DOCUMENT RESUME

ED 399 724 EC 305 055

| | |
|---|---|
| AUTHOR | Stefanich, Greg P.; Egelston-Dodd, Judy, Ed. |
| TITLE | Improving Science Instruction for Students with Disabilities: Proceedings. Working Conference on Science for Persons with Disabilities (Anaheim, California, March 28-29, 1994). |
| INSTITUTION | Science Association for Persons with Disabilities, Cedar Falls, IA. |
| SPONS AGENCY | National Science Foundation, Arlington, VA. |
| PUB DATE | 95 |
| NOTE | 154p.; For the 1993 conference proceedings, see EC 305 054. |
| PUB TYPE | Collected Works - Conference Proceedings (021) -- Guides - Classroom Use - Teaching Guides (For Teacher) (052) -- Guides - Non-Classroom Use (055) |
| EDRS PRICE | MF01/PC07 Plus Postage. |
| DESCRIPTORS | Biology; *Disabilities; *Educational Strategies; Elementary Secondary Education; Genetics; Hearing Impairments; Inclusive Schools; Learning Disabilities; Lesson Plans; Mainstreaming; Physical Disabilities; Physics; *Science Activities; Science Curriculum; *Science Instruction; Teaching Methods; Teaching Models; Visual Impairments |

ABSTRACT

This proceedings report includes papers presented at a conference on teaching science to students with disabilities. In the first paper, "Family Pedigrees: A Model Lesson Illustrating Strategies for Teaching Students with Disabilities in a Mainstreamed High School Biology Class" (Kathleen Ball and Edward C. Keller, Jr.), strategies are described for including a student with motor/orthopedic disabilities in classroom activities and a model lesson on Mendelian genetics is presented. In the second paper, "Integrating Students with Learning Disabilities into Regular Science Education Classrooms: Recommended Instructional Models and Adaptations" (Katherine Norman and Dana Caseau), the learning styles of students with learning disabilities are explained and different instructional models are described. "A Demonstration Lecture in Physics for Deaf and Hard-of-Hearing Students in Mainstream Settings: 'The Doppler Effect'" (Harry G. Lang) provides specific strategies and handouts for teaching students with hearing impairments. "Heat Conduction (A Science Lesson for Junior High Students Who Are Deaf or Hard-of-Hearing)" by Robert Storm, provides objectives and step-by-step instructions for teaching heat conduction. "Guidelines for Teaching Science to Students Who Are Visually Impaired" (Benjamin Van Wagner) describes specific accommodations and adaptive equipment that teachers can use. Conference participants' suggestions to practicing teachers, a list of conference participants, and conference evaluation information are appended. Each paper contains references. (CR)

# Improving Science Instruction for Students with Disabilities

# PROCEEDINGS
# Working Conference on Science for Persons With Disabilities

March 28-29, 1994
Anaheim, CA



Directed by

Greg P. Stefanich
Professor
University of Northern Iowa
Cedar Falls, IA

Edited by

Judy Egelston Dodd, Ed.D.
Professor
National Technical Institute for the Deaf at RIT
Rochester, NY

Supported by

National Science Foundation

Improving Science Instruction for Students with Disabilities

# PROCEEDINGS
# Working Conference on Science for Persons With Disabilities

## March 28-29, 1994
## Anaheim, CA

Directed by

Greg P. Stefanich
Professor
University of Northern Iowa
Cedar Falls, IA

Edited by

Judy Egelston Dodd, Ed.D.
Professor
National Technical Institute for the Deaf at RIT
Rochester, NY

Supported by

National Science Foundation

# Table of Contents

# Acknowledgements

The authors of this monograph wish to acknowledge the dedication and facilitating support of Virginia Stern and Laureen Summers from the American Association for the Advancement of Science who provided valuable assistance in planning, conducting, and summarizing the activities in this project. Appreciation is expressed to Dana Weiss and David Berenhaus from the National Science Teachers Association for their special assistance in making arrangements for the conference facilities and rooming arrangements for participants.

The director is especially grateful to Pat Keig from Fullerton State University who volunteered support with local arrangements, contacting local agencies, and helping with the acquisition of supplies for the conference. Appreciation is also expressed to Linda Rosulek, Jill Uhlenberg, Linda McCartney, Mary Jean Takes, Kathy Frame, Diana Hunn, Janet Mansfield Davies and Judith Sweeney who assisted with facilitation and recording during the group sessions.

Finally, we wish to acknowledge the outstanding work of Betty Ingram and Virginia Hughes who served as interpreters throughout the conference, and all the participants for their enthusiasm and sharing of ideas.

# Conference Presenters

**Conference Co-Facilitators**
Greg Stefanich, Professor
University of Northern Iowa
Cedar Falls, IA 50614-0606

Virginia Stern
Directorate for Education and
Human Resource Programs
American Association for the
Advancement of Science
1333 H. Street, N.W.
Washington, DC 20005

**Deaf and Hard-of-Hearing**
Harry Lang, Professor
Department of Educational Research
and Development
National Technical Institute for the Deaf
Rochester Institute of Technology
52 Lomb Memorial Drive
Rochester, NY 14623

Robert Storm, Science Teacher
Clarke School for the Deaf
47 Round Hill Road
Northampton, MA 01060

**Motor/Orthopedically Impaired**
Kathy Ball
123 Snyder Hall
University of Minnesota
1475 Gartner Avenue
St. Paul, MN 55108-1095

Edward Keller, Jr.
West Virginia Union
University of West Virginia
Morgantown, WV 26506-6057

Laureen Summers
Directorate for Education and
Human Resource Programs
American Association for the Advancement
of Science
1333 H. Street, N.W.
Washington, DC 20005

**Visually Impaired**
Ben Van Wagner
Science Education
Fresno Pacific College
1717 S. Chestnut Ave.
Fresno, CA 93702

H. David Wohlers
Department of Science
Northwest Missouri State University
Kirksville, MO 63501
Fresno, CA 93702

**Learning Disabled**
C. David Christensen
Price Laboratory School
University of Northern Iowa
Cedar Falls, IA 50613-3593

Dana L. Caseau
School of Education and Human
Development
Department of Special Education Counseling
5310 N. Campus Drive
Fresno, CA 93740-0003

Katherine Norman
Department of Education
80 Fort Brown
Brownsville, TX 78520-4991

# Preface

For the past two decades, following enactment of legislation on effective service delivery within the structure of Section 504 of the Rehabilitation Act of 1973, schools have slowly been making a transition from a utilitarian view of education. However the present system of group instruction in the regular classroom, with limited sensitivity to the unique needs of individual students, indicates that students with disabilities are not provided with equity of opportunity for science learning. Working Conferences on Teaching Science to Students with Disabilities have been held as pre-conference programs in conjunction with the National Science Teachers Association Annual Conferences in 1993 and 1994.

The conference participants have worked toward meeting a common goal: it is the duty of all teachers to recognize their responsibility to adapt the curriculum and show sensitivity to the unique requirements of learning for each student. Until recently, with the increased use of inclusion as a more appropriate instructional placement for the majority of students with disabilities, responsibility for accommodation rested largely upon professional educators with special education endorsements. The general classroom teacher of science received little or no academic coursework on meeting the needs of special students and were seldom afforded opportunities to teach these students in preservice or graduate teacher preparation programs. Most university programs which required preparation for exceptional students provided a general course with a focus on definitions of exceptionalities and special education legislation, but with little or no methodology.

While the members of the working conference expressed concern about meeting the needs of all students, there is a special sensitivity to a population of students with special needs who become invisible in the school community because they meet the general achievement standards and curriculum expectations. These are students of average intelligence to extremely gifted who have disabilities. It has been suggested by Whitmore (1981) that a figure as high as 540,000 students who are both gifted and disabled in the United States is reasonable. Collaboration may be one of few current viable alternatives for meeting the needs of students with disabilities in science.

While the shortcomings of inequitable education in science are not immediately observable looking at achievement data, it becomes very evident in the numbers of persons with disabilities who are practicing scientists and engineers. As an example, of the more than 500,000 persons in the United States who are deaf or hard-of-hearing, Lang (1994) reported an identified sample of 675 deaf scientists. He reported further on problems encountered by deaf students in special school programs serving deaf students. Of the teachers responsible for the education of students who are deaf or hard-of-hearing, only 3.7 percent of the male teachers and .6 percent of the female teachers receive certification to teach science. Without inclusion, the vast majority of science instruction students with disabilities will receive will be taught by teachers with very limited content knowledge.

Pope and Tarlov (1991) indicate that there is a population of approximately 35 million Americans with a disability severe enough to interfere with life's daily activities. The United

States Department of Education (1990), *Digest of Educational Statistics* reports that 10.97 percent of all students in 1986-1987 had a disabling condition reflecting a population of 4,374,000 individuals receiving special services in schools. Approximately 3.6 percent of school age students had a physical disability or health impairment. The U.S. Department of Education (1987) reports the following:

speech-impaired - 2.85%
hard-of-hearing and deaf - .16%,
motor/orthopedic impaired - .14%,
other health-impaired - .13%,
visually-impaired - .07%,
multi-disabled -.24%.

In addition, other identified conditions eligible for special education services include:

learning disabled - 4.8%
mentally impaired - 1.61%
seriously emotionally disturbed - .96%

All science teachers must be willing to assume an active role in assisting student socialization along with academic instruction. Science teachers who are warm and receptive to individual student needs are crucial if we are to improve student and public perceptions toward science.

Traditional approaches to instruction are not sufficient in meeting the needs of disabled students. Stake and Easley (1978) reported that teachers rely on textbooks at least 90 percent of the time and "assign-recite-discuss-test" is the typical method of lesson presentation. In a more recent investigation Yager (1989) states similar findings and notes that over ninety percent of all science teachers use a textbook ninety percent of the time. Furthermore, this approach is encouraged by parents and administrators (Hurd, 1983).

Research on teaching science to students with disabilities is lacking. There are few model programs, and there are no successful dissemination mechanisms to share programs which are effective. Many teachers with special talent and ability spend all of their energy teaching childrn and seldom have opportunities to share their skills beyond the classroom in which they teach. There is an essentially non-existent research base on how students with disabilities actually learn in science classes with regard to pace, learning based on disability, correlation to modality of teaching, learning style and style of teacher, amount of integration, etc.

Adaptations of space, the physical environment, and special adaptations are piecemeal at best. We are only beginning to address issues such as emotional and physical safety in accessibility to materials, size and fragility of materials and instruments, laboratory investigations which involve field sites, and information to teachers on how to adapt the classroom environment and activities.

Mainstream educators have almost no knowledge of legislation regarding the rights of persons with disabilities. There is a lack of knowledge of state and national mandates throughout the profession. Differences in state legislation make networking a challenge, since mandates, resources and attitudes vary.

Participants at these two working conferences have begun the process of introducing science teachers to practices which will help in more effectively providing quality learning experiences for students with disabilities in the science classroom. A futures agenda on meeting the needs of students with disabilities in science was established and is printed in a monograph titled, *A Futures Agenda: Proceedings of a Working Conference on Science for Persons with Disabilities* (Stefanich and Egelston-Dodd, 1994). The monograph contains position statements and critiques from reactants in four disability areas; motor/orthopedic impairments, visual impairments, deaf and hard-of-hearing, and learning disabilities. Strengths, limitations and recommendations are also presented.

Building on the *Futures Agenda* with this publication, the authors have introduced suggestions and model lessons in each of the four disability areas noted above. The primary thrust of the document is to begin the dissemination effort of classroom suggestions for meeting the needs of students with disabilities to prospective and practicing teachers, and to methods instructors in teacher preparation programs. This effort will hopefully make a small dent in the need for concrete and practical suggestions for teachers who work with students who have disabilities.

Greg P. Stefanich
Project Director

# References

Hurd, P. D. (1983). State of precollege education in mathematics and science. *Science Education, 67*, 57-68.

Lang, H. G. (1994). Silence of the spheres: The deaf experience in the history of science. Westport, CT: Greenwood.

Pope, A. M., & Tarlov, A. R. (eds.) (1991). *Disability in America: Toward a national agenda for prevention.* Washington, DC: National Academy Press.

Stake, R. E., & Ensley, J. A., Jr. (1978). *Case studies in science education.* Urbana: Center for Instructional Research and Curriculum Education, University of Illinois.

Stefanich, G. (dir.), Egelston-Dodd, J. C. (ed.) (1994). *A futures agenda: Proceedings of a working conference on science for persons with disabilities.* Cedar Falls, IA: University of Northern Iowa.

Whitmore, J. (1981). Gifted children with handicapping conditions: A new frontier. *Exceptional Children, 48* 106-114.

United States Department of Education. (1990). *Digest of educational statistics.* Washington, DC: Author.

Yager, R. E. (1989). A rationale for using personal relevance as a science curriculum focus in schools. *School Science and Mathematics, 89*, 144-156.

# Family Pedigrees: A Model Lesson Illustrating Strategies for Teaching Students with Disabilities in a Mainstreamed High School Biology Class

Kathleen Ball
Education Specialist in Biology
University of Minnesota
Minneapolis, MN

and

Edward C. Keller, Jr., Ph.D.
Biology Professor
West Virginia University
Morgantown, WV

Paper presented at the
1994 Working Conference on Science
for Persons With Disabilities

March 28-29, 1994
Anaheim, CA

# Background

We have focused on mitigative strategies that may be used in teaching students with motor/orthopedic disabilities in the junior high, senior high or lower division college classroom because our experience lies in the teaching of biology at these different levels. These strategies may, however, be used in any type of science classroom in various combinations. While many students with disabilities may present less of a challenge to a teacher in a high school biology class than, for example, a student with a severe visual impairment, there are various strategies that can be used to accommodate those students who do not have full use of their limbs and who also may have additional limitations. Obviously, students with physical disabilities present a range of abilities and limitations as broad as those of students without disabilities. You may have a student with a slight limp, another who uses crutches, but has full use of his or her arms, a student with quadriplegia and excellent communication abilities or a student with athetoid cerebral palsy who uses a wheel chair and lacks speech. Each student is going to have a distinctive set of circumstances that need to be taken into account for effective learning to take place. For the former two students, very few accommodations would be necessary. For the third student, some variations may be necessary to accommodate the wheel chair at the lab bench and the fact that the student may have difficulty in writing and may need to respond verbally, via a computer or some other electronic aid. The fourth student will provide the teacher with the greatest challenge in integrating into regular classroom activities, but can certainly become an integral member of most biology classes.

