force to draw expertise from the various groups charged with the science education for handicapped students. The functions of the task force will be to assess the needs of the science community for technical assistance in providing science instruction for handicapped students and to develop strategies for providing this technical assistance. The recommended strategy is the development of a clearinghouse and technical assistance network to deal with the dissemination of available information, the improvement of existing information systems and the development of new information and resources to fill the gaps that exist. If both the task force and information clearinghouse and technical assistance network were established, interaction between the two would be fruitful. However, we do not wish to suggest that one depends on the other for success, nor that one cannot exist without the other. Nor do we suggest that these are the only two strategies needed to implement the recommendations we suggest, but these seemed central to some conference participants.

The Task Force

An interdisciplinary task force to remove barriers to post-secondary science education for handicapped students should be representative of various scientific disciplines, types of colleges and universities science departments, and different types of handicapped persons. The task force would attempt to meet the needs of science departments and programs, professional schools, vocational rehabilitation counselors, and/or handicapped students wishing to enter careers in science. The human resources available to the group would be mainly the disabled scientists, the scientific professional societies, handicapped students of science, and the members of science faculties across the nation that have been successful in providing adequate science education for handicapped students. Such a task force could be set up on a local, state or national level by a science department, the State Academy of Science or a professional society. This type of organization is suggested because it would bring together persons from a variety of disciplines and with expertise to solve problems of access.

It is suggested that such a task force be composed of two bodies. One, a group that meets face-to-face and is small enough that it can be called together on a regular and frequent basis. The other, a much larger group, would draw together many people who would communicate by mail with the smaller group, collect data in their own communities, and serve as suppliers of useful information. A link with the clearinghouse described earlier would have obvious advantages. As materials are developed and additional helpful information and resources are identified by both task force activities, they could be fed into the clearinghouse system for dissemination to a wide variety of organizations and universities that are outside of the reach of various task forces.



Between working sessions, coffee brought together people sharing their concerns and scientific interests. Rear: Mr. Thomas Shworles, Ms. Linda Fay, Ms. Cheryl Davis. Foreground: Ms. Janet Miller, Mr. Gary Farnsworth.

At a working session: Dr. Myron Weinberger, Dr. Nansie Sharpless, Ms. Barbara Mendius, Dr. Thomas Austin, Dr. David Hartman.

Suggested activities for such a task force are:

- To build connections between scientific associations and disabled students, counselors, science faculty;
- To study the structure of the science community to discover the most viable resources and communication network for development of technical assistance for science faculty, counselors and handicapped students;
- To encourage the active participation of disabled scientists and students of science in the various professional associations;
- To identify existing committees within organizations that do, or should, include issues of science education for handicapped students on their agenda;
- To survey science and mathematics departments in colleges and universities, medical schools, engineering schools, to discover the needs for technical assistance in providing access to handicapped students;
- To survey science laboratories, equipment and instruments used in order to determine needs for adjustment and adaptations;
- To study existing suppliers of laboratory furnishings and equipment for possible alternatives to most frequently used equipment that might be adaptable for handicapped persons;
- To develop strategies for offering technical assistance through existing organizational structures, such as work shops/seminars, at regional and national conventions, use of newsletters and journals, and adding handicapped issues to existing hot-line services;
- To persuade textbook publishers to include pictures of handicapped persons engaged in scientific activities;
- To review the suitability of curricula materials for handicapped persons and suggest any adaptations that may be needed;
- To review science programs in a select group of colleges and universities, especially those that have been leaders in education of the handicapped to determine if their science programs offer models for other institutions.

Some of the participants at the barriers conference will form the nucleus for a task force modelled after the above suggestions. The group plans to meet first during the AAAS Annual Meeting in Houston in January 1979. Invited to that first meeting will be all participants at the barriers conference, representatives of AAAS Affiliate Societies, and other interested persons attending the AAAS meeting. Special emphasis will be placed on persons attending who are actively involved

in teaching science at the higher education level. The AAAS Directory of Handicapped Scientists will be used to contact other disabled scientists to make them aware of the first task force meeting, and representatives from Federal agencies will be invited. At this first meeting, the barriers conference report will be reviewed, and the group will be encouraged to present additional recommendations. From those recommendations will be selected those to be addressed by the group. Subcommittees will be appointed to deal with particular tasks.

It is intended that this description of the task force strategy and the plans for such a meeting in January 1979 will encourage the organization of similar task forces in other organizations and at other locations. The working group that developed the task force idea emphasized that such groups must remain pragmatic and task oriented. They must focus on reasonable, attainable strategies, usable by individual students, teachers and administrators. The task force described above will focus, at this time, on higher education.

Clearinghouse of Information and Technical Assistance Network

The issue of information dissemination was thought by many conference participants to be the most crucial to barrier removal. Most people felt also that some information is available in some form although not easy to locate through the existing channels. Several of the working groups developed strategies for structuring a system to remove the information barriers; they called the system a clearinghouse of information or technical assistance network.

The system described here for information collection, development and dissemination is a compilation of the similar suggested strategies of several conference groups. Such an information center could be developed at a large, national organization concerned with access by the handicapped to science education, or on a smaller scale, on a regional, state, or local level. At this time, and for probably the next two or three years, a nationwide system would be most useful since recent legislation has raised a multitude of questions concerning access for handicapped persons to science laboratories and classrooms. Since the organizations that usually furnish information on the handicapped to campuses rarely include any information concerning access to science programs, there are still great gaps in the system. However, it was the recommendation of the conference that as the information system is developed, the various components of it might be located in a variety of existing organizations.

The various tasks suggested for development and implementation of such a clearinghouse are as follows:

- To search the literature for research, teaching methodology, curriculum and materials that relate to teaching science to handicapped students;
- To suggest to existing information systems, such as ERIC, that careful study be made of existing methods of access to the system to discover why articles relating to the handicapped in in science often do not appear within their abstracts;

- To review sources of information available to the blind from the Library of Congress and other sources and offer suggestions on additions in scientific fields;
- To develop resource lists of available materials, articles and manuals, that deal with barrier removal or classroom and laboratory accommodations;
- To recommend handicapped persons to serve on grant review panels and as role models for handicapped students;
- To give on-the-spot advice or reference for problems unique to providing accommodations to an individual handicapped student in science;
- To prepare or stimulate papers that deal with particular issues of access for publication in scientific journals or newsletters;
- To produce and distribute a newsletter to encourage handicapped students to choose science careers and give science faculty assistance in providing this access;
- To assess the needs of persons using the service and suggest special publications or training materials to deal with those needs;
- To make recommendations to the appropriate groups for the development of information resources not now available;
- To form links with similar networks to which questions can be referred.

For this strategy to be successful, an efficient system for dissemination must be developed and persons needing information must be aware of the resource. For this reason it was recommended that a flyer be developed and widely disseminated that describes the clearinghouse and invites the people to use it.

A CHARGE TO GROUPS AND INDIVIDUALS RESPONSIBLE FOR REMOVING BARRIERS TO SCIENCE EDUCATION FOR THE HANDICAPPED

Only when institutions, organizations and agencies, and the people who run them make decisions and act, can barriers be struck down. The recommendations suggested earlier deserve attention because they come from the experience of handicapped persons, science educators, university administrators and counselors. The law now requires that handicapped students have access to science programs in all institutions that receive government funds. This certainly places the burden of responsibility for barrier removal on the groups and individuals we address. The strategies suggested earlier are a beginning, but each concerned organization and individual should look at the recommendations, consider their unique needs and competencies, and develop strategies to begin the task of barrier removal. The charge now is to act.

Institutions of Higher Education

Up until now, few institutions have had more than one or two handicapped persons in attendance at any one time. Even the schools with the largest population of handicapped students had few who enrolled in science courses. Handicapped persons who did receive degrees in science were often considered unique cases, unlikely to be repeated, but now with new legislation and a national thrust for equal opportunity for handicapped persons, colleges and universities must make their science programs truly accessible. The charge to institutions of higher education is to commit the institutions, and particularly the science departments, to the elimination of barriers. In order to meet the requirements of the law and especially to affect science departments, we suggest that a special committee be appointed on each campus to evaluate access to the science program. The committee should include science faculty representing the various disciplines, disabled scientists, disabled students of science and persons with expertise in areas of laboratory furnishings, facilities and instruments. There are some resources available to assist in this evaluation. (See the bibliography in the Appendices) After the evaluation process is completed, plans should be made for doing whatever is necessary to achieve full program accessibility and the plans then be implemented. It may be that the university decides that experts need to be brought in to advise on particularly difficult problems of laboratory access, or adjustment or accommodation for a particular type of handicapped person to the science program.