In Mainstream Teaching of Science: A Resource Book, one of us (Keller, 1983), states that students with motor/orthopedic disabilities usually have deficiencies (not necessarily related to the nature of their disability) that are somewhat different from those of students who do not have disabilities. These include deficiencies in educational background, limitations in experiences or inability to perform common educational functions in the same manner as students without disabilities. Because of such factors, teachers will find that students with disabilities often have special needs, which are usually not related to their ability to learn subject matter, but are different from those of his/her peers. These needs may be slight or great depending upon such factors as rehabilitation success, efficacy of medication and the degree of the disability.

According to Bishop (1979) there are ten recognized educational approaches used for students with motor/orthopedic impairments ranging from complete mainstreaming in the regular classroom to complete exclusion from instruction. It is our belief that most students with motor/orthopedic disabilities will benefit from some classroom experience whether it includes the presence of only the regular classroom teacher in a completely mainstreamed setting or a combination of efforts from that teacher and consultants, itinerant teachers, resource room personnel or special educators in separate classrooms.

As mentioned in Keller's (1983) Resource Book, it is important for the classroom teacher to have an understanding of the disability and its ramifications in the classroom if he or she is to effectively accommodate and teach the student with a disability. That student should have several opportunities to communicate using all modes of communication available to him/her. Presently, these communication options include a wealth of electronic methods that were unavailable when the authors were being educated. Optimal access to information is also imperative in attempting to neutralize specific disabilities such as visual access for students with hearing impairments or audio-tactile information for students with visual impairments. Access to information will be less of a problem for students with most types of motor/orthopedic disabilities.

As mentioned previously, an essential component of education for students with disabilities is the opportunity for experiences that compare favorably with those of students without disabilities. Two of the most important experiences that led to one of us (Ball) choosing science education as a career were opportunities for camping experiences and the opportunity to spend two summer sessions studying at a field station administered by the University of Minnesota. The former opportunity involved seven years of attendance at an Easter Seal Camp in Central Minnesota for two weeks each summer. Without that experience, her introduction to the world of life would have been much diminished. It also set the stage for her to have the determination to study in a completely mainstreamed field environment in northern Minnesota. One of the courses taken there was a field ecology course. The instructor didn't learn until the first day of class that one of the students walked slowly with the aid of crutches. He then adapted his rapid walking pace to hers and provided a number of options including a buddy system to perform field exercises and a graduate student to operate a boat so that she could collect water samples. These and several other accommodations were made so that she was fully integrated into that course.

Experimental learning is another facet of education that might be lacking from the background of the student with disabilities to an even greater degree than it is from that of the repertoire of the student without disabilities. As stressed in Project 2061: Science for All Americans (AAAS, 1989), science should be taught as science is practiced. The low level of science literacy that plagues Americans is due in part to the fact that most individuals do not know what science attempts to provide. Too many of us were given information as "scientific truths" or "facts" which were nothing more than current best guesses of how natural phenomena occur. Such incontrovertible statements have been shown to be partially correct or at least the best way to explain the evidence at hand. Today, hopefully, more science educators are able to relate the tentative nature of science. Teachers must understand and be able to explain to their students how the process of science works, and the best way to do this is to coach students in the methods used by scientists to attack problems.

In addition to experimental learning, students with disabilities often lack incidental learning experiences that students without disabilities commonly experience. This may be especially true of students with disabilities who are raised in very sheltered environments and not encouraged to join in family, neighborhood, church or school activities. Educators should pay special attention to the development of self esteem and successes in learning. It shouldn't be too difficult to find some area in which a particular student excels and to reinforce accomplishments made. Multi-level learning opportunities are necessary in order to develop more than a simplistic view of the world. Students should be given the opportunity in the curriculum to question concepts and subject matter on several levels in order to have understanding of the real world.

Perhaps one of the easiest things that can be done to neutralize a student's disability is to provide successful role models in the classroom. The AAAS Project on Science, Technology, and Disability has established a resource group of more than 950 scientists and engineers who are available for consultation in areas of technical expertise and career choices. Their directory of members lists individuals by geographic region, by disability and by areas of technical expertise.

## Model Lesson

The model lesson presented in this paper involves having students produce family pedigrees of traits that illustrate principles of simple Mendelian genetics. This lesson would be placed in the genetics unit after a thorough discussion of cell biology, cell reproduction including mitosis and meiosis (and most importantly, the difference between the two), Mendelian genetics, monohybrid crosses, prediction, and the use of Punnett squares in tracing hereditary traits.

The teaching of genetics provides an especially challenging task for all students because it necessitates the use of two skills that are not well developed by students aged 13 to 16: a fairly technical vocabulary and the ability to handle simple mathematical calculations. With our experience in teaching both high school and beginning college students, these skills do not show much improvement between the ages of 16 and 22! The fact that students will be working with traits that some members of their families possess, will make this exercise all the more meaningful to them. Unfortunately, most students have no fascination whatsoever for Mendel's work with garden peas. The ability to roll one's tongue is far more fascinating and memorable, and the involvement of family participation puts the students in the esteem-building role of "expert."

The ten traits which we have chosen to use for developing family pedigrees are fairly straightforward and neutral in terms of their impact on the human condition. The traits are all autosomal (no sex-linked traits are involved). They include the presence or absence of freckles, the presence of pigmented or non-pigmented iris, bent or straight little fingers, Darwin's ear point versus no ear point, a widow's peak or its absence, free or attached ear lobes, the ability or inability to roll one's tongue into a U shape, the presence or absence of mid-digital hair on one's fingers, hair type (whether curly, wavy or straight), and the ability to taste or not taste PTC (phenylthiocarbamide) paper. The benefit of using traits such as these resides in the fact that these traits probably do not have any selective or any other apparent human value. We either have them or lack them and their presence or absence doesn't affect our lives in any meaningful way.

Prior to assigning this lesson, students should have a working knowledge of the following terms:

| | | | | |
|---|---|---|---|---|
| population | random | sample | traits | heredity |
| chromosomes | genes | alleles | dominant | recessive |
| offspring | generation | pedigree | genotype | phenotype |
| mutation | | | | |

Students are asked to develop family pedigrees for each of the ten traits previously listed that include three generations within his or her family including the grandparents, parents and the student and his or her siblings. For students who lack contact with their family of origin, it may be wise to use data from an "adopted family" with whom they are familiar. Alternatively, the teacher can have available information about a mythical family. In general, the recorded pedigree should be visually observed by the student with alternative methods only used under unusual circumstances.

For constructing some pedigrees like the presence of a widow's peak or perhaps the presence of freckles, the use of family photographs may be helpful. But for most of these traits, a typical photograph would not document such specific information as Darwin's ear point or mid-digital hair.

Each student is to be provided with the Family Pedigree booklet of information and the pedigree forms which are included in the appendix of this article. In the hair structure trait use the symbols: ● = curly hair; ◐ = wavy hair, and ○ = straight hair. In the nine dominant/recessive traits the example pedigree shows the dominant (and heterozygote) phenotype as a solid (♂ or ♀) and the recessive homozygote as (♂ or ♀). For the classroom portion of the exercise, it is recommended that students work in groups of three or four depending on the size of the class. The smaller group is preferred in order to get the maximum active involvement for each individual. Students will begin with their generation and fill in each pedigree with the information about themselves. Since it may be difficult if not impossible to determine whether one has Darwin's ear point, the other members of the group would need to observe and provide this information. Students may also have some accurate information about siblings in terms of certain traits like pigmented irises, presence of freckles or presence of a widow's peak. But for most of these traits students will actually have to inspect members of their families at home.

Prior to assigning students to work in groups, the teacher should go through a fictional (or their own) pedigree, using traits that are present in students in the class and having the students add their input to see whether a specific trait is present or absent in one of their family members. This can be done by drawing an enlarged pedigree on the board, by using an overhead, or a handout to demonstrate how the pedigree circles, identified by sex, are designated by generation and gender. This part of the exercise should involve only the recording of data. Perhaps if the assignment is begun on a Monday, then students might have a week to collect their data at home and fill in the pedigrees before they complete the analysis in class. Again, the group analysis would occur after the teacher has modeled analyzing the fictional pedigree that has been used in demonstration.

## Strategies for Including a Student with a Motor/Orthopedic Disability in Classroom Activities

By the time you encounter students with motor/orthopedic disabilities in the junior high science or high school biology class, many of them will have had years of experience in adapting situations to meet their needs. So the best source of information is the student.

Especially if the disabling condition results from a congenital source, the student has had 12-14 years of practice in modifying his or her surroundings. This, of course, will not be true of students who have newly acquired disabilities. Depending on how recently the condition has developed, there may be many frustrating adjustments that need to be made. The focus should always be on what can be done, not what the limitations may be. People with chronic disabilities become excellent problem solvers and learn to think divergently about solutions to situations that would not be problematic to individuals who do not have disabilities. So whenever possible, seek guidance from the individual student first.

## Analyzing the Data

After students have completed collecting their information, you will need to take at least one class period to analyze it and see which rules of heredity seem to be operating. If the results of the pedigrees do not meet your expectations (e.g. dominant traits are skipping a generation), then you will have to provide an explanation. There are four (4) major possible reasons for "strange" outcomes in these pedigrees. First of all, a mutation may have occurred. Secondly, the student may have been adopted and not informed of that matter. Thirdly, the student may be the result of an illegitimate liaison, and one of the presumptive parents is not the natural parent, and finally, the student made an error.

Good luck in your efforts to provide active involvement in science classes for students with disabilities. Following the bibliography is a list of selected resources and a lesson plan for the videotaped lesson on pedigree.

# References

Bishop, M. E. (Ed.). (1979). *Mainstreaming: Practical ideas for educating hearing-impaired students.* Washington DC: Alexander Graham Bell Association for the Deaf.

Keller, E. C., Jr., (Ed.). (1983). Resource Book. *Teaching the physically disabled in the mainstream science class at the secondary and college level.* Available from: E. Keller, West Virginia University, Morgantown, WV, 26506-6057.

Resource Directory of Scientist and Engineers with Disabilities (2nd edition) (1987). Washington, DC: American Association for the Advancement of Science.

Science for All Americans. A Project 2061 Report on Literacy Goals in Science, Mathematics and Technology. (1989). Washington, DC: American Association for the Advancement of Science.

# Selected Resources for Teaching Science to Students with Motor/Orthopedic Disabilities

AAAS Project on Science, Technology and Disability. 1333 H Street, N.W., Washington, DC 20005, (202) 326-6630 (Voice or TDD). Project Director: Virginia Stern. A clearing house of information for teachers at all levels.

Science Association for Persons with Disabilities. Janet L. Davies, President, Colorado Christian University, 180 S. Garrison, Lakewood, CO 80226. Provides information on teaching science to students with disabilities.

Association on Higher Education and Disability (AHEAD) P.O. Box 21192, Columbus, OH 43221, (614) 488-4972.

Barrier Free in Brief: Access in Words and Deed 1991 Publication #91-28S, Washington, DC: AAAS.

Barrier Free in Brief: Access to Science Literacy 1991 Publication #91-29S, Washington, DC: AAAS.

Barrier Free in Brief: Labs and Classrooms in Science and Engineering 1991 Publication #91-27S, Washington, DC: AAAS.

Communication Outlook, Artificial Language Laboratory, Michigan State University, 405 Computer Center, East Lansing, MI 4824, (517) 353-0870. For information on Communication aids and technologies for people who cannot speak.

Fisher Scientific Co., 30 Water Street, West Haven, CT 06516, (203) 934-5271. This company makes a portable lab station for students with orthopedic disabilities.

Foundation for Science and Disability. West Virginia University, Morgantown, WV 26506-6057, (304) 293-5201. Ed Keller Jr., editor. Produces a quarterly newsletter of information relevant to science, engineering and disability.

Mainstream: A Resource Book. Teaching the Physically Disabled in the Mainstream Science Class at the Secondary College Level. 1989. West Virginia University, Morgantown, WV 26506-6057, (304) 293-5201. Ed Keller Jr., editor

Mainstream: Testing Students with Disabilities. 1989. West Virginia University, Morgantown, WV 26506-6057, (304) 293-5201. Harry Lang, editor.

Resource Directory of Scientists and Engineers with Disabilities. (2nd edition) 1987. Washington, D.C.: American Association for the Advancement of Science. A listing of over 950 individuals who are willing to offer advice and expertise on a wide range of disabilities.

Science Success for Students with Disabilities. 1993. R.A. Weisberger, editor. Addison-Wesley Publishing Co. A handbook of information for teaching elementary, middle school and secondary students.

Teaching Chemistry to Physically Handicapped Students, 1985. Ken Reese, editor. American Chemical Society, 1155 16th St. N.W., Washington, DC 20036, (202) 955-5823 (voice or TDD)

# Family Pedigrees
# Genes in Populations and Pedigree Analyses

Your assignment is to gather information for ten different human genetic traits. Remember from our discussions about genetics that all we can tell about the transmission of hereditary traits is the outward appearance of the individual. This outward manifestation of a trait is called an individual's phenotype. Your phenotype for eye color may be brown or blue or several other may be possible colors. Your phenotype for freckles is either that you have them or lack them. So in producing a pedigree, all we can indicate is whether the person in question either has or lacks a certain trait. For most of the pedigrees in this exercise there are only two options: presence or absence. For the trait on hair texture (curly, wavy or straight) there are three possibilities. You will see later that most human traits are not this simple. There may be many degrees of certain traits, like human height or skin pigmentation.