The recommendations discussed earlier in this chapter that are of particular importance to institutions of higher education are found under Sections B, C and F.

In conclusion, the charge to universities is to commit, organize, evaluate and make plans for change, seek the additional resources and training needed, and thus provide true access to science programs for qualified, handicapped students who seek to enter science careers, or simply to enroll in the science course offered at a given institution.

Professional Associations

Professional associations of scientists, educators, and counselors, have long sought to serve the needs of their constituents. When an issue such as access to science for handicapped students presents new demands, the organization must develop strategies to assist in meeting the needs. The professional associations can meet this challenge in a unique way with respect to existing networks that provide information to their members. Most professional societies to whom this charge is given have newsletters and journals that reach their members on a regular basis. These newsletters and journals can carry technical assistance immediately to the science faculty providing access to disabled students. The journals can present the research and articles that describe accommodations that have been found successful for such access. In addition, professional associations have developed the training capabilities that meet the unique needs of their members. Training sessions at regular association meetings can distribute information on working with handicapped students through an existing channel to the persons who need it most.

The charge to professional associations is to first identify disabled people within their own ranks, ask these disabled people to consult on removing the barriers to young people who would follow in their steps and enter the profession and thus the association.

The recommendations listed earlier that can best be accomplished by professional societies are found in Sections A, B, and E.

Consumer Organizations of Handicapped Persons

Links between consumer groups of handicapped persons and academics that are charged with the provision of access to science programs can be the key to easy facilitation for these students. Nowhere can first-hand information on accommodations be secured more rapidly and more accurately than from consumer groups. These groups should encourage their members to approach the various professional societies and institutions where they work to offer their assistance in achieving equal opportunity. Consumer organizations should assist college and university science departments in interpretation of the law as to the requirements for program access as well as the rights of disabled students to services both inside and outside the university. A great deal of confusion that surrounds disability can be resolved by honest discussions between consumer groups and educational institutions. More first-hand experience in meeting disabled people, and more discussion of aids, appliances, and services, could quickly help science faculty to overcome their apprehension and lack of information.

The recommendations listed earlier that are of particular significance to this group are found under Sections A, B, D, and E.

The charge to consumer groups of disabled people is to initiate links between their organizations, institutions of higher education, and professional associations of scientists, educators and counselors in order that interaction may be developed between the people who are most able to suggest coping strategies that work, and the people who are responsible for providing access to science education for handicapped students.

Government Agencies

Institutions of higher education have long looked to certain government agencies for funds for science education and for counseling and financial assistance for handicapped students. One of the problems that continues to inhibit the development of better science education for the handicapped is that traditionally the agencies responsible for education of the handicapped have had little interest and concern about science education, and the offices responsible for science education and research and training for careers in science have had minimal expertise on the needs of handicapped students. This means that there is no place in the federal or most state education agencies where one can get technical assistance to develop science education for handicapped students. When the section 504 regulations required that science programs be made accessible, for instance, there was no mechanism in the National Science Foundation for providing either the technical assistance or funding for programs to test ways to best accomplish this.

It was logical for science departments to look to the Bureau of Education for the Handicapped/Department of Health, Welfare and Education for this assistance, but little help could be found there either because neither science nor higher education are priorities of the Bureau.

The charge to government agencies is to initiate interagency projects that would bring together expertise for the various agencies so that problems of providing adequate science education for handicapped students can be addressed adequately and expediently without the need to redesign the entire program thrust of an individual agency.

The recommendations discussed earlier that are particularly appropriate to be carried out by Federal agencies are found primarily in Sections A,B, C, and D.

Congressional Committees

The Congressional committees who deal with legislation affecting science or handicapped persons are very important in the improvement of post-secondary education in science. Often issues that affect the relatively small population of handicapped persons who wish to pursue an education or career in science are lost among those that affect the rest of the large handicapped population. Consideration, for instance, of whether graduate education will be supported for handicapped students through vocational rehabilitation funds may be lost in debate over appropriations for funding more global issues such as the deinstitutionalization of retarded citizens. However, such an issue is very important to a disabled person faced with a career decision as he or she enters college.

The first charge to members of Congressional committees is that when drafting federal legislation careful attention should be given that language be included to allow adequate interaction between issues of science education and rights of handicapped persons. In other words, when writing legislation that addresses the quality and scope of science education, the language should be such that it allows for the participation of handicapped students. Likewise, in legislation addressing issues of education and access for the handicapped, the language must be such that science education and access to science laboratories and programs are not excluded from the coverage of the law. Federal agencies, and thus science faculty and disabled students, depend on the guidance of legislation for much program development. Much confusion can be reduced from the start by adding the language that eliminates a dichotomy between science education and the handicapped youth.

An additional charge to Congressional committees is to hear testimony from disabled scientists and science students when considering any legislation that would affect this segment of the population.

All recommendations stated earlier have relevance to the work of Congressional committees responsible for legislation on the handicapped and on science education.

A Final Charge to Action

Most barriers to science education for handicapped students can be struck down. The architectural barriers, though they are most evident, will, in most cases, be the least complicated to eliminate. Aids and appliances, adapted instrumentation and furnishings will further add to laboratory access. Adjustments in classroom presentations, interpreters, note-takers and readers will facilitate science program access. Even attitudes will change. In the end, the barriers to be removed most be brought down by individuals -- disabled students, science faculty, counselors, administrators, disabled scientists, professionals in governmental agencies, and members of the Congress. We hope that in the future it will not be necessary for the major burden to fall on the disabled student or, for that matter, on any one group of individuals. We trust that as a result of recent legislation and the good faith effort of individuals in institutions of higher education, institutional change will come about to assure access to science programs for handicapped students.

APPENDIX A

PARTICIPANTS

CONFERENCE ON BARRIERS TO HANDICAPPED STUDENTS OF SCIENCE

AT COLLEGES AND UNIVERSITIES

*ADRIENNE ASCH
(doctoral candidate,
social psychology)
Teachers College
Columbia University
New York, New York

*DR. THOMAS S. AUSTIN
Director, Environmental Data Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Washington, D.C.

*DR. JEFFREY BOHRMAN
(postdoctoral fellow)
Biology Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee

DR. JOHN A. BORNMANN
Chairman, Division of Natural Sciences
and Mathematics
The Lindenwood Colleges
St. Charles, Missouri

*DR. LATHAM BREUNIG
President (ret.)
Alexander Graham Bell
Association for the Deaf

*GEORGE CHIN
(doctoral candidate, chemistry)
University of Florida
Gainesville, Florida

DR. NANCY CREWE
Associate Professor of Physical
Medicine and Rehabilitation Counseling
and Psychological Services
University of Minnesota
Minneapolis, Minnesota

*ALFRED H. DEGRAFF
Director, Disabled Student Services
Boston University
Boston, Massachusetts

DR. BAILEY L. DONALLY
Dean of Faculty
Lake Forest College
Lake Forest, Illinois

EDWARD S. DUTTO
Management Services Officer
College of Chemistry
University of California
Berkeley, California

*GARY FARNSWORTH
(student, physics)
Monroe Community College
Rochester, New York

*DR. CAROL FAUL
Associate in Geology
University of Pennsylvania
Philadelphia, Pennsylvania

*LINDA FAY
(student, premedical)
University of Massachusetts-Harbor Campus
Boston, Massachusetts

*GERALD FELDHAKE
(student, mathematics and physics)
University of Cincinnati
Cincinnati, Ohio

*DR. EMERSON FOULKE
Professor of Psychology
Director, Perceptual Alternatives Laboratory
Louisville, Kentucky

*CATHY GATCHELL
(student, chemistry)
Utah State University
Logan, Utah

*DR. JOHN GREEN
Professor of Biology
Nicholls State University
Thibodaux, Louisiana

*DR. E. STEPHEN HALPERT
(psychiatrist)
Veterans Administration Hospital/
Mental Health
Tampa, Florida

DR. TEODORO HALPERN
Director, School of Theoretical
and Applied Science
Ramapo College
Mahwah, New Jersey