Recall from our previous discussion that chromosomes occur in pairs in almost all human cells except for gametes (egg and sperm). As a result of the process of fertilization (and the formation of the zygote), each of us gets one chromosome of each pair from our mother and the other from our father. Arranged in specific order along these chromosomes are the genes that actually determine whether or not we will have freckles, for example. In some cases the genes that we get for a certain trait are identical and we say that our genotype is "homozygous" for that trait. Thus, if you got a gene for freckles (F) from both of your parents, your genotype for freckles would be homozygous and written as FF. And you would have freckles. Perhaps you would get a gene for freckles from your mother but a gene for no freckles from your father. In this case, your genotype for freckles would be Ff, called "heterozygous" genotype. You would still have freckles and perhaps even as many as someone who was homozygous for freckles. When we look at a heterozygous genotype and note the different forms of the gene that make it up, we see the reason for another term, called alleles. Alleles are alternative forms of a gene for the same trait. We can say that F is an allele of f and vice versa. When we look at such a heterozygous genotype we are provided with even more information. In a case such as this, where a person with genotype FF or Ff has freckles and someone with genotype ff lacks freckles, we say that the F allele is dominant to the f allele and the effect of the dominant F allele masks the effect of the recessive f allele. Therefore the only way a person is going to avoid having freckles is if he or she has the genotype ff. The person with freckles has the dominant phenotype (and genotype) and the person without freckles has the recessive phenotype (and genotype). Dominance and recessiveness are neither good nor bad; they merely exist. Dominant traits are expressed in the phenotype as long as there is at least a single dominant allele present. Recessive traits are present only if the person is homozygous recessive. One trait that you will look at is that of hair type. In the natural state (non-permanented) hair may be curly, wavy or straight. So there are three possibilities and not only two options like we have had for the other traits. In this situation, there are still only two alleles involved, but each produces an effect so that there is an intermediate state. In this case, the intermediate state is wavy hair. This type of inheritance is called co-dominance.

It would be wonderfully simple if all traits worked this way. Unfortunately they don't. Most of the traits that we recognize in humans and in other organisms are far more complicated, and we have only limited knowledge about many of them.

Today you will work in groups to see which of these traits you have. Later you will take this assignment home and look at other members of your family to see if they have these traits. After collecting these data, you can construct a family pedigree and begin to see where some of these family resemblances come from.

For this assignment you will be working with three generations of people: (G1) your grandparents, (G2) your parents and (G3) your generation (including your siblings and cousins). These generation numbers are obviously quite arbitrary. Also it's obvious that your grandparents had parents and so on back to the beginning of human existence. We are using only these three generations, because there is a good chance that people in all three will still be alive.

These pedigrees contain unisex symbols. If the person in question is female, indicate that with the cross protruding from the bottom of the circle ♀. If the person is male, indicate this with an arrow heading off the circle toward the direction of about 2 o'clock ♂. If the person has the trait, then blacken the circle. If the person lacks the trait, leave the circle open, but indicate the person's gender with either the cross or arrow.

In class today you will begin with yourself in the third generation and collect your own data. So starting with one of the symbols in the middle of the third line (representing the third generation), indicate yourself and your gender. You will do this with each of the ten different traits. For some of these traits you will want to consult with other members of your group to see whether or not you have the trait. For others, you will know automatically whether you have it or not. One of these traits, the presence of mid-digital hair may be somewhat confusing from the picture. The middle digit does not need to be this hairy in order for the trait to be present. Look carefully at all of your fingers and if you see only a few hairs on the middle digit, then the trait is present. You may have to look hard, and it might help if you use a magnifying glass.

Tonight you should take this assignment home and begin to collect data from other members of your family. This will probably take at least a week, especially if some members of your family live out of state. While it would be ideal to collect all of these data by inspecting all of your family members yourself, there is a good chance that you will have to rely on others to determine some of this information and have them report it to you. This introduces another source of bias (error) that your teacher should discuss in class.

After you have collected all of your data, you will bring your sheets back to class and we will analyze it together.

One of the most important uses of pedigree analyses is in the detection and verification of genetic disease in families (such as Huntington's disease or cystic fibrosis). Once a genetic counselor has determined a trait such as one of these, he or she can provide information about the probability of producing a child with that specific trait. Depending on the type of inheritance (whether it's a case of dominance/recessiveness or a different type of inheritance) various degrees of certainty can be predicted. An important point to remember is that genetic counselors only provide information about the probability of passing on traits from one generation to the next. It is up to the individuals involved to decide whether or not to have a child.

# Family Pedigree

**1. Gathering Data**

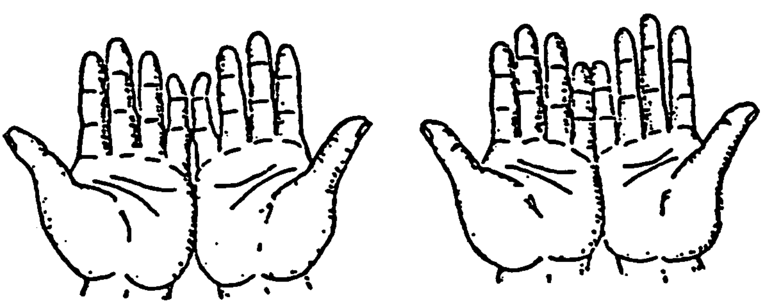
The data which you collect will be used to produce a number of pedigree charts for your family. If you are unable to record members of your family, you will be provided with information about a mythical family.

The traits that you will examine are:

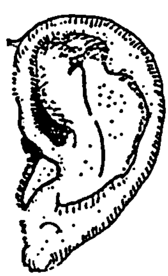
*The presence or absence of freckles (F).* The presence of freckles ● is dominant over no freckles ○. Here, you will have to determine whether the person has freckles because of over-exposure to the sun or whether they have freckles even when they haven't been exposed to the sun. If this exercise is done during the winter in a cold climate, then you can be fairly sure it's genetic.

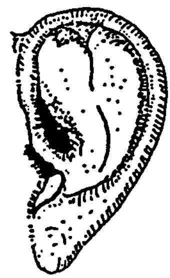
*Pigmented Iris (PI).* A pigmented iris ● (brown, hazel or green) is dominant over a non-pigmented iris ○ (blue or gray).

*Bent Little Finger (BLF).* A bent little finger ● is dominant over a straight little finger ○.



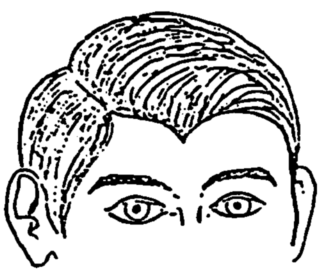
*Darwin's Ear Point (DEP).* An ear point ● is dominant over no ear point ○.



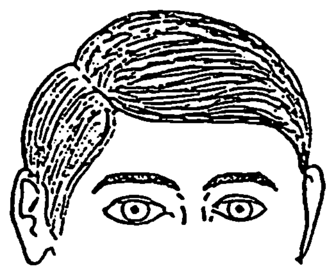


*Widow's Peak (WP).* A widow's peak is dominant over a smoothly continuous hairline.

WP = ●

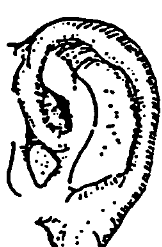


Non-WP = ○



*Free Ear Lobe (FEL).* A free ear lobe is dominant over an attached ear lobe. You may find some people with one free ear lobe and one attached ear lobe. As long as one ear lobe is free, the individual has the dominant trait.

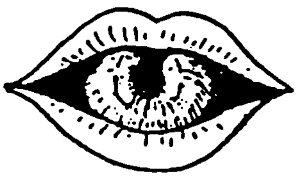
FEL = ●

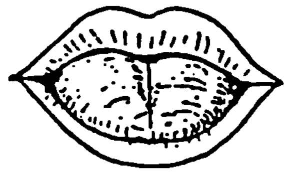


Non-FEL = ○

*Ability to Roll Your Tongue (TR).* The ability to roll your tongue into a U shape is dominant over the inability to roll your tongue.

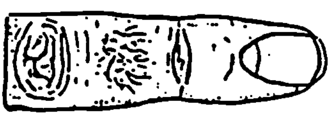
TR = ● Non-TR = ○

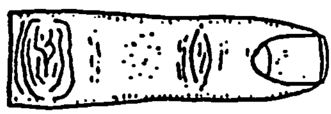




*Mid-Digital Hair (MDH).* The presence of mid-digital hair on any finger is dominant over a bare middle joint. This one can be a little tricky. Use a hand lens on all of your fingers. If there are any hairs on the middle digit, the trait is present.

MDH = ● Non-MDH = ○





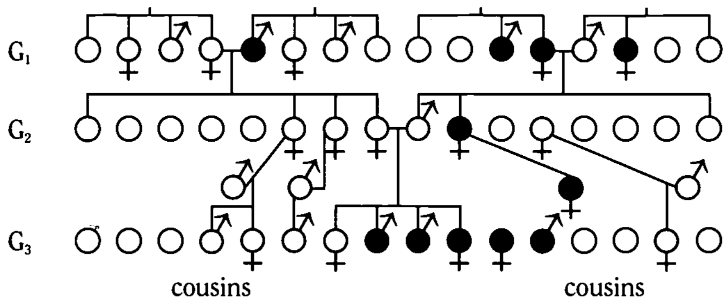
*Hair Type (Curly, Wavy or Straight (HT).* This trait is the result of two different alleles that produce an intermediate affect when both are present. This is called co-dominance. For the purpose of the pedigree indicate curly hair as a blackened circle; wavy hair as a half blackened circle; and straight hair as an empty circle. This trait must be determined on untreated (hair that has not been subjected to permanents) so be sure to ask about the natural state of the person's hair.

Curly = ● Wavy = ◐ Straight = ○

*Ability to Taste PTC Paper (PTC).* PTC stands for phenylthiocarbamide which is a chemical that some people can taste and others cannot. If you are a "taster," you will find that it has a horrid taste. If you are a "non-taster," you will only be able to detect a slight taste of paper. You will be provided with mint candy in order to get rid of the bad taste.

Taster = ● Non-taster = ○

# Sample Family Pedigree Form




Dominant Trait = ●

$G_1$ – Grandparents and their brothers and sisters
$G_2$ – Parents and their brothers and sisters
$G_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

Add additional lines of relationship where they apply in your case.

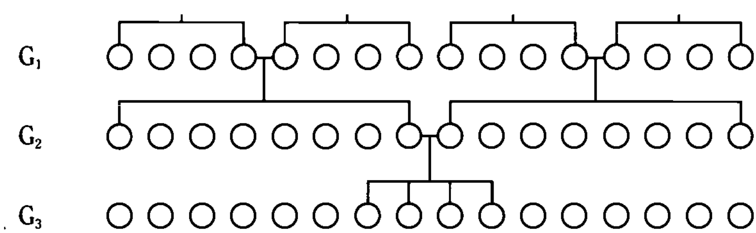
Conclusions: Is there a new mutation present? ________________ Explain your answer.

______________________________________________________________

______________________________________________________________

Data Collection.

## Pedigree Analysis
## Family Pedigree Form for Freckles (F)




F = ●

$G_1$ – Grandparents and their brothers and sisters
$G_2$ – Parents and their brothers and sisters
$G_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

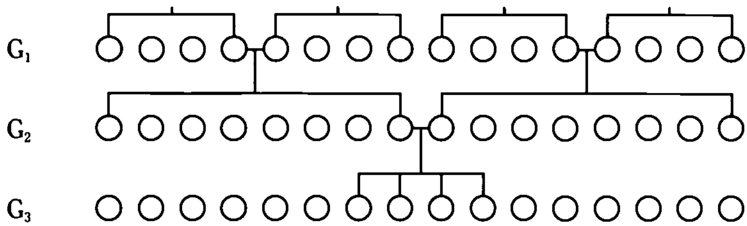
Add additional lines of relationship where they apply in your case.

Conclusions: Is there a new mutation present? ________________ Explain your answer.

______________________________________________________________

______________________________________________________________

## Family Pedigree Form for Pigmented Iris (PI)




PI = ●

$G_1$ – Grandparents and their brothers and sisters
$G_2$ – Parents and their brothers and sisters
$G_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

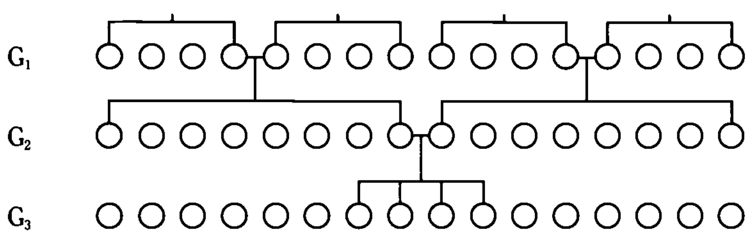
Add additional lines of relationship where they apply in your case.

Conclusions: Is there a new mutation present? ________________ Explain your answer.

________________________________________________________________________

________________________________________________________________________

## Family Pedigree Form for Bent Little Finger (BLF)




BLF = ●

$G_1$ – Grandparents and their brothers and sisters
$G_2$ – Parents and their brothers and sisters
$G_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

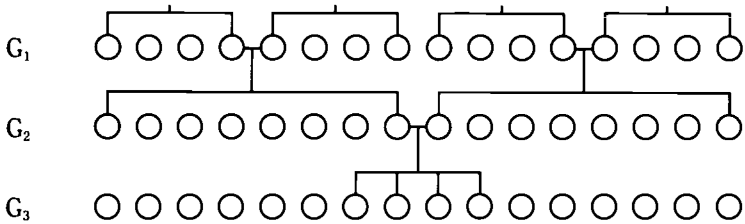
Add additional lines of relationship where they apply in your case.

Conclusions: Is there a new mutation present? ________________ Explain your answer.

________________________________________________________________________

________________________________________________________________________

## Family Pedigree Form for Darwin's Ear Point (DEP)




DEP = ●

$G_1$ – Grandparents and their brothers and sisters
$G_2$ – Parents and their brothers and sisters
$G_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

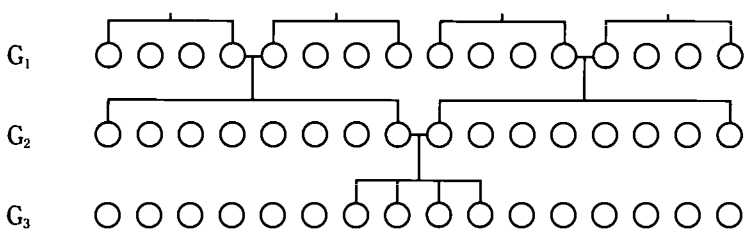
Add additional lines of relationship where they apply in your case.