DR. S. MARIA HARDY
Associate Professor of Biology
Rutgers University
Livingston College
New Brunswick, New Jersey

*DR. DAVID HARTMAN
(psychiatrist)
Department of Psychiatry
University of Pennsylvania
College of Medicine
Philadelphia, Pennsylvania

DR. JAMES J. HAZDRA
Director, Health Care Education
Illinois Benedictine College
Lisle, Illinois

*DR. RONALD HERBOLD
Instructor of Chemistry
Ohlone College
Fremont, California

*JEFFREY HIMMELSTEIN
(doctoral candidate, science education)
Rutgers University
New Brunswick, New Jersey

*DR. EDWARD KELLER
Professor of Biology
University of West Virginia
Morgantown, West Virginia

DR. JOSEPH J. LAGOWSKI
Professor of Chemistry
University of Texas
Austin, Texas

*DR. HARRY LANG
Assistant Professor of Physics
National Technical Institute for the Deaf
Rochester, New York

RAYMOND LIFCHEZ
Associate Professor of Architecture
University of California
Berkeley, California

DR. THOMAS LIPPINCOTT
Professor of Chemistry
University of Arizona
Tucson, Arizona

*STEVEN MACHALOW
(doctoral candidate, anthropology)
University of Minnesota
Minneapolis, Minnesota

DR. LEROY MCLAREN
Professor of Microbiology
School of Medicine
University of New Mexico
Albuquerque, New Mexico

*ALLEN JAY MASSAR
(graduate student, chemistry)
University of California, Crown College
Santa Cruz, California

*BARBARA MENDIUS
(graduate student, biology)
University of Illinois
Urbana, Illinois

*JANET MILLER
(student, industrial technology)
University of Lowell
Lowell, Massachusetts

DR. GENE M. NORDBY
Vice President for Business Affairs
Georgia Institute of Technology
Atlanta, Georgia

DR. ROBERT M. PFEISTER
Professor of Microbiology
Ohio State University
Columbus, Ohio

*JANE REEHL
(graduate student, molecular genetics)
Carnegie Mellon University
Pittsburgh, Pennsylvania

*DR. ROBERT REHWOLDT
Professor of Chemistry
Marist College
Poughkeepsie, New York

DR. DAVID M. RICE III
Associate Professor of Rehabilitation Counseling
Director, Disabled Student Services
Edinboro State College
Edinboro, Pennsylvania

*JUNE ROOKS
(graduate student, physics)
Southern Illinois University
Carbondale, Illinois

ANDREA SCHEIN
Director Handicapped Student Center
University of Massachusetts-Harbor Campus
Boston, Massachusetts

*DR. NANSIE SHARPLESS
(neurochemistry)
Assistant Professor of Psychiatry
Albert Einstein College of Medicine
Bronx, New York

*THOMAS R. SHWORLES
Director, Center for Program Development
and the Handicapped
Chicago City-Wide College
Chicago, Illinois

*WILLIAM J. SKAWINSKI
(student, chemical engineering)
New Jersey Institute of Technology
Newark, New Jersey

DR. CONRAD D. SNOWDEN
Associate Provost
Princeton University
Princeton, New Jersey

*DR. S. PHYLLIS STEARNER
(biology)
Division of Biological and Medical Research
Argonne National Laboratory
Argonne, Illinois

*KATHY SUSANY
(student, biology)
University of Pittsburgh
Pittsburgh, Pennsylvania

*DR. ANNE BARRETT SWANSON
Research Associate
Department of Oncology
McArdle Laboratories
University of Wisconsin
Madison, Wisconsin

DOROTHY TOMBAUGH
Department of Biology
Euclid High School
Euclid, Ohio

JOHN TRUESDALE
Director, Rehabilitation-Education Services
University of Wisconsin
Whitewater, Wisconsin

DR. BRUCE WEEMS
Assistant Professor of Physics
East Central Oklahoma State University
Ada, Oklahoma

*DR. MYRON WEINBERGER
Associate Professor of Medicine
Director, Specialized Center of
Research in Hypertension
Indiana University School of Medicine
Indianapolis, Indiana

DR. RICHARD WRIGHT
Instructor of Biology
Valencia Community College
Orlando, Florida

*DR. HAROLD YUKER
Provost and Dean of Faculty
Hofstra University
Hempstead, New York

*DR. IRVING K. ZOLA
Professor of Sociology
Brandeis University
Waltham, Massachusetts

*Asterisk denotes handicapped conference participants.

APPENDIX B

WORKING GROUP ASSIGNMENTS

Conference on Barriers to Postsecondary Science
Education for Handicapped Students
Sheraton National Hotel
Arlington, Virginia
June 9 - 11, 1978

Conference Facilitator: Mark Ozer

GROUP A

Led - Helen Marie Hoffman

Rapporteur - Michele Aldrich

Interpreter - Oral

Latham Breunig
George Chin
Nancy Crewe
Bailey Donally
Ed S. Dutto
Carol Faul
S. Maria Hardy
Jeffrey Himmelstein
Raymond Lifchez
Leroy McLaren
Steve Machalow
Janet Miller
John Truesdale
Irving K. Zola

GROUP B

Led - Cheryl Davis

Rapporteur - Jim Sattler

Interpreter - Oral

Adrienne Asch
John A. Bornmann
Gary Farnsworth
Linda Fay
Gerald Feldhake
Cathy Gatchell
E. Stephen Halpert
Thomas J. Lippincott
Gene M. Nordby
Robert Pfeister
Jane Reehl
David M. Rice
Thomas Shworles
Anne Barrett Swanson

GROUP C

Led - Ginny Stern

Rapporteur - June Maker

Interpreter - Oral

Thomas A. Austin
Emerson Foulke
David Hartman
James J. Hazdra
Joseph J. Logowski
Barbara Mendius
Robert Rehwoldt
Andrea Schein
Nansie Sharpless
Kathy Suzany
Bruce Weems
Myron Weinberger
Richard J. Wright
Harold Yuker

GROUP D

Led - Ed Keller

Rapporteur - Diane DiQuinzio

Interpreter - Sign Language

Jeffrey Bohrman
Alfred DeGraff
John Green
Teodoro Halpern
Ronald Herbold
Harry Lang
Allen Jay Massar
June Rooks
William J. Skawinski
Conrad D. Snowden
Phyllis Stearner
Dorothy Tombaugh
David Young

APPENDIX C

CONFERENCE SCHEDULE

BARRIERS TO POSTSECONDARY SCIENCE EDUCATION FOR HANDICAPPED STUDENTS

CONFERENCE SCHEDULE

FRIDAY JUNE 9, 1973

6:00 - 8:00 pm	Registration and buffet supper. Check in, pick up materials; mix, mingle, get acquainted
8:00 - 9:30	Welcome "Access to Higher Education for Handicapped Students," Martha Redden, Director, Project on the Handicapped in Science, Office of Opportunities in Science, American Association for the Advancement of Science (AAAS). "Consumer Participation and Higher Education," Eunice Fiorito, Special Assistant to the Commissioner, Office of Advocacy and Coordination, Rehabilitation Services Administration, United States Department of Health, Education and Welfare. "Preliminary Considerations for the Conference," Mark Ozer, Associate Professor of Child Health and Development, George Washington University School of Medicine, Associate Professor of Neurology, Howard University School of Medicine, Washington, D.C.