Conclusions: Is there a new mutation present? ________________ Explain your answer.

______________________________________________________________

______________________________________________________________

## Family Pedigree Form for Widow's Peak (WP)




WP = ●

$G_1$ – Grandparents and their brothers and sisters
$G_2$ – Parents and their brothers and sisters
$G_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

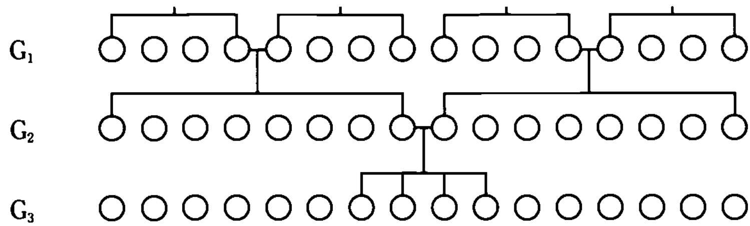
Add additional lines of relationship where they apply in your case.

Conclusions: Is there a new mutation present? ________________ Explain your answer.

______________________________________________________________

______________________________________________________________

## Family Pedigree Form for Free Ear Lobe (FEL)



FEL = ●

$G_1$ – Grandparents and their brothers and sisters
$G_2$ – Parents and their brothers and sisters
$G_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

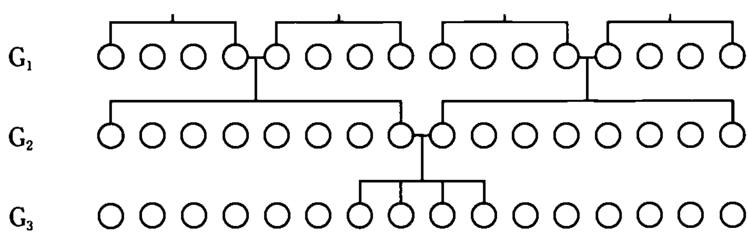
Add additional lines of relationship where they apply in your case.

Conclusions: Is there a new mutation present? ________________ Explain your answer.

______________________________________________

______________________________________________

## Family Pedigree Form for Tongue Rolling (TR)



WP = ●

$G_1$ – Grandparents and their brothers and sisters
$G_2$ – Parents and their brothers and sisters
$G_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

Add additional lines of relationship where they apply in your case.

Conclusions: Is there a new mutation present? ________________ Explain your answer.

______________________________________________

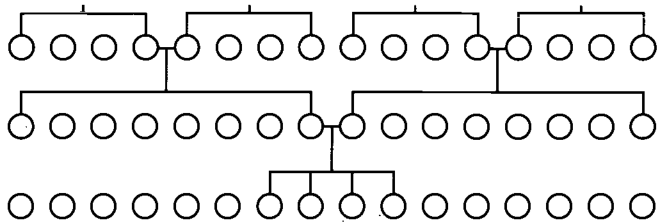
______________________________________________

## Family Pedigree Form for Mid-Digital Hair (MDH)

G$_1$

G$_2$

G$_3$



MDH = ●

G$_1$ – Grandparents and their brothers and sisters
G$_2$ – Parents and their brothers and sisters
G$_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

Add additional lines of relationship where they apply in your case.

Conclusions: Is there a new mutation present? ________________ Explain your answer.

______________________________________________________________

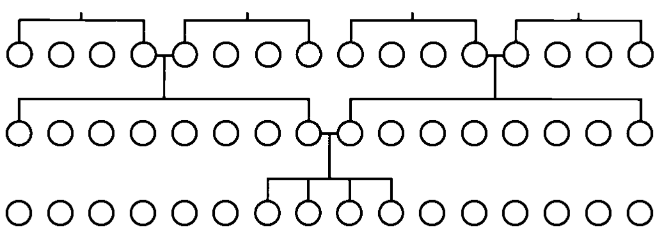
______________________________________________________________

## Family Pedigree Form for Hair Type (HT)

G$_1$

G$_2$

G$_3$



○ = Straight
◐ = Wavy
● = Curly

G$_1$ – Grandparents and their brothers and sisters
G$_2$ – Parents and their brothers and sisters
G$_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

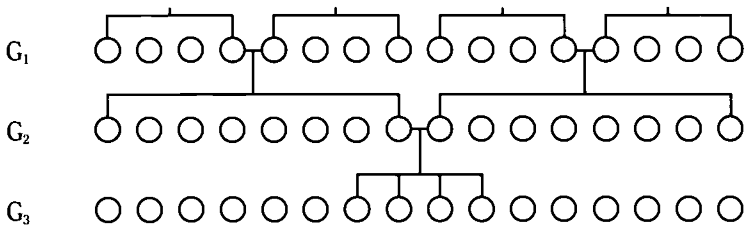
Add additional lines of relationship where they apply in your case.

Conclusions: Is there a new mutation present? ________________ Explain your answer.

______________________________________________________________

______________________________________________________________

# Family Pedigree Form for Ability to Taste PTC Paper (PTC)




Taster = ●

$G_1$ – Grandparents and their brothers and sisters
$G_2$ – Parents and their brothers and sisters
$G_3$ – You and your brothers, sisters and cousins

♂ – male ♀ – female

Add additional lines of relationship where they apply in your case.

Conclusions: Is there a new mutation present? ________________ Explain your answer.

______________________________________________________________________

______________________________________________________________________

# Integrating Students with Learning Disabilities Into Regular Science Education Classrooms: Recommended Instructional Models and Adaptations

Katherine Norman, Ph.D.
School of Education
The University of Texas at Brownsville
Brownsville, TX

and

Dana Caseau, Ph. D.
Department of Counseling and Special Education
California State University-Fresno
Fresno, CA

Paper presented at the
1994 Working Conference on Science
for Persons With Disabilities

March 28-29, 1994
Anaheim, CA

Students with disabilities are increasingly being educated in general education classrooms (Hallahan & Kauffman, 1988). Officials of the U.S. Office of Special Education Programs indicate that more than half of all students with disabilities receive instruction in science in regular education classes (U.S. Department of Education, 1991). Science has been considered one of the most valuable subjects that can be taught to students with disabilities (Patton & Andre, 1989). Science has also been identified by teachers as the subject most responsive to mainstreaming special needs students (Atwood & Oldham, 1985). Advantages include: (a) concrete, hands-on learning activities; (b) less need for language skills such as reading and writing; (c) high level of group interaction and participation; (d) provides for individual differences and success; (e) ease of establishing cooperative learning groups; and (f) high interest and inquisitiveness. However, teachers identified several potential problems for students with learning disabilities in regular science classrooms: (a) the need for language skills such as reading, recording answers, following directions and verbal expression; (b) difficulty with concepts and terminology; (c) loose classroom structure leading to behavior problems; (d) inadequate time for helping individual students and for teacher preparation; and (e) difficulty with testing and evaluation.

The science learning needs of many students with disabilities are not being met in regular classrooms, as evidenced by the failing or borderline passing grades these students are receiving (Cawley, Kahn, & Tedesco, 1989; Donahoe & Zigmond, 1986). Many regular class science teachers say they don't know how to teach students with disabilities and are unwilling to make major adaptations to meet individual learner needs. Unfortunately, there are very few studies indicating effective instructional models or approaches appropriate for use with special needs students in integrated settings such as science.

The following paper will define learning disabilities, and discuss the characteristics and learning styles of learning disabled students. Instructional models which teach to the learning strengths of students with learning disabilities are presented, and a list of modifications and resources is provided.

## Definition of Learning Disabilities

The National Joint Committee on Learning Disabilities (NJCLD) defines learning disabilities as follows: Learning disabilities is a general term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual, presumed to be due to central nervous system dysfunction, and may occur across the life span. Problems in self-regulatory behaviors, social perception and social interaction may exist with learning disabilities but do not by themselves constitute a learning disability. Although learning disabilities may occur concomitantly with other handicapping conditions (for example, sensory impairment, mental retardation, serious emotional disturbance) or with extrinsic influences (such as cultural differences, insufficient or inappropriate instruction), they are not the result of those conditions or influences (NJCLD, 1988, p. 1).

## Characteristics of Learning Disabilities

The characteristics and behaviors of students with learning disabilities (LD) evidence problems in a variety of areas including: language, academic, perceptual, physical, cognitive, and social and emotional development.

*Language:* problems in listening, speaking, vocabulary, and linguistic competencies.

*Academic:* problems in decoding, basic reading skills, and reading comprehension; problems in spelling, handwriting, and written composition; problems in quantitative thinking, arithmetic, time, space, and calculation facts.

*Perceptual:* difficulty recognizing, discriminating, and interpreting visual and auditory stimuli; often exhibit hyperactivity, distractibility, poor concentration and short attention span.

*Physical:* exhibit general motor awkwardness and clumsiness, poor fine motor coordination, spatial problems, and deficits in body image.

*Cognitive:* exhibit general delay in abstract thinking and hypothetical reasoning, lack of organization, active learning strategies, metacognitive functions.

*Social and Emotional:* poor self esteem, task avoidance, social withdrawal, frustration, anxiety, poor peer relationships; learned helplessness.

## The Learning Styles of LD Students

Students with LD have been characterized as "inactive learners" (Torgeson, 1982; Torgeson & Licht, 1983). Inactive learners have a style of learning that is passive and disengaged. A study conducted by McIntosh et al., 1991) found that students with learning disabilities participate very little in regular classrooms, they seldom ask questions, do not volunteer to answer questions, participate in teacher-directed activities less often, and, overall, interact with both teacher and other students at a lower rate than their non-handicapped peers. They don't often self-monitor what is being taught or what information they are missing. Several explanations for the disengaged behavior of the students was offered. The primary mode of instruction in most classrooms was large-group, textbook driven instruction with few adaptations made to meet the learning needs of students with learning disabilities. There was little opportunity for students to discuss what they already knew about the topic and to relate what they knew to new concepts presented. This is especially relevant given the fact that students with learning disabilities generally exhibit a large gap between their knowledge and the material presented in class. Brozo (1990) pointed out that students' passive learning styles may be a way of adapting and getting through the school day.

Lerner (1993) points out that the learning styles of students are often in conflict with the style required to be successful in traditional education systems where textbooks and lecture are the primary mode of instruction. The characteristic processing difficulties encountered by the student with LD are exacerbated in traditional classrooms. At-risk students have not been taught with strategies, methods, and materials that accommodate their learning style preferences and strengths (Carbo, 1983a,b; Dunn, 1988; Hodges 1987; LaShell, 1986; Wheeler, 1980). Teachers often teach to the learning weaknesses and not the strengths of students with learning disabilities. The learning preferences of LD students include a need for visual/spatial, tactile/kinesthetic, and multisensory stimuli.

Research indicates that matching students' learning styles with appropriate instructional techniques improves their ability to learn (Carobo, Dunn, & Dunn, 1986). Accommodating the learning styles of students with disabilities improves academic achievement and reduces discipline problems (Carbo, Dunn, & Dunn, 1986; Hodges, 1987; LaShell, 1986; Wheeler, 1980). A dramatic improvement in mathematics and reading has also been reported by Hodges (1985, 1987). A significant decrease in stress has been noted when learning styles are matched to appropriate instructional approaches (Carbo, 1983b; Hodges, 1987; LaShell, 1986).

## Instructional Models To Teach Science

Several studies indicate that students with LD can benefit from activities-oriented science (Bay et al., 1990; Linn et al., 1979; MacDougall et al., 1981; Morocco et al., 1990). Students with learning disabilities may require fewer accommodations in science than in any other academic subject; in fact classes that are well structured and activity-based seem perfect for mainstreamed students (Choate, 1993). Following is a discussion of instructional models that can benefit all students, and teach to the learning strengths of students with learning disabilities. An excellent reference for these models is contained in Models of Teaching by Joyce, Weil and Showers (1992).

### The Learning Cycle

The Learning Cycle Model of instruction is a method of teaching using guided inquiry. The learning cycle model has the following assumptions:

*Prior knowledge:* Students begin with the knowledge, skills and understandings that they bring to the classroom. Students already have what they consider to be reasonable explanations for how the world works. Those explanations are usually based on limited experiences.

*Common experiences:* The purpose of the curriculum is to provide the students with a common set of experiences that invite them to examine their current understanding of concepts.

*Specific information:* Students are provided with specific information about the concept to introduce terms and to examine how those terms relate to their previous experiences.

*Additional experience:* Additional experiences challenge students to apply their ideas and the information they receive to confirm, refute or expand what they have been thinking.

*Constructing an understanding:* In order for students to understand a concept, they must be actively involved in their learning. Instructional processes that involve students in a questioning environment and coerce them to ponder, discuss, argue, and come to conclusions may facilitate conceptual understanding.

The phases of the Biological Sciences Curriculum Study (BSCS) model of the learning cycle include:

*Engagement:* Engagement activities mentally engage the student with an event or a question. These activities help students make connections with what they already know and can do.

*Exploration:* During exploration activities, the students work with each other and explore ideas together. They acquire a common base of experience, usually through hands-on activities. Under the guidance of the teacher, students clarify their understanding of major concepts and skills.

*Explanation:* During explanation activities, the students explain their understandings of the concepts and processes they are learning. The teacher clarifies student understanding, and introduces and defines new concepts and skills.

*Elaboration:* During elaboration activities the students apply what they have learned to new situations, and they build on their understanding of concepts. Students use these new experiences to extend their knowledge and skills.

*Evaluation:* During evaluation activities, the students assess their own knowledge, skills, and abilities. Evaluation activities also focus on outcomes that a teacher can use to evaluate a student's progress.

References on The Learning Cycle Model include Marek, Eubanks, and Gallaher (1990) and The Biological Sciences Curriculum Study (1990).

## Dilemma Discussion Groups

This method facilitates the development of moral reasoning by offering students opportunities for (a) role-taking experiences, (b) participation in group decision making, (c) exposure to the next higher level of moral reasoning and (d) the consideration of fairness and morality. In addition, moral dilemmas provide a way for students to actively practice science and acquire scientific knowledge and process skills.