SATURDAY JUNE 10, 1978

	Session	Grouping	Objectives	Room
8:30 - 9:00 am	continental breakfast			North
9:00 - 9:30	I. Plenary	All assembled	Overview of goals, procedures, and conference product	North
9:30 -10:30	II. Goal Setting	Role groups (5).	Groups define own goals for conference, relating to roles (e.g., student, faculty, etc.)	A,B,C,D
10:30 -11:00	Break			
11:00 -12:30	III. Barriers	Mixed groups (4).	Identify and clarify barriers, especially in science education	A,B,C,D
12:30 - 1:30	Lunch	All(groups from previous session please remain together)		North
	IV. Report on Barriers	Each group reports to all on Session III, Barriers		North

"Access to Higher Education: The Total Environment." Raymond Lifchez, Associate Professor of Architecture, University of California, Berkeley

Conference Schedule

2:00 - 3:30	V. Solutions	Mixed Groups (4).	Brainstorm, synthesize, and select solutions which have worked for you--or others.	A,B,C,D
3:30 - 4:00	Break			
4:00 - 5:00	V. Solutions (cont'd)			A,B,C,D
5:00 - 5:30	VI. Report on Solutions	All, mixed (4).	Each group reports to all on Session V, Solutions.	North
5:30 - 6:00	Break			
6:00 - 7:30	VII. Small Groups	Role groups (5).	All may meet in self-directed groups, to discuss barriers or solutions which may be most appropriately explored in depth in areas with special relevance to individual groups (e.g. faculty, students, women, handicapped, physics, chem.).	A.B.C.D
7:30 - 9:00	Dinner. "A Sociologist Considers His Handicap." Irving Kenneth Zola, Professor of Sociology, Brandeis University, Waltham, Mass.			North

SUNDAY JUNE 11, 1978

8:30 - 9:00 am	Continental Breakfast			North
9:00 -10:30	VIII. Strategies	Mixed groups (4).	Analyze and develop recommendations. Given some of the solutions, what would you want to see happen?	A,B,C,D
10:30 -11:00	Break			North
11:00 -12:30	IX. Strategies	Role groups (5)	Recommendations discussed, in terms of roles & circumstances of conferees. How would strategies and recommendations relate to students? faculty? administrators? What effects might there be? Any agenda for action by your group?	A,B,C,D
12:30 - 1:30	Luncheon.			North
1:30 - 2:00	X. Report on Recommended Strategies & Recommendation	All, assembled	Each group reports to all on Sessions on Recommendations	North
2:00	Adjournment (Time approximate)			

A late check-out for 2:00 p.m. has been arranged.

APPENDIX D
STUDENT QUESTIONNAIRE USED TO
SOLICIT DATA FOR THE STUDY

American Association for the Advancement of Science

1776 MASSACHUSETTS AVENUE, NW, WASHINGTON, D. C., 20036

Phone 467-4400 (Area Code 202) Cable Address: Advancesci, Washington, D.C.

Dear Student:

WE NEED YOU! We are looking for handicapped students to help us identify the barriers many face in studying science (especially lab sciences). We also seek strategies for coping with those barriers. We are also interested to learn about barriers which were anticipated, but which turned out to be unimportant. The American Association for the Advancement of Science has been working for several years now to eliminate barriers to the scientific professions and education. In all that time, we have found that the best resources for constructively changing programs and policies which concern handicapped individuals are the handicapped individuals themselves!

Participation will take only a little time. Please fill in the brief questionnaire below and return it to us in the enclosed stamped, self-addressed envelope. No information in it will be used in a way which could identify you without your permission. IF YOU PREFER TO SPEAK WITH US, PLEASE FEEL FREE TO CALL COLLECT 202-467-4496 (VOICE OR TTY), AND ASK FOR CHERYL DAVIS. Our efforts have had continuing input from handicapped scientists and staff. Cheryl Davis uses a wheelchair and is active in organizations representing persons with various handicaps. We are open to your ideas and eager to hear from you. Your assistance is vital and very much appreciated.

Hoping to hear from you soon!

Sincerely,

Martha Redden
Director, Project on the
Handicapped in Science
Office of Opportunities in Science

Cheryl A. Davis
Senior Program Associate
Project on the Handicapped in Science
Office of Opportunities in Science

P.S. If you know any other handicapped students who are taking science courses, please photocopy this letter and questionnaire and pass it on. Printed, typed, or filled in over the phone, we want to hear from you!

---

1. Name _____ 2. Age ____ 3. Sex _____

4. Your address at school _____

5. Phone number (include area code) Home _____ School _____

6. What school are you attending? _____

7. What degree do you seek? _____ Field(s) of concentration _____

(continued other side)

8. What is your disability? _____

9. Expected date of graduation or completion of studies _____

10. What kinds of schools did you attend? Check as applicable, noting which years attended.

	Elementary	Junior High	High School
Regular class, private or public, integrated with non-handicapped peers			
Regular class, with added special classes as needed			
Regular school, but segregated in special classes			
Special schools			

11. Did you take lab and/or field sciences at any of the following levels? __elementary __junior high __high school __college undergraduate If YES, check as they apply. If NO, check here__. Specify courses taken _____

_____

_____

12. Please describe fully any modifications in the lab, in equipment, and in procedure that may have been utilized. Were any needed, but not provided? Were any instructors helpful in this regard? Attach extra sheet if needed. _____

_____

_____

13. Have you confronted attitudinal, administrative, architectural, or other barriers in pursuing your educational goals? How have you coped with them? What worked for you? Were there problems specific to science education? Were there any professors who helped or encouraged you that we can contact? Have you developed any special strategies, or has any equipment been improvised by or for you that you could tell us about? Please discuss fully, using extra sheet(s) as necessary. _____

_____

_____

_____

14. Have you received encouragement in your educational and career goals? What has helped you in this regard? _____

15. Do you use any mobility aids or auxiliary appliances (eg, wheelchair, tape recorder)? Please describe _____

16. Do you use any special services (eg, interpreters, attendants)? Please describe.

_____

17. If you have further comments, or thoughts, please add whatever you wish. _____

_____

APPENDIX E

SELECTED PUBLICATIONS
OF CONSUMER ORGANIZATIONS OF HANDICAPPED PERSONS

ACCENT ON LIVING
P.O. Box 700
Gillum Road and High Drive
Bloomington, IL 61701

ACCD NEWSLETTER
American Coalition of Citizens
with Disabilities, Inc.
1346 Connecticut Ave. NW
Room 817
Washington, DC 20036

AMERICAN REHABILITATION
Rehabilitation Services
Administration
330 C Street, SW
Washington, DC 20201

AMICUS
National Center for Law and
the Handicapped
1235 North Eddy Street
South Bend, IN 46617

BRAILLE FORUM
American Council of the Blind
c/o Mary T. Ballard
190 Lattimore Road
Rochester, NY 14620

BRAILLE MONITOR
National Federation of
the Blind
1346 Connecticut Ave., NW
Washington, DC 20036

THE CHALLENGE
Veterans Administration Depart-
ment/Vocational Rehabilitation
P.O. Box 11045
Richmond, VA 23230

CLOSER LOOK
National Information Center
for the Handicapped
Box 1492
Washington, DC 20013

COPH BULLETIN
National Congress of Organizations
of the Physically Handicapped, Inc.
P.O. Box 19005
Minneapolis, MN 55419

CRUSADER
UCP Associations, Inc.
(United Cerebral Palsy)
66 East 34th Street
New York, NY 10016

DAV MAGAZINE
Disabled American Veterans
3725 Alexandria Pike
Cold Spring, KY 41076

THE DEAF AMERICAN
814 Thayer Avenue
Silver Spring, MD 20910

DISABLED USA
The President's Committee on
Employment of the Handicapped
Washington, DC 20210

EASTER SEAL BULLETIN
National Easter Seal Society
2023 West Ogden Avenue
Chicago, IL 60612

EXCEPTIONAL CHILDREN
1920 Association Drive
Reston, VA 22091

THE EXCEPTIONAL PARENT
20 Providence St., Room 708
Boston, MA 02116

GALLAUDET ALUMNI NEWSLETTER
Gallaudet College
7th and Florida Ave., NE
Washington, DC 20002

HANDY-CAP HORIZONS
3250 East Loretta Drive
Indianapolis, IN 46447

HARMONIZER
7611 Oakland Avenue
Minneapolis, MN 55423

THE INDEPENDENT
Center for Independent Living
2539 Telegraph Avenue
Berkeley, CA 94704

INTERNATIONAL STROKE
CLUB BULLETIN
805 12th Street
Galveston, TX 77550

JOURNAL OF REHABILITATION
National Rehabilitation Assn.
1522 K St., NW
Washington, DC 20005

JOURNAL OF REHABILITATION OF
THE DEAF
814 Thayer Avenue
Silver Spring, MD 20910

MUSCULAR DYSTROPHY NEWS
MD Association of America, Inc.
810 Seventh Avenue
New York, NY 10019

NAPH NATIONAL NEWSLETTER
National Association of
the Physically Handicapped
76 Elm Street
London, OH 43140

NATIONAL HOOKUP
Indoor Sports Club, Inc.
P.O. Box 838
Adelanto, CA 92301

THE NEW OUTLOOK FOR THE BLIND
American Foundation for the Blind
15 West 16th Street
New York, NY 10011

NEWSLETTER
Committee for the Handicapped
People-to-People Program
1028 Connecticut Ave. NW, #610
Washington, DC 20036

NEWSLETTER (and other publications)
Division of the Blind and
Physically Handicapped
Library of Congress
Washington, DC 20542

NTID FOCUS
National Technical Institute
for the Deaf
One Lomb Memorial Drive
Rochester, NY 14623

PARAPLEGIA LIFE
Editorial Offices
National Paraplegia Foundation
333 North Michigan Ave.
Chicago, IL 60601

PARAPLEGIA NEWS
935 Coastline Drive
Seal Beach, CA 90740

PATIENT SERVICE NEWS
National Multiple Sclerosis
Society
257 Park Avenue South
New York, NY 10010

THE POINTER
P.O. Box 131
Syracuse, NY 13210

REHABILITATION GAZETTE
4502 Maryland Avenue
St. Louis, MO 63108

REHABILITATION LITERATURE
National Easter Seal Society
2023 W. Ogden Avenue
Chicago, IL 60612

REHABILITATION WORLD
20 West 40th Street
New York, NY 10018

SPINE TINGLER
c/o Joan S. Physioc
5456 85th Avenue, #2
New Carrollton, MD 20784

STAR NEWS LETTER
Katherine Kreuser
6219 N. Naper Avenue
Chicago, IL 60631

VOLTA REVIEW
Alexander Graham Bell
Association
3417 Volta Place, NW
Washington, DC 20007

For additional organizations, refer to Directory of Organizations Interested in the Handicapped, published by the Committee for the Handicapped, People-to-People Program, 1028 Connecticut Avenue, NW, Suite 610, Washington, DC 20036,

or

Clearinghouse on the Handicapped--
Directory of National Information Sources
published by the Office for Handicapped Individuals
U.S. Department of Health, Education and Welfare
Washington, DC 20201

APPENDIX F

ORGANIZATIONS OF AND FOR THE HANDICAPPED

Alexander Graham Bell
Association for the Deaf
3417 Volta Place, NW
Washington, DC 20007

American Coalition of Citizens
with Disabilities
1346 Connecticut Ave. NW, Rm 817
Washington, DC 20036

American Council of the Blind
1211 Connecticut Ave. NW, #506
Washington, DC 20036

American Professional Society of
the Deaf
c/o Dr. Donald L. Ballantyne
NYU Medican Center
560 First Avenue
New York, NY 10034

Blinded Veterans Association
1735 De Sales Street, NW
Washington, DC 20036

Disabled American Veterans
3725 Alexandria Pike
Cold Spring, KY 41076

Disabled in Action
175 Willoughby Street
Brooklyn, NY 11201

Epilepsy Foundation of America
1828 L Street, NW
Washington, DC 20036

Gallaudet College Alumni Assn.
Gallaudet College
7th and Florida Avenue, NE
Washington, DC 20002

Indoor Sports Club
1145 Highland Street
Napoleon, OH 43545

National Association of the Deaf
814 Thayer Avenue
Silver Spring, MD 20910

National Association of the
Deaf-Blind of America
c/o Dr. Doris M. Callahan
616 E. 124th Street
Cleveland, OH 44108

National Association of the
Physically Handicapped, Inc.
6473 Grandville Avenue
Detroit, MI 48228

National Congress of Organizations
of the Physically Handicapped, Inc.
7611 Oakland Avenue
Minneapolis, MN 55423

National Federation of the Blind
1346 Connecticut Ave. NW, Suite 212
Washington, DC 20036

National Multiple Sclerosis Society
205 East 42nd Street
New York, NY 10017

National Paraplegia Foundation
369 Elliot Street
Newton, MA 02164

Paralyzed Veterans of America
4330 East-West Highway, Suite 300
Bethesda, MD 20014

Spina Bifida Association of America
P.O. Box 5568
Madison, WI 53705

United Cerebral Palsy Association
66 East 34th Street
New York, NY 10016

United Ostomy Association, Inc.
1111 Wilshire Boulevard
Los Angeles, CA 90017

N.B. See Appendix E for publications
and directory of additional organi-
zations.

APPENDIX G

Bibliography

The material listed in large part is taken from "Science for the Handicapped Bibliography" compiled for the Science for the Handicapped Association of the National Science Teachers Association by Dr. Kenneth Ricker, Department of Science Education, University of Georgia. The material is representative of the publications available on science and the handicapped, as well as education of the handicapped generally.

Articles included do not necessarily express opinions of the AAAS Project on the Handicapped in Science. Some of the articles listed herein diverge from contemporary philosophy and practice and are included primarily to provide historical perspective.

General

Affirmative Action to Employ Handicapped People. A Pocket Guide to the Regulations of Section 503 of the Rehabilitation Act of 1973. Wash. D.C.: President's Committee on Employment of the Handicapped, 1976.

American Association of Collegiate Registrars and Admissions Officers and the American Council on Education. Recruitment, Admissions and Handicapped Students. Wash. D.C., Office for Civil Rights, U.S. Dept. of Health, Education and Welfare, 1978.

Architectural Accessibility for the Disabled of College Campuses: Stephen R. Cotler, R.A. and Alfred H. DeGraff. State University Construction Fund, Washington, D.C.: Architectural & Transportation Barriers Conference Board, 1977.

Ashley, Irvin E., Jr. "Agricultural Laboratories for the Physically Handicapped." Agricultural Education Magazine, 41: 144, 1968.

Brown, Janet Welsh. "Who Are the Handicapped Scientists?" Science, November 7 1975, pp. 546-593.

BSCS Newsletter. The Biological Sciences Curriculum Study, Boulder, Colorado.
No. 36 (September 1969)
No. 38 (February 1970) (Whole No. 38)
No. 43 (April 1971) (Whole No. 43)
No. 44 (September 1971)
No. 46 (February 1972)
No. 48 (September 1972)
No. 52 (September 1973)
No. 53 (November 1973)
No. 55 (April 1974)
No. 56 (September 1974)

Clearinghouse on the Handicapped. Directory of National Information Sources. Wash. D.C.: Office for Handicapped Individuals, U.S. Dept. of Health, Education and Welfare, 1978.

The College Guide for Students with Disabilities. Eleanor Gollay and Alwina Bennet. ABT Publications, 55 Wheeler Street, Cambridge, MA 02138.

Council for Exceptional Children. Abstract 1252, EC 003 1252, ED 046 168, Publ. Date November 1970, 162 pp.; Science: A Guide for Teaching the Handicapped. Iowa University, Iowa City, Iowa: Special Education Curriculum Development Center, Office of Education (U.S. Dept. of Health, Education and Welfare) Wash. D.C. Bureau of Education for the Handicapped, EDRS mf, hc, BR-6-2883.

Davis, Cheryl and Martha Redden. "Achievement in Biology: An Introduction to Handicapped Biologists," American Biology Teacher, March 1978.

Directory of Organizations Interested in the Handicapped. Wash., D.C.: Committee for the Handicapped/People to People Program, 1976.

Federal Assistance for Programs Serving the Handicapped. Wash. D.C., Office for Handicapped Individuals, U.S. Department of Health, Education and Welfare, 1977.

First Ponder, Then Dare. Disabled Students of America. President's Committee on the Employment of the Handicapped. U.S. Government Printing Office, 1975.

Gentile, Eric. "Architectural Affirmative Action: A University with a New Concept," Amicus 2 (4): 31-36 (1977).

Gollay, E. and A. Bennett, The College Guide for Students with Disabilities. ABT Publications, Cambridge, MA 02138, 1976.

Getting Through College with a Disability: A Summary of Services Available on 500 Campuses for Students with Handicapping Conditions. The President's Committee on Employment of the Handicapped, Washington, D.C. 20210.

Hadary, Doris. "Picking Up Good Vibrations from Science for the Handicapped." The Science Teacher, December 1975, pp. 12-13.

Handicapped Americans Reports: Plus Publications, Inc., 2626 Pennsylvania Ave. NW., Wash. D.C. 20037.

Hayden, Jean S. and Helen M.E. Woodward. "Rationale for a Science Program." Volta Review: V70, N3, pp. 159-65, March 1968.