Dilemma discussions are based on the work of Kohlberg and are characterized by (a) being open-ended with no single right answer, (b) a free exchange of ideas, (c) student to student interaction, (d) the development of listening and verbal skills, (e) a focus on reasoning and (f) conflict produced by the dilemmas (Iozzi, 1982). In using dilemma discussions as a method of instruction, teachers should follow a specified sequence of activities: presentation of background information, presentation of the dilemma, selection of alternative positions, small group discussions, class discussion, summary and closing of discussion, and extension activities.

Brinckerhoff (1992) discussed the components that should be included in moral dilemmas:

1. Dilemmas should include plausible but competing claims, with no clear social norms governing their resolution.

2. The major focus should relate to the course content, life experiences of the students, or a realm of social significance to the students.

3. The main characters should be confronted with a choice: competing claims, mutually exclusive decisions, and/or conflicts of interest with no clearly discernible socially acceptable answer.

4. Dilemmas should center on one (or more) moral issue or common moral values that are important to students. Moral issues commonly include punishment, property, roles or concerns of affection, roles or concerns of authority, law, life, liberty, justice, truth, and sex.

5. The teacher should act as a facilitator and should implement a variety of probes: clarifying probes to determine the type of reasoning being used; general probes to elicit responses about the dilemma; issue-specific probes to focus students' attention on a specific issue; stage-higher probes to confront a student with a problem that cannot be solved adequately at his or her stage of moral reasoning; role-taking probes to encourage students to make claims based on the perspective of a moral dilemma different from the one being examined.

## Concept Attainment Model

In the Concept Attainment Model, the concept already exists. The task is to determine the basis of examples and nonexamples. The concept attainment model is designed to lead students to a concept by asking them to compare and contrast examples that contain the attributes of the concept with examples that do not contain those attributes. The process ensures that students learn the attributes that define a concept (called essential or critical attributes) and can distinguish them from other attributes that are associated with the concept but are not essential to the concept (called nonessential or noncritical attributes). In the concept attainment model, students learn to recognize, distinguish, and verbalize the essential attributes of a concept. Examining negative examples (nonexamples) helps students to identify the boundaries of the concept. The concept attainment model is designed to produce long-term learning so that students can recognize concepts in the future by knowing the attributes. Understanding a concept means knowing the name, examples, attributes (essential and nonessential), and attribute values (degree to which attributes are present). The concept attainment model consists of three phases: presentation of data and identification of concept, testing concept attainment, and analyzing thinking strategies. In the third phase, students describe their thoughts and thinking processes by which they attained the concept, discuss the role of hypotheses and attributes, and discuss the type and number of hypotheses.

Concept attainment is designed to produce long-term learning—to be able to recognize concepts by knowing attributes. Understanding a concept means knowing the name, examples, attributes and attribute values (degree to which the attribute is present).

Concept attainment provides opportunities for the teacher to analyze students' thinking processes and helps students develop more effective strategies. The Concept Attainment Model provides the following elements of the teaching and learning process for students:

1. Instruction on specific concepts and the nature of concepts.

2. Practice in inductive reasoning.

3. Opportunities for altering and improving concept-building strategies.

4. Nurturing of awareness of alternative perspectives, sensitivity to logical reasoning in communication, and tolerance of ambiguity.

The phases and tasks of the Concept Attainment Model are outlined below:

1. Presentation of data and identification of concept

   a. State purpose and procedures.

   b. Present labeled "yes" and "no" examples. Ask questions to key in on attributes.

   c. Students compare attributes in "yes" and "no" examples.

   d. Students generate and test hypotheses about identity of concept.

   e. Students state definition of concept: name and essential attributes.

2. Testing concept attainment

   a. Present unlabeled examples for students to name as "yes" or "no" examples.

   b. Students justify yes's and no's.

   c. Teacher confirms hypotheses, names concept and restates definition according to critical attributes.

d. Students generate own examples and justify by identifying essential attributes.

3. Analyze thinking strategies

   a. Students describe their thoughts and thinking processes.

   b. Students discuss the role of hypotheses and attributes.

   c. Students discuss the type and number of hypotheses.

## The Taba Inductive Model

The Taba Inductive Thinking Model is designed to expand students' conceptual systems with which they process information. Students form their own concepts with which to approach new information. Concept formation enables students to develop mental structures that hold information better than structures provided to them. The inductive model is based on the following postulates: (a) thinking can be taught; (b) thinking skills should be taught in sequence because mental operations are performed in a certain sequence; (c) thinking is an active transaction between the individual and the information. Students perform overt activities that are underlaid by covert mental operations. The inductive model includes teaching strategies built around three inductive thinking tasks: concept formation, interpretation of data, and application of principles. The teacher moves each strategy along by presenting questions to guide the student from one phase of activity into the next phase.

Students must go through certain covert operations to perform the overt activities of each stage. At each stage, students alter and expand their capacities to handle information. Students are actively involved with the learning material, and learn to look at information from different perspectives. The inductive model increases both the amount of information learned and the concepts that are developed to organize the information.

The phases and tasks of the Taba Inductive Model are outlined below:

1. Concept formation

   a. Identify, list and enumerate data relevant to problem.

   b. Group items according to similarity.

   c. Develop categories and labels for the groups.

The purpose of this phase is to induce students to form concepts they subsequently can use to approach new information. Concept formation enables students to develop mental structures that hold information better than structures provided to them.

2. Interpretation of data

   a. Identify critical aspects of the data.

b. Explore relationships (cause and effect) between the categories.

c. Make inferences by going beyond data to arrive at possible conclusions based on inferences.

3. Application of principles

a. Predict consequences, explain unfamiliar data, or hypothesize.

b. Explain/support the predictions/hypotheses.

c. Verify predictions.

## The Synectics Model

Synectics is a move from the information-processing family of instructional models (to get information across) into the personal family (for personal growth). It can be used to develop fresh ways of thinking, deliberately avoiding logical thought:

1. Enhance creative thought.

2. Promote problem solving (turn things around).

3. A way to develop new paradigms and discard the old ones.

4. Promote collaborative work and get everyone involved.

5. Encourage empathy.

6. Exercises right brain.

The drawbacks of this model include the time required to carry out lessons designed around this model and the risk involved that such a lesson may "fall flat." Synectics strategies using metaphoric activity are designed to provide structure through which students can free themselves to develop their imagination and insight into activities. The metaphoric activity depends and draws from the students' knowledge, and helps students to connect ideas from familiar content to those from new content, or to view familiar content from a new perspective.

Synectics actually includes two models:

1. Making the familiar strange - using analogies to create conceptual distance in order to develop new perspectives, and

2. Making the strange familiar - to increase understanding of something new.

The phases and tasks of the Synectics Model are outlined below:

1. Description
   a. Elicit ideas about the topic.
   b. Describe (write) what it would be like to be (topic)
2. Direct analogy
   a. Define.
   b. Specify category—should contrast topic.
   c. Elicit analogy: ______________ is like what kind of ______________.
      List new concepts and have students clarify.
   d. Students pick one of new concepts that is familiar to all and describe.
3. Personal analogy
   a. Define.
   b. Ask students to become (the selected) new concept.
   c. If you were a _______, how would you feel? (Creates distance from reality.)
4. Compressed conflict
   a. Define.
   b. Elicit compressed conflict: What are two words from above that clash, grind, rub against each other like ugly/beautiful?
5. New direct analogy
   a. Name some things that have both these characteristics.
6. Re-examination of original task
   a. Describe original task (idea) in terms of last direct analogy.
   b. Write another paragraph with new insight into original concept.

## The Integrative Model

Eggen's Integrative Model combines inductive and deductive strategies with content. Teaching is built around a data table in which information is supplied. The second aspect is a series of escalating questions which reflect increasingly higher cognitive demands. The Integrative Model has one or more of the following components:

1. A data chart of information or data.

2. Two or more parallel topics which can be compared to one another and placed in a column or row.

3. A series of dimensions or variables on which the topics will be compared.

4. Data in a form that students can process and use to summarize and generalize from those summaries.

5. Data inclusive enough to document conclusions about the information presented in the chart.

The phases and tasks of the Integrative Model are outlined below:

1. Describe

    a. Questions encourage the students to describe data in the table.

    b. The questions direct students' attention to a particular cell/s in the table, and require students to observe and describe information.

    c. This process cycles through questions that direct students to describe two or more cells in the data table.

2. Compare

    a. Students are encouraged to compare previously described data through further questioning.

    b. By focusing students' attention on two sets of data, questions direct students to identify similarities and differences among data.

3. Explain

    a. After a comparison has been made between data, questions direct students to explain why there is a difference.

    b. Questions become interdependent and require critical thinking.

4. Hypothesize

    a. Questions encourage students to respond to a hypothetical situation.

b. Questions require students to transfer information from the chart and the previous discussion to a novel situation.

5. Generalize

a. Questions require students to summarize what they have learned.

## Environmental Issue Investigations

Environmental Issue Investigations are used as a method of instruction to involve students in investigating pertinent environmental issues in their own community. The purpose of all environmental education investigations are to change behavior so that individuals become environmentally literate citizens and act in responsible ways toward our environment. The environmentally literate citizen is able and willing to make environmental decisions which are consistent with both a substantial quality of human life and a substantial quality of the environment. This individual is further motivated to act on these decisions either individually or collectively. Harold Hungerford has written extensively on Environmental Issue Investigations and proposed a model for investigating Environmental Issues in his book, *Investigating and Evaluating Environmental Issues and Actions: Skill Development Modules* (1988).

The stages of Environmental Issue Investigations are outlined below:

1. Identify an environmental issue of local concern as the object of investigation.
2. Conduct a library research on this issue.
3. Write "research questions" and plan data collection.
4. Develop and obtain instruments.
5. Collect and organize data. Write letters, conduct interviews, do experiments.
6. Analyze data and interpret findings.
7. Write conclusions and inferences.
8. Formulate solutions to the environmental problem or issue.
9. Make recommendations for future action.
10. Prepare summary tables and graphs.
11. Produce a final report.
12. Present investigation, results, and recommendations.

***Modifications.*** There is an abundance of literature on adaptive strategies for science instruction with special needs students. Strategies for modifying science instruction are divided into five categories: classroom environment, curricular/materials, instructional, textbook, and modifications for assignments and tests.

Environmental Modifications include:

1. Settings that are well-organized and structured (Wood, 1993).

2. Seating students away from distracting noises; addressing safety needs through clear rules and classroom procedures taught by demonstration, guided practice, and independent practice (Wood, 1993).

3. Teacher enthusiasm (Chaiken et al., 1978).

Curricular/materials modifications include:

1. *Framed outlines:* highlight text passages with key words deleted for the student to fill in (Lovitt et al., 1986).

2. *Graphic organizers:* identify and present key terms before students encounter them in class lectures and textbooks (Vaca et al., 1987).

3. *Key word method:* a mnemonic device that promotes memory of meanings of new vocabulary words by associating the new word with a word that sounds similar and an illustration that is easy to remember (Fulk, Mastropieri, & Scruggs, 1992; Scruggs & Mastropieri, 1992).

4. *Advance and post organizers:* written or oral statements and illustrations that offer students a framework for determining and understanding the essential information in a learning activity (Darch & Gersten, 1986; Lenz, 1983; Lenz, Alley, & Schumaker, 1987).

5. *Concept teaching routines:* teachers present new concepts to students through use of a concept diagram that presents the relevant characteristics of the concept (Bulgren, Schumaker, and Deshler, 1988).

6. *Participation guides:* introduce students to content by having them respond to several oral or written statements or questions concerning the new material (Vaca et al., 1987).

7. *Semantic webs:* provide a visual depiction of important points as well as the relationships between these points (Scanlon, Duran, Reyes, & Gallego, 1992; Wandel, Kennedy, & Kretschmer, 1988; Freedman & Reynolds, 1980).

Instructional modifications include:

1. Use active instruction (Good, 1983).

2. Use guided practice (Wood, 1993).

3. Accommodate learning styles; involve the tactile (e.g., paints, games, typewriters, computers, sand trays to write words in, floor games, and manipulatives); kinesthetic (e.g., role-play, field trips, building models); visual (e.g., overhead transparencies, photographs, films, drawings, filmstrips) (Carbo & Hodges, 1991).

4. Use concept analysis - identifying critical and noncritical dimensions of the concept to be taught (Cole, Kitano, & Brown, 1981).

5. Use wait time: give students time to respond before teacher replies and between student responses (Cain & Evans, 1990; Tobin, 1980).

6. Use informational and motivational feedback (Wood, 1993).

7. Teach for generalization: relate instruction and activities to real-life situations (Keller, 1981; Cronin & Patton, 1993) and students' own life experiences.

**Textbook modifications:**

Research indicates that over ninety percent of all science teachers use a textbook 95 percent of the time (Yager, 1989). If textbooks are used on a regular basis, teachers should select those that are activity-oriented, using an inquiry or discovery approach to instruction, and consider the needs of diverse learners. Meese (1994) pointed out that most textbook adaptations are really modifications in the teacher's instructional presentation to enhance the student's involvement with the text.

**Assignment and test modifications:**

Meese (1994) lists the following adaptations for assignments and tests:

**Assignments**

1. Post directions for assignments in designated area of classroom, and use consistent format for written work.

2. Reduce the quantity of items to be completed.

3. Assign a "study buddy" (i.e., a peer helper).

4. Give alternatives to written work (e.g., oral presentations, hands-on projects, tape recorded answers).

5. Extend time for assignment completion.

6. Break down long assignments into small chunks.

7. Ask students to verbalize the necessary steps for assignment completion.

8. Permit the use of calculators, word processors, or other aids in assignment completion.

9. Allow some written assignments to be completed by cooperative groups.

**Tests**

1. Review essential information.

2. Give frequent small tests, or practice tests, to alleviate "test anxiety."

3. Tell students the types of questions to expect and provide them with a study guide.

4. Use multiple-choice items with fewer choices.

5. Arrange matching items so that related information is grouped together with no more than five or six items in a group.

6. Provide a list of terms or phrases from which students can choose for short-answer tests;

7. Provide a partial outline for students to complete when giving essay tests.

8. Permit the student to tape-record answers to test questions;

9. Underline important directions or key words on the student's test paper.

10. Allow extended time for test taking.

# References

Atwood, R. K., & Oldham, B. R. (1985). Teachers' perceptions of mainstreaming in an inquiry oriented elementary science program. *Science Education*, 69, 619-624.

Bay, M., Staver, J. R., Bryan, T., & Hale, J. B. (1990). Science instruction for the mildly handicapped: Direct instruction versus discovery teaching. *Journal of Research in Science Teaching*, 29(6), 555-570.

Biological Sciences Curriculum Study. (1990). Science for life and living: Integrating science, technology, and health. Sneak Preview. Dubuque, IA: Kendall/Hunt.

Brinckerhoff, R. F. (1992). One-minute readings. Issues in science, technology, and society. New York: Addison-Wesley.

Brozo, W. G. (1990). Hiding out in the secondary classroom: Coping strategies of unsuccessful readers. *Journal of Reading*, 33, 324-328.

Bulgren, J., Schumaker, J. B., & Deshler, D. (1988). Effectiveness of a concept teaching routine in enhancing the performance of LD students in secondary-level mainstream classes. *Learning Disability Quarterly*, 11, 3-17.

Cain, S. E., & Evans, J. M. (1990). Sciencing: An involvement approach to elementary science methods (3rd ed., pp. 237-240). New York: Merrill/Macmillan.

Carbo, M. (1983a). Research in reading and learning style: Implications for exceptional children. *Exceptional Children*, 49, 486-494.

Carbo, M. (1983b). Reading style inventory research supplement. Roslyn Heights, NY: Learning Research Associates.

Carbo, M., Dunn, R., & Dunn, K. (1986). Teaching students to read through their individual learning styles. Reston VA: Reston Publishing Co. (ERIC Document Reproduction Service No. ED 281 171).

Carbo, M., & Hodges, H. (1991). Learning styles strategies can help students at risk. Reston VA: Reston Publishing Co. (ERIC Document Reproduction Service).

Cawley, J. F., Kahn, H., & Tedesco, A. (1989). Vocational education and students with learning disabilities. *Journal of Learning Disabilities*, 22(10), 630-634.

Chaiken, A. L., Gillen, B., Derlega, V. J., Heinen, J. R., & Wilson, M. (1978). Students' reactions to teachers' physical attractiveness and nonverbal behavior: Two exemplary studies. Psychology in the Schools, 15(4), 144-149.

Choate, J. S. (1993). Successful mainstreaming; Proven ways to detect and correct special needs. Needham Heights: Allyn & Bacon.

Cole, J. T., Kitano, M. K., & Brown, L. M. (1981). Concept analysis: A model for teaching basic science concepts to intellectually handicapped students. In M. E. Corrick (Ed.), Teaching handicapped students science (pp. 51-53). Washington, DC: National Education Association.

Cronin, M. E., & Patton, J. R. (1993). Life skills for students with special needs: A practical guide for developing real life programs. Austin, TX: PRO-ED.

Darch, C., & Gersten, R. (1986). Direction setting in reading comprehension: A comparison of two approaches. *Learning Disability Quarterly*, 9, 235-243.

Donahue, K., & Zigmond, N. (1986, April). High school grades of urban LD students and low-achieving peers. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Dunn, R. (1988). Teaching students through their perceptual strengths or preferences. *Journal of Reading*, 31, 304-309.

Freedman, G., & Reynolds, E. G. (1980). Enriching basal reader lessons with semantic webbing. *The Reading Teacher*, 33, 677-684.

Fulk, B. J., Mastropieri, M. A., & Scruggs, T. E. (1992). Mnemonic generalization training with learning disabled adolescents. *Learning Disabilities Research and Practice*, 7(1), 2-10.

Good, T. (1983). Classroom research: A decade of progress. *Educational Psychologist*, 18, 127-144.

Hallahan, D. P., & Kauffman, N. (1988). Exceptional Children: Introduction to special education. Englewood Cliffs, NJ: Prentice Hall.

Hungerford, F. R. (1988). Investigating and evaluating environmental issues and actions. Skill development modules. Champaign, IL: Stipes.

Hodges, H. (1987). I know they can learn because I've taught them. *Educational Leadership*, 44(6), 3.

Iozzi, L. A. (1982). Preparing for tomorrow's world. Curriculum Model. Teacher's guide. Longmont, CO: Sopris West.

Joyce, B., Weil, M., & Showers, B. (1992). Models of teaching. Boston: Allyn and Bacon.

Keller, W. D. (1981). Science for the handicapped. *Focus on Exceptional Children*, 13(5), 1-11.

LaShell, L. (1986). An analysis of the effects of reading methods on reading achievement and locus of control when individual reading style is matched for learning disabled students. Unpublished doctoral dissertation, Fielding Institute, Santa Barbara, CA.

Lenz, B. K. (1983). Using advance organizers. *The Pointer*, 27, 11-13.

Lenz, B. K., Alley, G. R., & Schumaker, J. B. (1987). Activating the inactive learner: Advance organizers in the secondary content classroom. *Learning Disability Quarterly*, 10, 53-67.

Lerner, J. (1993). Learning disabilities: Theories, diagnosis & teaching strategies (6th ed.). Boston: Houghton Mifflin.

Linn, M. C., & Peterson, R. W. (1973). The effect of direct experience with objects on middle class, culturally diverse, and visually-impaired young children. *Journal of Research in Science Teaching*, 10, 83-90.

Linn, M. C., Hadary, D., Rosenberg, R., & Haushalter, R. (1979). Science education for the deaf: Comparison of ideal resource and mainstream settings. *Journal of Research in Science Teaching*, 16, 305-316.

Lovitt, T., Rudsit, J., Jenkins, J., Pious, C., & Benedetti, D. (1986). Adapting science materials for regular and learning disabled seventh graders. *Remedial and Special Education*, 7(1), 31-39.

MacDougall, A., Schnur, R., Berger, C., & Vernon, D. (1981). The use of activity-centered science activities to facilitate the mainstreaming of elementary school children with special needs. *Science Education*, 65, 467-475.

Mann, P. H., Suiter, P. A., & McClung, R. M. (1992). A guide for educating mainstreamed students. Needham Heights: Allyn & Bacon.

Marek, E. A., Eubanks, C. & Gallaher, T. H. (1990). Teachers' understanding and the use of the learning cycle. *Journal of Research in Science Teaching*, 27(9), 821-834.

McIntosh, R., Vaughn, S., Schumm, J. S., Haager, D., & Lee, O. (1991, April). Observations of students with learning disabilities in general education classrooms. *Exceptional Children*.

Meese, R. L. (1994). Teaching learners with mild disabilities; Integrating research & practice. Belmont, CA: Brooks/Cole.

Morocco, C. C., Dalton, B., & Tivnan, T. (1990). Interim report: Problem solving in science project. Newton, MA: Education Development Center.

National Joint Committee on Learning Disabilities. (1988). Letter to NJCLD member organizations.

Patton, J. R., & Andre, K. E. (1989). Individualizing for science and social studies. In J. Wood (Ed.), Mainstreaming: A practical approach for teachers, 301-351. Columbus, OH: Merrill.

Salend, S. J. (1994). Effective mainstreaming; Creating inclusive classrooms (2nd ed.). New York: Macmillan.

Scanlon, D. J., Duran, G. A., Reyes, E. I., & Gallego, M. A. (1992). Interactive semantic mapping: An interactive approach to enhancing LD students' content area comprehension. *Learning Disabilities Research and Practice*, 7, 142-146.

Scruggs, T. E., & Mastropieri, M. A. (1992). Effective mainstreaming for mildly handicapped students. *The Elementary School Journal*, 92(3), 389-409.

Tobin, K. G. (1980). The effects of teacher wait-time on science achievement. *Journal of Research in Science Teaching*, 17, 469-475.

Torgeson, J. K. (1982). The learning disabled child as an inactive learner: Educational implications. Topics in Learning and Learning Disabilities, 2(1), 45-52.

Torgeson, J. K., & Licht, B. G. (1983). The learning disabled child as an inactive learner: Retrospect and prospects. In J. D. McKinney & L. Feagans (Eds.), Current Topics in Learning Disabilities. Norwood, NJ: Ablex.

U.S. Department of Education. (1991). Thirteenth annual report to Congress on the implementation of the Education of the Handicapped Act. Washington, DC: U.S. Government Printing Office.

Vaca, J. L., Vaca, R. T., & Gove, M. K. (1987). Reading and learning to read. Boston: Little, Brown.

Wandel, J. E., Kennedy, K.L., & Kretschmer, R. E. (1988). Linguistics in the classroom: Semantic mapping for hearing-impaired students. New York: Teachers College, Columbia University.

Wheeler, R. (1980). An alternative to failure: Teaching reading according to students' perceptual strengths. *Kappa Delta Pi Record*, 17, 59-63.

Wood, J. W. (1993). Mainstreaming: A practical approach for teachers (2nd ed.). New York: Merrill.

Yager, R. E. (1989). A rationale for using personal relevance as a science curriculum focus in schools. *School Science and Mathematics*, 89, 144-156.

# Resources

## ADAPTED TEXTBOOKS

Globe's *Pathway to Science*—provides junior and senior high chemistry, physics, and biology content to students reading at the fifth to sixth-grade level.

Steck-Vaughn's—*Science For You: Wonders of Science.*

## ACTIVITY ORIENTED SCIENCE CURRICULA ELEMENTARY AND MIDDLE SCHOOL

*Expanding Children's Thinking Through Science*—activities stress creativity, inventiveness and problem solving.

CESI Sourcebook II
National Science Teachers Association
1742 Connecticut Avenue, NW
Washington, DC 20009

*Physical Science Activities for Elementary and Middle School*—activities built around free or inexpensive materials.

CESI Source book V
Edited by Mark Mallone, 1986
Available from the National Science Teachers Association

*More Science Activities*—twenty additional activities designed to develop children's problem solving skills. Washington, DC: Smithsonian Institution, 1988
Available from the National Science Teachers Association

*Still More Science Activities*—activities that stress group interactions and questioning. Washington, DC: Smithsonian Institution, 1989
Available from the National Science Teachers Association

*Experiments with Everyday Objects*—hands-on physical science investigations using easy-to-obtain materials. Goldstein-Jackson, Kevin et al.
Prentice-Hall, Inc., 1978

*The Idea Factory's Super Science Sourcebook*—over 100 pupil-centered, hands-on activities in the physical, life, and earth sciences; activities require only inexpensive materials. Smith, Ellyn et al.
Idea Factory, 1987

*Investigate and Discover: Elementary Science Lessons*—one hundred fifty activities divided among the physical, life, and earth sciences. Sund, Robert B. et al.
Allyn and Bacon, Inc., 1975

*Science Activities for the Visually Impaired* (SAVI)—SAVI takes a laboratory approach to teaching science that stresses observations, manipulation of materials, and the development of science language. (Malone, Petrucchi, and Thier (1981)

McGraw Hill's—*Elementary Science Study Program*

Opportunities for Learning's—*IDEAL Science Curriculum*

Biological Sciences Curriculum Study's—Me in the Future; Me and My Environment; Me Now

New Science Programs—From J. W. Wood's (1989) *Mainstreaming: A Practical Approach for Teachers* (2nd ed. p. 377). New York: Macmillan.

The New Science Programs are more relevant, cover fewer topics, engage students in their own learning, integrate science with other subjects, and provide a balance between content and process (*Science and Children*, 1988).

Biological Sciences Curriculum Study—*Science for Life and Living: Integrating Science, Technology, and Health*. Features: K-6, students and teachers are active learners; more time on fewer concepts; activities incorporate skills in reading, math, writing; develops graphing, measuring, and social skills.

Educational Development Center and Sunburst Communication—*Improving Urban Elementary Science: A Collaborative Approach*. Features: focus on creative and critical thinking skills; 25 activity-based modules in life, physical and earth science topics; multilevel assessment strategies; inquiry based.

Technical Education Research Center and The National Geographic Society—*The National Geographic Kids Network Project*. Features: telecommunications-based curriculum 4-6; experiments done in classroom and shared with other classes across the country; hands-on, cooperative inquiry; networking with members of scientific community.

Delta Education—*Delta Science Modules*. Features: modules relate to local situation; designed for 3-5 week duration; emphasizes scientific concepts and critical thinking; integrates science/technology issues whenever possible; hands-on.

## HIGH SCHOOL

American Association of Physics Teachers. *Issue-Oriented Module Series*—each module is a collection of articles on a topic of societal consequence. Examples: medical physics, musical acoustics, weather modification, physics of sports, nuclear weapons, tidal energy. American Association of Physics Teachers, 5112 Berwyn Rd., College Park, MD 20740-4100.

Barman, C. R., Rusch, J. J., and Cooney, T. M. 1981. *Science and Societal Issues: A Guide for Science Teachers*. Ames, IA: Iowa State University Press—chapters on dealing with values and controversial issues in a classroom setting; extensive activities and bibliography.

*BSCS Science, Technology, and Society Modules* are published by Kendall/Hunt Publishing Company, P. O. Box 539, Dubuque, IQ 52001. Five modules are available, each consisting of one or more books. Topics: science, technology, and society; human reproduction; television; computers and privacy; and biomedical technology.

Bybee, R., ed. *Science-Technology-Society*. Published by National Science Teachers Association. Twenty-six science education experts nationwide offer philosophical bases and practical approaches for designing curricula and lively classroom strategies for implementing STS. The 1986 NSTA Yearbook.

## MAINSTREAMING GUIDELINES

Choate, J. S. (1993). Successful mainstreaming; Proven ways to detect and correct special needs. Needham Heights: Allyn & Bacon.

Mann, P. H., Suiter, P. A., & McClung, R. M. (1992). A guide for educating mainstreamed students. Needham Heights: Allyn & Bacon.

Mastropieri, M. A. & Scruggs, T. E. (1993). Guidelines for effective mainstreaming in science. West Lafayette, IN: Purdue Research Foundation.

Meese, R. L. (1994). Teaching learners with mild disabilities; Integrating research & practice. Belmont, CA: Brooks/Cole.

Salend, S. J. (1994). Effective mainstreaming; Creating inclusive classrooms (2nd ed.). New York: Macmillan.

Wood, J. W. (1993). Mainstreaming: A practical approach for teachers (2nd ed.). New York: Macmillan.