Hessler, John. "College Education for the Severely Disabled," American Rehabilitation, 1 (5), May-June 1976, pp. 29-33.

Hillam, Bruce P. "You Gave Us Your Dimes..." Newsweek, Nov. 1, 1976, p. 19.

Holden, Constance. "The Handicapped: HEW Moving on Civil Rights in Higher Education." Science 194: 1399-1402 (Dec. 24, 1976).

Kirkpatrick, Lyman B., Jr. "Twenty-five Years in a Wheelchair," Brown University Alumni Monthly, Jan.-Feb. 1978.

Lawrence, R., Krieger, G.S., Barad, C.B.;"Rehabilitation Concerns of the Handicapped College Student." Rehabilitation Research and Practice Review, 3 (3), Summer 1972, 53-61.

Molloy, Larry. "Law and the Handicapped." Science and Children, March 1976, pp. 7-10.

Monaco, Theresa M. "Mainstreaming, Who?" Science and Children, March 1976, pp. 11-13.

National Association of College and University Business Offices, Self Evaluation Guide. Wash. D.C.: Office of Civil Rights, 1977.

National Directory of Products and Services for the Disabled. Winter Park, Florida: The Green Pages, Inc., 1978.

Newman, J. "Faculty Attitudes Toward Handicapped Students." Rehabilitation Literature, July 1976, Vol. 37, No. 7., 194-197.

Newsletter: Access to Science, American Association for the Advancement of Science, Office of Opportunities in Science, 1776 Massachusetts Ave. NW, Wash. D.C. 20036.

"Non-Discrimination Provisions of the HEW Regulations," Amicus, 2. (June 1977.)

Planning for Accessibility: Margaret Milner, Director of Programs. National Center for a Barrier-Free Environment. The Association of Physical-Plant Administrators of Universities and Colleges, Suite 250, Eleven DuPont Circle, Wash. D.C. 20036.

Post, Thomas R., Alan H. Humphreys and Mickey Pearson. "Laboratory-Based Mathematics and Science for the Handicapped Child." Science and Children, March 1976, pp. 41-43.

Proceedings of "The Disabled Student on American Campuses: Services and the State of the Art": Ms. Pat Marx, Editor; Office for Handicapped Students, Wright State University, Dayton, OH 45435.

Project HEATH (Higher Education and the Handicapped). Informational Brochure. Wash. D.C., American Council on Education, 1978.

Proscia, Vito, Phyllis Stearner, E.C. Keller, Jr., and Donald L. Ballantyne. "A Challenge to Teachers from Handicapped Scientists." Science and Children, 13:15-16, March 1976.

Redden, Martha Ross, "Handicapped Resource Group Members Work for Barrier Elimination," Science, February 4, 1977.

Redden, Martha Ross and Janet Welsh Brown, "Expanding Horizons: Careers in Science," Rehabilitation Counseling Bulletin, June 1976.

Redden, Martha Ross, Janet Welsh Brown and Wayne Fortunato-Schwandt, Barrier Free Meetings: A Guide for Professional Associations, American Association for the Advancement of Science, 1976.

Redden, Martha Ross and Wayne Schwandt, Science Technology and the Handicapped, Proceedings of a Symposium, American Association for the Advancement of Science, 1976.

Redden, Martha Ross, June Maker and Steven Tonelson, Coping Strategies of Successful Disabled Scientists. In press.

Redden, Martha Ross and Shirley Mahaley Malcom. "A Move Toward the Mainstream." Science and Children, March 1976, pp. 14-16.

Ricker, Kenneth S. "Providing Unhandicapped Teachers for Handicapped Pupils: A Pre-service Science Education Course for Special Education Teachers." Paper presented at National Science Teachers Association Convention, March 1977, Cincinnati, Ohio.

Rustin, J. and R. Nathanson. "Integrating Students into a College Population." Social Casework. Nov. 1975, 56 (9), 538-542.

SCIS Newsletter. The Science Curriculum Improvement Study, Berkeley, California.
No. 22 (Winter 1972)
No. 23 (Fall, 1972)
No. 24 (Spring, 1973)

Section 504 of the Rehabilitation Act of 1973. Fact Sheet. Handicapped Persons' Rights under Federal Law. Wash. D.C., Office for Civil Rights, U.S. Dept. of Health, Education and Welfare, March 1978.

Your Responsibilities to Disabled Persons as a School or College Administrator: Task Force on Public Awareness and the Rights of Disabled People, Hubert H. Humphrey Building, U.S. Dept. of Health, Education and Welfare, Wash. D.C. 20210.

Yuker, Harold E., et al. Modification of Educational Equipment and Curriculum for Maximum Utilization by Physically Disabled Persons. Albertson, N.Y.: Human Resources Center, 1967.

Blind

Albano, L.G. Prominent Geographical Features Appearing on Continental Maps. Unpublished Manuscript, American Printing House for the Blind (Instructional Materials Reference Center), 1972.

Baughman, James and Dean Zollman, "Physics Lab for the Blind." The Physics Teacher, 15:339-342, September 1977.

Benham, Thomas A. "Aids for the Blind." Electrical Engineering, Vol. 66, 1947

Benham, Thomas A. "Recording Books for the Blind." American Foundation for the Blind, Talking Book Department, New York, 1957.

Benham, Thomas A. "Science for the Blind." American Journal of Physics, 23:177, March 1955 and 24:45, January 1956.

Boldt, Werner. "The Development of Scientific Training in Blind Children and Adolescents: Results of Empirical Research Regarding the Teaching of Science in Schools of the Blind." Education of the Visually Handicapped, March 1969.

Boyle, J. and others. "A Braille Code for Interactive Terminal Use." American Foundation for the Blind Research Bulletin. Vol. 27, pp. 267-72, April 1974.

Brett, James J. "Pathways for the Blind." Conservationist, pp. 13-16, June/July, 1971.

Brier, H.S. "Oscar, A Milliammeter for Sightless Amateurs." C.Q., July 1948.

Brower, Kenneth, "On the Reef Darkly." Atlantic, November 1976, pp. 94-102.

Bryan, Arthur H. "Chemistry for the Blind." Science Education, 36:91-95, March 1952.

Bryan, Arthur H. "General Science for the Blind." Science Education, 41:26-30, February 1957.

Bryan, Arthur H. "Physics for the Blind." Science Education, 35:271-74, December 1951.

Bryan, C.A. "Secondary School Sciences for the Blind." International Journal for the Education of the Blind, 5 (October 1956), 11-18.

Bunner, William R. and Richart T. Bunner. "What About Your Visually Defective Student?" The American Biology Teacher, 30, No. 2, (February 1968), 108-109.

Burke, E.A. "Laboratory Work in Science for the Blind." Teachers Forum, 4:48-49, 1932.

Carver, Thomas R. "Laboratory Science for Blind Students and the Evolution, Design and Use of an Optical Light Bulb." American Foundation for the Blind, Research Bulletin, #16, May 1968.

Catalog of Captioned Films. University of Southern California, Los Angeles, National Information Center for Educational Media. Office of Education (U.S. Dept. of Health, Education and Welfare) Wash. D.C., Bureau of Education for the Handicapped.

Central Catalog. Instructional Materials Reference Center for Visually Handicapped Children, Louisville, Kentucky. American Printing House for the Blind. Office of Education (U.S. Dept. of Health, Education and Welfare) Wash. D.C.

Connecticut Institute for the Blind. "Basic Concepts of Blind Children." The New Outlook for the Blind, 29:341; December 1965.

Cooper, Katherine E. and Herbert D. Thier. "Do You Have to See It to Believe It?" Learning, 2; (April 1974), 54-55.

Council for Exceptional Children. Abstract 884, EC 03 0884, ED N.A., Publ. Date 1970, 10 pp.; Franks, Frank L., Measurement in Science for Blind Students; EDRA not available, Teaching Exceptional Children; Vol. 3, No. 1, pp. 2-11, Fall 1970.

Coville, M.G. "Content of a Course in General Science Adapted for Use with the Blind." American Association of Instructors of the Blind, 1932, pp. 773-775.

Coville, M.G. "Science Committee Notes, Laboratory Work." Teachers Forum. 4:90-93, 1932

Cranmer, T.V. "Liquid Level Indicator for the Blind: Electronic Device." Popular Electronics, 26: 59-60, May 1967.

Cravats, Monroe. "Biology for the Blind," The Science Teacher, Vol. 39, No. 4, April 1972.

Dawson, James R. "Biology for the Blind." American Biology Teacher. 20:42-44, Fall, 1958.

Directory of Agencies Serving the Visually Handicapped in the U.S. N.Y.: American Foundation for the Blind, 1978.

Egelston, Judy, Guest Editor. "Editorial Comment on Adapting Science Materials for the Blind: (Asmb) Student Outcomes." Science Education, Vol. 59, No. 2, April-June 1975, pp. 235-6.

Eichenberger, Rudolph J. "Teaching Science to the Blind Student." The Science Teacher, 41:53-54, December 1974.

Evans, Q. "A Simple Capacitance Bridge." Braille Technical Press, Vol.9, No. 11, November 1958.

Francouer, Pearl and Eilam Belhah, "Teaching the Mammalian Heart to the Visually Handicapped: A Lesson in Concrete Experience." The Science Teacher, December 1975, pp. 8-11.

Franks, Frank L. "Educational Materials Development in Primary Science: An Introductory Science Laboratory for Young Blind Students." Education of the Visually Handicapped, 7:97-101, December 1975.

Franks, F.L. "Measurement in Science for Blind Students." Teaching Exceptional Children, 1970, 3, 2-11.

Franks, F.L. "An Operational Approach to the Development of Tangible Apparatus." Unpublished report, American Printing House for the Blind, 1971.

Franks, F.L. and M.J. Murr and A. Biacchi. Biological Models Project. Unpublished Report, American Printing House for the Blind, 1973.

Franks, F.L. and C.Y. Nolan,"Measuring Geographical Concept Attainment in Visually Handicapped Students." Education of the Visually Handicapped, 1971, 3, 11-17.

Franks, F.L. and L. Sanford. "Using the Light Sensor to Introduce Laboratory Science." Science and Children, March 1976, pp. 48-49.

Fulker, Wilber H. and Mary Fulker. Techniques with Tangibles. Springfield, Illinois: Charles C. Thomas Publisher, 1968.

Gladstone-Miller, L. "Studying Science By Touch and Ear," Times Education Supplement, 31:49-46-7, October 10, 1975.

Graham, Milton D., Science and Blindness: Retrospective and Prospective. American Foundation for the Blind, Inc., 15 West 16th Street, New York, NY 10011.

Gunderson, R. "A Simple Capacitance Bridge." Braille Technical Press, Vol. 2, No. 11, November 1951.

G[illegible] "Blind Improved Test Gear." Radio Electronics, 22, No. 6, pp. 28-30, 1[illegible]

Gunderson, R. "Reading Visual Meter Movements by the Voltage Comparison Method." Braille Technical Press, Vol. 9, No. 12, December 1958.

Hance, R.T. "Laboratory Work for the Blind." Science Counselor. Vol. 1, No. 4, p. 4 and p. 34, 1935.

Handbook for Blind College Students. Wash. D.C. National Federation of the Blind. Student Division. 1977.

Heisler, W.T. "The Need for Three Dimensional Instruction in Science Curricula." American Association of Instructors of the Blind. pp. 103-104, 1946. Proceedings of the 38th meeting.

Henderson, David Ray. "Laboratory Methods in Physics for the Blind." Pittsburgh University, Pennsylvania. Publ. Date 1965. ERIC ED 011-155, #9, Sept. 1967.

Hiemenz, Paul C. and Elizabeth Pfeiffer. "A General Chemistry Experiment for the Blind." Journal of Chemical Education, 49, No. 4, (April 1972) 263-5.

Hoover, W.C. "The Techniques of Science Instruction of Visually Handicapped Students." Masters Thesis, State Teachers College, Pittsburgh, PA. 1936.

Hurst, A.D. "Ways and Means of Teaching General Science to Blind Students." Teachers Forum, 6:34-37, 1933.

Instructional Materials Reference Center for Visually Handicapped Children, American Printing House for the Blind. The Central Catalogue. Wash. D.C. Office of Education, U.S. Dept. of Health, Education and Welfare, 1961.

International Guide to Aids and Appliances for Blind and Visually Impaired Persons. N.Y.: American Foundation for the Blind, 1978.

Kaufman, A.S. "Science for the Blind in the Secondary Schools." Paper presented at National Science Teachers Association, March 1976, Philadelphia, PA.

Kaufman, A.S. "Tutoring a Visually Handicapped Student in High School Chemistry." The New Outlook for the Blind, 65, No. 10, (December 1971), pp. 313-317.

Lennon, Elizabeth M, J.L. Feirer and W.K. Purdy. "Metrics for Visually Impaired Persons." New Outlook for the Blind, 70:1-4, January 1976.

Linn, Marcia and H. Thier. "Adapting Science Materials for the Blind (SMB): Expectation for Student Outcomes." Science Education, Vol. 59, No. 2, April/June 1975, pp. 237-246.

Long, R.E. "The Importance of a Laboratory in Science Classes -- What Shall It Be In?" American Association of Instructors of the Blind. pp. 173-5, 1940, 35th Biennial Convention.

Loomis, Madeleine S. and P.C. Mitchell. "Braille Chemical Notations and How to Use Them." New York, 1939. The New York Institute for the Education of the Blind. Monograph No. 8.

Maley, P.V. "Suggestions for Using the Senses in Teaching Science." American Association of Instructors of the Blind, pp. 125-127, 1950, 40th Convention.

Mallinson, George C. "Programmed Learning for the Blind." Final Report, BR Project No. 5-00758. U.S. Educational Resources Information Center, ERIC Document ED 014 193, March 1967.

Mallinson, George C. and Mallinson, J.V. "Symbolic Science Learning for the Blind." School Science and Math, 67:pp. 432-49, May 1967.

Mitchell, P.C. "Some Ways of Teaching Attitudes and Methods in Science." American Association of Instructors of the Blind, pp. 171-172. 35th Biennial Convention.

Murr, M.J. Seed Plan Illustrations in Biology Textbooks. Unpublished manuscript. American Printing House for the Blind (Instructional Materials Reference Center) 1971.

Napier, Grace D. "Special Subject Adjustments and Skills." The Visually Handicapped Child in School, Ed. Berthold Lowenfeld (New York: The John Day Company) 1973, pp. 221-227.

Nolan, C.Y. and J.E. Morris. "Japanese Abacus as a Computational Aid for the Blind." Exceptional Child, 31:15-15, Sept. 1964.

Overbeay, D.W. "Enriching and Extending the Science Program to Meet Postwar Needs." American Association of Instructors of the Blind. pp. 100-102, 1946. 38th Convention.

Pappas, C. Jr., "Teaching Chemistry at Perkins." American Association of Instructors of the Blind, pp. 127-129, 1950. 40th Convention.

Peterson, E.G. "The Extent and Importance of Laboratory Work in Biology Class." American Association of Instructors of the Blind. pp. 158-161, 1940. 35th Biennial Convention.

Redden, Martha Ross and Cheryl Davis, "Mainstreaming, the Kurzweil Reading Machine and Science Education for the Handicapped," The Kurzweil Reading Machine, Boston: Exceptional Parent (in press).

SAVI Newsletter, Science Activities for Visually Impaired, Berkeley, California. No. 1, February 1977.

Schatz, Dennis; Frank Franks, Herbert Thier and Marcia Linn. "Hands-On Science for the Blind." Science and Children, March 1976, pp. 21-22.

Schatz, Dennis and Herbert Thier. "Increasing the Accessibility of Hands-On Science for Blind Students." New Outlook for the Blind (vol. 70, no. 2) pp. 61-63, February 1976.

Schwartz, Jonathan R. "Survey of Nature Trails for the Visually Impaired." Journal of Visual Impairment and Blindness, 71:54-61. February 1977.

SCIS Newsletter, Summer 1969, Discovery Without Sight.

SCIS Newsletter, Spring 1971. Adapting Science Materials for the Blind.

Shugrue, Sylvia K., Walter Morris and Carolyn Kuhne. "Braille Trail Model." Science and Children, 6:23-24, October 1968.

Thier, Herbert and others. "Adapting Science Materials for the Blind, Report of an Evaluation Planning Conference." U.S.Educational Resources Information Center, ERIC Document ED 038 282, December 1969.

Thomas, Barry. "Environmental Education for the Blind." Instructor, 86:9:106-7, May 1977.