## ADDITIONAL SCIENCE EDUCATION CURRICULA AND RESOURCES

Activities for integrating math and science. (1987). Fresno, CA: AIMS Educational Foundation.

Apple, M. W. Teaching and technology: The hidden effects of computers on teachers and students. In Beyer, L. E. and Apple, M. W. (Eds.), The curriculum: Problems, politics, and possibilities. Albany, NY: State University of New York.

Beals, P. E. (1989). The newspaper: A tool for teaching environmental awareness. Shippensburg, PA: Shippensburg University.

Biological Sciences Curriculum Study. (1966). Biological science: Patterns and processes. New York: Holt, Rinehart and Winston.

Biological Sciences Curriculum Study. (1978). Biological science: A molecular approach. Lexington, MA: D.C. Heath.

Biological Sciences Curriculum Study. (1978). Biological science: An ecological approach. Chicago: Rand-McNally.

Biological Sciences Curriculum Study. (1978). Biological science: An inquiry into life. Chicago: Harcourt Brace Janovich.

Biological Sciences Curriculum Study. (1983). Genes and surroundings. Dubuque, IA: Kendall/Hunt.

Biological Sciences Curriculum Study. (1989). ENLIST Encourage literacy of science teachers in the use of microcomputers. Ellis, J. D., & Kuerbis, P. J.(Eds.). Danbury, CT: EME Corporation.

Bolton, R. P., Lamphere, E. V., Menesini, M., & Huang, P. C. (1973). Action chemistry. New York: Holt, Rinehart.

Burns, M. (1976). The book of think: Or how to solve a problem twice your size. Boston: Little, Brown.

Cohen, M. J. (1989). Connecting with nature: Creating moments that let Earth teach. Eugene, OR: World Peace University.

Collette, A. T., & Chiapetta, E. L. (1989). Science instruction in the middle and secondary schools. Columbus, OH: Merrill.

Conservation seeds activities book. An early childhood conservation education program. (1990). Missouri Department of Conservation.

Criteria for excellence: An NSTA science compact. (1987). Washington, DC: National Science Teachers Association. (ERIC Document ED 280 739)

Del Giorno, B. J., & Tissair, M. E. (1975). Environmental science activities: Handbook for teachers. West Nyack, NY: Parker.

Dolmatz, M. S., & Wong, H. K. (1983). Biology: The key ideas. Englewood Cliffs, NJ: Prentice-Hall.

Earth trek. Explore your environment. (1987). Washington, DC: U.S. Environmental Protection Agency.

Educator's Earth Day Sourcebook: Grades K-6. (1990). Washington, DC: U.S. Environmental Protection Agency.

Environmental curriculum: A five-day plan. (1990). Kansas City, KS: U.S. Environmental Protection Agency, Region 7.

Environmental education materials for teachers and young people (Grades K-12). (1988). Washington DC: U.S. Environmental Protection Agency.

Freier, G. D., & Anderson, F. J. (1981). A Demonstration handbook for physics (2nd Ed.). American Association of Physics Teachers.

Full Option Science System (FOSS). University of CA: Lawrence Hall of Science, Center for Multisensory Learning.

Gega, P. C. (1990). Science in elementary education. New York: Macmillan.

Gega, P. C. (1991). How to teach elementary school science. New York: Macmillan.

Goldstein-Jackson, K., Rudnick, N., & Hyman, R. (1978). Experiments with everyday objects: Science activities for children, parents, and teachers. Englewood Cliffs NJ: Prentice-Hall.

Granger, C. R. (1989). Curricular materials for teaching core competencies and key skills in the life sciences. St. Louis, MO: University of Missouri-St. Louis.

Green guide: An educator's guide to free and inexpensive environmental materials. (1991). San Francisco, CA: Sierra Club.

Guide to curriculum planning in environmental education. (1985). Madison, WI: Wisconsin Department of Public Instruction.

Hassard, J. (1992). Minds on Science: Middle and secondary school methods. New York: Harper.

Hazen, R. M., and Trefil, J. (1990). Science matters. New York, NY: Doubleday.

Hickman, F. M., Patrick, J. J., and Bybee, R. (1987). Science/technology/society: A framework for curriculum reform in secondary school science and social studies. Boulder, CO: Social Science Education Consortium.

Johnson, R. & Johnson, D. (1987) Learning together and alone: Cooperative, competitive and individualistic learning. Englewood Cliffs, NJ: Prentice-Hall.

Joyce, B., Weil, M., & Showers, B. (1992). Models of teaching. Boston: Allyn and Bacon.

Lawson, A.E.. Abraham, M.R., & Renner, J.W. (1989). A theory of instruction: Using the learning cycle to teach science concepts and thinking skills. National Association of Research in Science Teaching Monograph, Number One. 13-55.

Learning with Otis. A conservation education curriculum for grades 1-6 and special education. (1989). Missouri Department of Conservation.

Lind, K. K. (ed.). (1991). Water, stones, and fossil bones. Washington, DC: National Science Teachers Association.

Munby, H. (1984). Analyzing teaching for intellectual independence. In Munby, H., Orpwsood, G., and Russell, T. (Eds.) Seeing curriculum in a new light: Essays from science education. New York: University Press of America.

National Center for Improving Science Education. (1990). Elementary school science for the 90's. Andover, MA: The Network.

National Center for Improving Science Education. Assessment in elementary school science education. Andover, MA: The Network.

National Center for Improving Science Education. Assessment in science education: The middle years. Andover, MA: The Network.

National Center for Improving Science Education. Building scientific literacy: A blueprint for science education in the middle years. Andover, MA: The Network.

National Center for Improving Science Education. Developing and supporting teachers for elementary school science education. Andover, MA: The Network.

National Center for Improving Science Education. Getting started in science: A blueprint for elementary school science education. Andover, MA: The Network.

National Center for Improving Science Education. Science and technology education for the elementary years: Frameworks for curriculum and instruction. Andover, MA: The Network.

National Center for Improving Science Education. Science and technology education for the middle years: Frameworks for curriculum and instruction. Andover, MA: The Network.

Nature Scope Library. (1989). Washington, DC: National Wildlife Federation.

Novak, J. D., & Gowin, D. B. (1984). Learning how to learn. New York: Cambridge University Press.

Partners with wildlife: 7-12 curriculum. (1987). Pratt, KS: Kansas Department of Wildlife and Parks.

Platt, D. R. (1990). Learning in the prairie. North Newton, KS: Bethel College.

Project learning tree. (1988). Washington, DC: The American Forest Council.

Project wild. (1986). Boulder, CO: Western Regional Environmental Education Council.

Renner, J. W. (1982). The power of purpose: Science education, 66(5), 709-716.

Renner, J. W., Abraham, M. R., & Birnie, H. H. (1983). Sequence language activities in teaching high school physics. Washington, DC: National Science Foundation Grant # Sed-8015814.

Renner, J. W., and Marek, E. A. (1988). The learning cycle and elementary school science teaching. Portsmith, NH: Heinemann.

Renner, J. W., Cate, J. M., Grzybowski, E. B., Atkinson, L. J., Suber, C., & Marek, E. A. (1985). Investigations in natural science: Biology. Norman, OK: Science Education Center, College of Education, University of Oklahoma.

Renner, J. W., Nickel, J. A., Westbrook, S. L. & Renner, M. J. (1985). Investigations in natural science: Physics. Norman, OK: Science Education Center, College of Education, University of Oklahoma.

Russell, H. R. (1990). Ten-minute field trips. Washington, DC: National Science Teachers Association.

Safe planet: The guide to environmental film and video. (1990). New York, NY: Media Network.

Sandford, F. The tropical rain forest food web game. Cedar Rapids, IA: Coe College.

SCIS 3 - Science Curriculum Improvement Study. (1993). Hudson, NH: Delta Education, Inc.

*Science for Children: Resources for teachers*. (1988). Washington, DC: National Academy Press

Scope, sequence, and coordination of secondary school science. Volume I. The content core: A guide for curriculum designers (1992). Washington, DC: The National Science Teachers Association.

Streibel, M. J. (1988). A critical analysis of three approaches to the use of computers in education. In Beyer, L. E., and Apple, M. W. (Eds.), The curriculum: Problems, politics, and possibilities. Albany, NY: State University of New York.

Weinberg, S. L. & Stoltze, H. J. (1977). Action biology. Dallas: Allyn and Bacon.

Wong, H. K. & Dolmatz, M. S. (1976). Ideas and investigations in science: Biology. Englewood Cliffs, NJ: Prentice-Hall.

# A Demonstration Lecture in Physics for Deaf and Hard-of-Hearing Students in Mainstream Settings

## "The Doppler Effect"

Harry G. Lang, Ed.D.
Professor
Department of Educational Research & Development
National Technical Institute for the Deaf
Rochester Institute of Technology
Rochester, NY

Paper presented at the
1994 Working Conference on Science
for Persons with Disabilities

March 28-29, 1994
Anaheim, CA

# Introduction

Many physics programs have very helpful apparatis for demonstrating principles associated with the phenomena of sound. These include such equipment as the ripple tank, the Savart's Wheel (for students to hear/feel/see frequency and pitch as they hold a piece of cardboard against the teeth of the rotating wheel), or oscilloscope. Normally, I would set these up to enhance the lesson and have the students experience these hands-on operations.

A teacher should meet with deaf and hard-of-hearing students to establish rapport, talk about how much hearing they have, and their preferences for learning. Such rapport is, of course, important with all students. In an actual mainstream class in high school or college, I would attempt to find one student who takes good notes and encourage her or him to share them with the deaf and hard-of-hearing students. The demand on deaf and hard-of-hearing students to attend to multiple visual tasks is formidable. These tasks include watching the teacher, especially during demonstrations, speechreading and/or sign language interpreting, referring to handouts and other visuals, etc. To reduce the need for notetaking is to facilitate learning. Develop good handouts for all students. Handouts for physics students are particularly important to add structure to the lesson. Research indicates that such organizers are vital for deaf students (Lang, McKee & Conner, 1993). Visual aids/ media are especially valued by students who are deaf and hard-of-hearing.

I would also meet with the interpreter, even if only for a few minutes before class, and briefly discuss the material. Although this may be more often difficult, such a collaborative approach may pay off in enhanced learning for deaf and hard-of-hearing students.

One kind of research I find really useful for science teachers is called "Action Research," which can be done in a way as to blend into the lessons. This is planned, systematic inquiry that can tell us much about how our students are learning, and how they view science. At the end of a lesson, for example, hand out an index card to each student. Don't ask for their names. Ask the students to write down in one or two sentences what they thought was the most important concept they learned in that particular science class. This will give you an idea of whether you are coming across well with your emphases. It also encourages students to form some conclusions and think about what they learned. You may also wish to ask the students periodically to write down [again without their names] whether they are enjoying science. Ask them to explain why or why not. The information can be helpful in understanding their motivation and attitude and, for some teachers, it might lead to some midcourse changes in style or emphasis.

**The Doppler Effect**

The handout (see next page) for physics students adds some structure (i.e., the use of objectives) which is appreciated by many students.

# The Doppler Effect

*(Example of handouts to organize the lesson and relate lesson to previous learning)**

## HANDOUT ONE: OBJECTIVES

UPON COMPLETION OF THIS LESSON, YOU WILL BE ABLE TO:

1. DEMONSTRATE AN UNDERSTANDING OF THE EFFECT DESCRIBED BY CHRISTIAN DOPPLER IN 1842 WHICH EXPLAINS THE CHANGE IN FREQUENCY OF A SOUND OR LIGHT WAVE WHEN THERE IS RELATIVE MOTION BETWEEN THE SOURCE AND OBSERVER.

2. GIVE AN EXAMPLE OF THE DOPPLER EFFECT FROM YOUR DAILY EXPERIENCES.

3. DESCRIBE HOW THE DOPPLER EFFECT IS USED BY ASTRONOMERS TO STUDY THE MOTION OF BINARY STARS.

## HANDOUT TWO: REVIEW FROM LAST FRIDAY'S LESSON

FREQUENCY

WAVELENGTH

SPEED

PITCH

*If used for overhead transparency, type in a larger font to reduce eye fatigue.

## HANDOUT THREE: VOCABULARY DISCUSSED LAST WEEK

FREQUENCY

SPEED

WAVELENGTH

PITCH

PERIOD

COMPRESSIONAL WAVES

LONGITUDINAL WAVES

*Note:* This overhead again illustrates the use of visual aids to organize the presentation. Especially important is the process of reviewing the important concepts learned earlier that will be used to bridge to new concepts learned in the present lecture.

## HANDOUT FOUR: THE DOPPLER EFFECT

THE APPARENT CHANGE IN THE FREQUENCY OF WAVES, AS IN SOUND OR LIGHT, OCCURRING WHEN THE SOURCE AND OBSERVER ARE IN MOTION RELATIVE TO ONE ANOTHER.

*Note:* This definition includes multiple clauses and a number of "secondary" vocabulary that may prove challenging to many deaf and hard-of-hearing students. Such words as "relative" have multiple meanings. Other words such as "apparent" and "occurring" may need to be explained.

It may also be helpful to break down the major points being made in the demonstration, such as show below:

The frequency of a wave seems to change when the source of the wave is moving.

The frequency of a wave may also seem to change when the observer is in motion.

Examples of this can be observed with both sound and light waves.

This is called "The Doppler Effect."

**ASSIGNMENT #3** [DUE April 27]

[Writing down assignments or announcements of quizzes or tests can be very helpful. Again, the multiple demands on the sense of vision make it difficult to attend to all the communication. Many deaf students have horror stories about missing announcements of tests and even final exams. Write them down.]

CHOOSE ONE OF THE TOPICS LISTED BELOW AND WRITE A THREE-PAGE ESSAY ON THIS TOPIC:

THE DOPPLER EFFECT: ITS USEFULNESS IN STUDYING BINARY STARS

APPLICATIONS OF THE DOPPLER EFFECT [e.g., radar, echo location in studying the human heart.]

OR

CHOOSE ONE OF THE SCIENTISTS BELOW AND WRITE A THREE-PAGE BIOGRAPHY [DOUBLE-SPACED, TYPED].