Tombaugh, E. Dorothy. "Biology for the Blind." 1973, Euclid Public Schools, Euclid, Ohio.

Tombaugh, Dorothy, "Laboratory Techniques for the Blind." The American Biology Teacher, 34, No. 5, (May 1972) 258-260.

Walker, I. Constance. "Computer Programmer Training for the Blind and Visually Impaired: A Case for Quality Standards and Professionalism." Research Bulletin, Vol. 24, pp. 95-112, March 1972.

Weems, Bruce. "A Physical Science Course for the Visually Impaired." The Physics Teacher, 15:333-338, September 1977.

Wexler, A. Experimental Science for the Blind. London, Pergamon Press, 1963.

Wexler, A. Experimental Science for the Blind: An Instruction Manual, Pergamon Press, 1961.

Willoughby, Doris et al. Your School Includes a Blind Student. Wash. D.C. National Federation of the Blind, Teacher Division, 1977.

Witcher, C.M. "Laboratory Work for the Blind." Zahl, P.A. Editor, Blindness, 1950, pp. 247-258.

Zahl, P.A. Blindness: Modern Approaches to the Unseen Environment. Hafner Publishing Company, New York, 1962.

Deaf

Borron, Roberta A. "An Analysis of Behavior Change Through Science Instruction with Deaf Children." Unpublished Master's Thesis, Univ. of Texas at Austin, 1972.

Boyd, Eunice and K. George. "The Effect of Science Inquiry on the Abstract Categorization Behavior of Deaf Children." Journal of Research in Science Teaching, 10, No. 1 (1973) 91-99.

Bybee, R.W. "A Review of Literature of Science for the Deaf." Science Education, 56, No. 2 (1972) 237-242.

Clarcq, Jack. "Educational Needs of the Deaf and NTID." Journal of Rehabilitation of the Deaf: Vol. 4, No. 2, pp. 64-74, October 1970.

Clarcq, Jack and others. Career Development and Media Utilization at the National Technical Institute for the Deaf. American Annals of the Deaf: Vol. 118, No. 5, October 1973.

Editorial Comment on Science for Handicapped Students: Deaf Education. Science Education, Vol. 59, No. 2, April/June 1975, p. 255.

Egelston, Judy C. and David Mercaldo. "Science Education for the Handicapped: Implementation for the Hearing Impaired." Science Education, Vol. 59, No. 2, April/June 1975, pp. 257-261.

Fellendorf, George W. "Technical Training for Deaf Students at a Community College." Volta Review: Vol. 72, No. 5, pp. 296-302. May, 1970.

Frisina, Robert. "Careers, Technology and NTID." American Annals of the Deaf. Vol. 118, No. 5, October 1973.

Frisina, Robert. The National Technical Institute for the Deaf. Vol. 17, No. 1, pp. 7-13. Winter 1968.

Greenleaf, Gene. "A Trade and Technical Institute Program for Deaf and Hard of Hearing Students." Volta Review, Vol. 72, No. 6, pp. 357-61, September 1970.

A Guide to College/Career Programs for Deaf Students. Rawlings, B.W. et al, eds. Gallaudet College and National Technical Institute for the Deaf. September 1975.

Haushalter, Robert and Richard Rosenberg. "Breaking Sound Barriers for the Deaf Child." Science and Children, XIV (November/December 1976), p. 33.

Isaacs, Morton. "Attitudes Towards the College Deaf Student: Stereotype or 'Kernel of Truth'?" Unpublished research paper, National Technical Institute for the Deaf, Rochester, New York, 1972.

Jamison, Steven L. Computing Careers for Deaf People. N.Y.: Association for Computing Machinery, Special Interest Group on Computers and the Physically Handicapped. 1976.

Lang, Harry G. "Mainstreaming: A New Dimension in Science Education for the Deaf" Unpublished seminar research paper, National Technical Institute for the Deaf, Rochester, New York, 1977.

Lang, Harry G. "Teaching Physics to the Deaf." Physics Teacher, December 1973, pp. 527-531.

Lauritsen, Robert and David Custer. "Careers....A Multi-Variate Approach." American Annals of the Deaf, Volume 118, Number 5, October 1973.

Lenth, J.W. "Purpose for Science in a Curriculum for the Deaf." American Annals of the Deaf, 109:356-8, September 1964.

Osguthorpe, Russell T. et al. "Training and Managing Paraprofessionals as Tutors and Notetakers for Mainstreamed Deaf Students." Paper presented at the bi-annual meeting of the Conference of American Instructors of the Deaf, Los Angeles, California, 1977.

Philips, Steve. "A Review of Literature on Science Materials for the Deaf." Science Education, April/June 1972.

Rothman, Gail & R. Greg Emerton, "Attitudes of Hearing Students Toward Deafness on a Deaf-Hearing College Campus," Unpublished report, National Technical Institute for the Deaf, Rochester, New York, 14623, Fall 1975.

Schein, Jerome D. "The Deaf Scientist." Journal of Rehabilitation of the Deaf, 9:17-21, July 1975.

SCIS Newsletter, "Helping the Deaf Hear." No. 27 (Spring 1975), p. 7.

Shultz, Ora Ann. "Planetarium Astronomy for the Hearing Impaired." Science Teacher, 40:45-6 (April 1973).

Stuckless, E. Ross. "Postsecondary Programs for Deaf Students in 1972." American Annals of the Deaf: Vol. 117, No. 3, pp. 377-82, June 1972.

Vaughn, Gwenyth R. Education of Deaf and Hard of Hearing Adults in Established Facilities for the Normally Hearing. Final Report. Idaho State University, Pocatello. Rehabilitation Services Administration, (U.S. Dept. of Health, Education and Welfare) Wash. D.C.

Wells, Douglas O. Guidelines for Planning Post Secondary Training Programs for the Deaf Within Existing Community Junior Colleges. Final Report. Delgado College. Academic & Vocational Programs for the Deaf. New Orleans, Louisiana.

Yonovitz, A. "Amateur Radio for the Deaf." The Volta Review, 71: 259, May 1969.

The preceding material was compiled from a variety of sources and stylistic consistency was regrettably impossible.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Founded in 1848, AAAS is the world's leading general scientific society with 125,000 individual members. It is also the world's largest federation of scientific organizations with nearly 300 affiliated societies and academies covering the entire spectrum of the natural and social sciences, engineering, and medicine. Despite its size and complexity, AAAS offers its individual members a voice in the larger scientific community through programs for the expansion and interchange of ideas in science and engineering and in the public understanding and appreciation of science. AAAS membership includes the weekly journal **SCIENCE** and the opportunity to participate in one of the 21 AAAS Sections of the Association that embrace the basic fields of science and engineering. Members also take part in programs that contribute toward the solution of problems affecting not only the scientific community but society as a whole.

For further information about AAAS, write

AAAS Membership Department
1515 Massachusetts Ave., N.W.
Washington, D.C. 20005

AAAS provides for the interchange of information of concern to scientists and to society through:

- SCIENCE, the weekly magazine which carries definitive articles and up-to-date reports on topics and issues in and about the scientific world.
- the Annual National Meeting which provides a forum for the presentation of symposia and lectures on recent developments in science, and informed discussions on policy issues that affect society as a whole.
- the quarterly review magazine SCIENCE BOOKS & FILMS, the Science Book Lists, and Science for Society which review or annotate and list the best science books, films and related articles currently available.
- other publications such as the Science Compendia Series which deal with critical topics (energy, food, population, materials, electronics), the AAAS Selected Symposia Series and the AAAS Audiotape Series (from the Annual National Meeting) which offer a broad perspective in the fields of science and technology, and books and reports on special topics (such as scientific freedom and responsibility and research funding in the public and private sectors).

AAAS supports various programs and activities that are concerned with national and international science policy, education, and employment opportunities by:

- giving national and regional policy-makers the science facts they need through special seminars and the Congressional Fellows Program.
- providing forums on such problems as scientific freedom and responsibility, the legal and technical implications of weather modification, the implications of energy development in the West, and more.
- relaying reliable science information to the news media.
- promoting public understanding of science and improving science curricula in the schools.
- improving international cooperation among scientists through innovative ventures like the new inter-American trilingual journal INTERCIENCIA.
- expanding the opportunities available to minorities, women, and the handicapped in all fields of science.