CHRISTIAN DOPPLER

JOSEPH SAUVEUR

JOHN GOODRICKE

ANNIE JUMP CANNON

HENRIETTA SWAN LEAVITT

ROBERT GRANT AITKEN

*Note:* The list includes both deaf and hard-of-hearing astronomers and other scientists, which relate to the presentation on applications of the Doppler Effect to astronomy. In the lesson, I showed slides of the deaf astronomers Goodricke, Cannon, Leavitt and Aitken, subtly blending in the information with the rest of the content.

# The Doppler Effect

Below are some examples of opening statements found in physics texts in sections on the Doppler Effect. They show generalizations that don't take into consideration the acoustical experience of the deaf physics student. These examples are fine to use in the mainstream class, but be sure to include a visual example as well. I chose to use the bug-in-the-pond example in the demonstration lesson, for example. I could have used another visual example in addition to illustrations involving whistles, horns, and other sounds.

> "Everyone has had the experience of hearing a train go by blowing its whistle, or a car with its horn going." R.L. Lehrman and C. Swartz. *Foundations of Physics*
>
> "We are all familiar with the increase in pitch of a sound when its source approaches us...And the decrease in pitch when the source recedes from us." A. Beiser, *Concepts of Modern Physics*
>
> "Everyone has heard the change in pitch of an automobile horn that occurs when the listener, or the horn, or both are in motion relative to the medium (air) through which the sound is propagated." R.T. Weidner, *Physics*
>
> "Most of us have heard the change in pitch of a train whistle as we were standing at a grade crossing and watching the train pass." F. Blatt, *Principles of Physics*

**Summary**

In conclusion, there are particular strategies that will facilitate learning by deaf and hard-of-hearing students in a mainstream physics (or any science) class. Some of the most salient strategies are briefly described below:

To enhance cognitive development:

1. Encourage active learning. Avoid "board work" (having the students sit and copy from the blackboard).

2. Use class time efficiently. The notion of "time-on-task" is crucial.

3. Encourage dialogue. Consider "experiential learning" activities with the very important "processing" [follow-up discussions of what was experienced/learned)

4. Introduce multisensory and "hands-on" activities in particular. The following should be repeatedly emphasized throughout the science lessons: estimation, measurement, and problem solving

5. Relate the lessons to the students' own experiences. As much as possible, be aware of the students' acoustic experiences, cognitive experiences, cultural experiences, and linguistic experiences

To enhance career development and motivate the student to learn:

1. Build self esteem. This is critical. Do everything possible to show respect for each student's own views on communication, language, culture, etc. Some students are very happy with their identities as deaf individuals while others strive to be as much as their hearing peers as possible. Don't take sides or make generalizations. Such has been an unproductive legacy in the education of deaf students. Let the students develop their identities through time and support each student with an open mind.

2. Importantly, emphasize wherever possible the active roles deaf women and men have played in science. This will serve to motivate deaf students to learn science and to consider science careers.

Below are some quotes I have taken from letters written to a deaf physicist friend of mine, Bob Menchel, after he visited classrooms around the country:

> "How can I ever explain to you the impact of your visits? All the feedback I've had from all concerned has been very positive....The students at Thomas Johnson are still buzzing about your visit there."

> "Your story is important, especially for the 'hard core' secondary science teachers who don't want handicapped students cluttering up their classes."

> "The mounting interest and attention (of our deaf teenagers) to the opportunities available in the future in scientific areas of inquiry was genuine."

> "Everyone who was there that day was moved by the message you delivered: prepare yourself academically for the future; it's worth every bit of the effort; make your plans early; take a firm stand for your rights; seek the highest goals; and finally, share your success with others."

To enhance learning through English language development:

1. Encourage students to read materials that are on an appropriate level.

2. Avoid excessive editing of their writing. That is, the students may benefit from some corrections in spelling, syntax, but also show them what they are doing well in their writing (lab reports, etc.).

3. If you give writing assignments in science, relate them to topics that the students enjoy. For example, if many students do not enjoy dissection but love to discuss weather, relate the writing to weather. The motivation factor comes into play.

4. On tests and quizzes, use vocabulary and syntax that were used in the lesson materials. Have an agreement with students that they are responsible for any vocabulary in the book and related lesson materials. If they don't understand a word, they should ask you for help. The goal of the assessment should be to evaluate how

well the student learned the science topic, not how well he/she can read the test item. These students are already being graded in English classes for such.

To enhance learning through sign language development (for students who depend on sign language):

1. Consider resource materials such as the technical signs project for yourself or your interpreter, in collaboration with the student (NTID has videotapes/manuals of signs for science).

2. Encourage hearing children in the mainstream class to learn some signs to facilitate communication.

3. If you do not know signs, consider learning some to help establish rapport.

**What Research Says To Teachers of Deaf and Hard-of-Hearing Students**

Several studies I completed recently with deaf adolescents have proved helpful in understanding how they agree and differ in their perspectives about effective teaching as compared to hearing adolescents and as compared to their teachers.

In a structured response study with 134 deaf and hard-of-hearing students, Lang, Conner, and McKee (1993) found that the top five ranked teaching characteristics (out of 32), as viewed by the students as important to their learning, were:

1. Knows the subject well (this is also the top ranked by hearing students).

2. Uses visual materials.

3. Understands deafness, deaf people and deaf culture.

4. Communicates expectations and assignments clearly.

5. Signs clearly (about seventy percent of the students were from mainstream environments).

In an unstructured response study by Lang, Dowaliby, and Anderson (1994), 840 "critical incidents" were collected from deaf adolescents recollecting experiences with effective and ineffective teaching. "Teacher Affect" variables appeared with the highest frequency (including "Willingness to Help" and "Warm/Friendly Personality," for example). Ability to communicate clearly with sign language showed up as the most frequent characteristic of effective teaching. While this may not be possible for mainstream teachers, it is important to know that it is viewed so significantly. The mainstream teacher must, therefore, make every effort to help establish the best communicative situation that is direct and accessible to their deaf and hard-of-hearing students.

# References

Battaglia, M., Scouten, E. & Hamil, F. (1982). A teaching strategy for the science laboratory. *Volta Review*, 84(1), 34-38.

Borron, R. (1978). Modifying science instruction to meet the needs of the hearing impaired. *Journal of Research in Science Teaching*, 15, 257-262.

Boyd, E., & George, K. (1973). The effect of science inquiry on the abstract categorization behavior of deaf children. *Journal of Research in Science Teaching*, 10, 91-99.

Burch, D., & Sunal, D. W. (1978). Science curricula for the young hearing-impaired: Present state of the art. In H. Hofman (Ed.), Science education for handicapped students: Proceedings (pp. 77-86). Washington, DC: National Science Teachers Association.

Bybee, R. W., & Hendricks, P. A. (1972). Teaching science concepts to preschool deaf children to aid language development. *Science Education*, 56, 303-310.

Cohen, O. (1967). Why teach science to deaf children? In Proceedings of the International Conference on Oral Education of the Deaf, Washington, DC: The Volta Bureau.

Elias, H. (1941). A method of teaching science to the deaf. *Volta Review*, October, 584-587.

Jarchow, E. M., & Karli, W. (1983). Hearing impairment [does not equal] career impairment. The Science Teacher, 50(9), 23-25.

Lang, H. G. (1973). Teaching physics to the deaf. The Physics Teacher, 11, 527-531.

Lang, H. G. (1979). Hearing impaired physics students and implications for teachers. In H. Hofman & K. Ricker (Eds.), Science education and the physically handicapped: Sourcebook (pp. 140-147). Washington, DC: National Science Teachers Association.

Lang, H. G., & Caccamise, F. (1980). One-on-one with the hearing-impaired. *The Science Teacher*, 47(8), 20-25.

Lang, H. G.; Dowaliby, F. J. & Anderson, H. P. (1994). Critical Teachings Incidents: Recollections of Deaf College Students. *American Annals of the Deaf*, 139(2), 119-127.

Lang, H. G. & Egelston-Dodd, J. (1981). Science teaching strategies for deaf students. *The Science Teachers Bulletin*, Vol. XLV, (2), 12-15.

Lang, H. G., McKee, B. G., & Conner, K. (1993). Characteristics of effective teachers: A descriptive study of perceptions of faculty and deaf college students. *American Annals of the Deaf*, 138(3), 252-259.

Lang, H. G., & Propp, G. (1982). Science education for hearing-impaired students: State of the art. *American Annals of the Deaf,* 127, 860-869.

Lang, H. G. (1982). Career education for hearing-impaired students: Infusion strategies for the science teacher. In Focus on Infusion (Vol. 1), pp. 60-71. Silver Spring, MD: Convention of American Instructors of the Deaf.

Lang, H. G., Egelston-Dodd, J., & Sachs, M. C. (1983). Science education for hearing-impaired students in the eighties: Priorities and projections. *American Annals of the Deaf,* 128, 801-808.

Lang, H. G. (1983). Testing hearing-impaired students in science. In H.Lang (Ed.), Testing physically handicapped students in science: A resource book for teachers (pp. 23-35). Morgantown, WV: Printech.

Lang, H. G. (1983). Preparing science teachers to deal with handicapped students. *Science Education*, 67(4), 541-542.

Lang, H. G. (1988). Academic development and preparation for work. In M. C. Wang, H. J Walberg, & M. C. Reynolds (Eds.), The handbook of special education: Research and practice. Oxford, England: Pergamon Press.

Lang, H. G. (1993). Science for Deaf Students: Looking Into the Next Millennium. Proceedings of the National Science Foundation Working Conference on Science Education for Students with Disabilities, Kansas City, Missouri, March 30-31.

Linn, M. C., Hadary, D., Rosenberg, R., & Haushalter, R. (1979). Science education for the deaf: Comparison of ideal resource and mainstream settings. *Journal of Research in Science Teaching*, 16, 305-316.

Mertens, D. M. (1991). Instructional factors related to hearing-impaired adolescents' interest in science. *Science Education*, 75(4), 429-441.

Owsley, P. J. (1962). Teaching science to deaf children. *American Annals of the Deaf,* 107, 339-342.

Rohland, P. & Lang, H. G. (1983). Sounds and silence. *Science and Children*, 20(7), 17-19.

# Resources

Some possible resources for teachers interested in deaf men and women in science and mathematics careers:

1. Is Science a Possible Career for You? A booklet and filmstrip about deaf people in science and computer careers. Developed at Research for Better Schools, Inc., and distributed by the National Association of the Deaf, 814 Thayer Ave., Silver Spring, MD 70910.

2. Able Scientists - Disabled Persons: Careers in the Sciences. In P. Stearner (Ed.) Science Role Models with Disabilities. Available rom the Foundation for Science and Disability, 236 Grand Street, Morganton, WV 26505.

3. A Resource Directory of Scientists and Engineers with Disabilities. Virginia Stern, D. E. Lifton, and S. M. Malcom, 1987. This reference lists several hundred deaf men and women by scientific specialty, sex, and geographic location (as well as persons with other disabilities). Many of these men and women are willing to be contacted for classroom visits, consulting, and other projects. Some may be willing to host classes on field trips to their laboratories or places of employment. Write to Virginia Stern, American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005.

4. My own book, *Silence of the Spheres: The Deaf Experience in the History of Science* (1994), has been published by Bergin & Garvey Press in the Greenwood Publishing Group, 88 Post Road West, PO Box 5007, Westport, CT 06881-5007. This book describes the lives and work of several hundred deaf men and women in science and mathematics fields, including Nobel Prize winners, discoverers of chemical elements, major principles in physics and biology, founders of fields and subfields of sciences, etc. The book also describes the struggles and strategies of deaf persons in gaining access to education and employment in scientific professions. ISBN 0-89789-368-9. Toll free phone number: 1-800-225-5800.

If you wish more information on this topic, please write to:

Dr. Harry G. Lang, Professor
National Technical Institute for the Deaf
Rochester Institute of Technology
Department of Educational Research and Development
52 Lomb Memorial Drive
Rochester, New York 14623-5604

# Heat Conduction

## (A science lesson for junior high school students who are deaf or hard-of-hearing)

Robert Storm, Science Teacher
Clarke School for the Deaf
Northampton, MA

Paper presented at the
1994 Working Conference on Science
for Persons With Disabilities

March 28-29, 1994
Anaheim, CA

# Goal

- To investigate the heat conducting properties of a variety of materials.

# Objectives

- To follow directions accurately when executing several hands-on experiments involving heat conduction.

- To work successfully in cooperative groups (2 or 3 students per group) while setting up and performing experiments and recording results.

- To discuss conclusions and compare and contrast them with other members of the class.

# Procedure

The teacher begins the class discussion by asking the students how they feel when it's hot outside or when they exercise a lot. Comments such as, "I sweat a lot," "I feel sticky," "It makes me thirsty," might be anticipated. (These could be listed on the blackboard as a visual reference for the deaf or hard of hearing student in the class).

Next, students are asked to recall how the inside of their car feels if they close all its windows and doors and park it in the sun for an hour. Then a discussion as to why it gets so hot should ensue. Students might mention how children and pets should NEVER be left inside a closed automobile in the summertime. Some hypothesizing about the anticipated interior temperature of a sealed car should be done. (Key words and phrases or a summation statement of this discussion might be written on the chalkboard or on the overhead projector).

The teacher will ask, "What is heat?" A graphic organizer should be used and can be developed on the chalkboard. For example, a large oval could be drawn in which is written the word "heat." From this oval, lines could be drawn like the spokes of a wheel at the end of which will be written synopses of students' responses to the question. It is important to include all responses so no student feels left out and so that no pre-judging occurs.

Next, the teacher will explain that everyone will be doing several experiments investigating if and how heat moves through a variety of objects. The teacher should ask the class what they predict will happen if a piece of cloth is held over the flame without any coin inside it. The variety of hypotheses should be recorded for all to see. The class might count off the seconds out loud until the cloth bursts into flame. This should also be recorded. A group discussion of why this happened then should be held.

**Experiment 1:** The instructor then demonstrates the first experiment. (See the handout entitled, "Heat Conduction of a Coin."). Transparencies of each page of this handout should be shown to the class as the teacher conducts this simple experiment. This should help to clarify the directions and ensure that groups of students will have a demonstrated model of what they are to do. Also, students could be asked to assist with the experiment, if that seems appropriate.

Before, during and after this experiment, the teacher should be sure to engage the class in a variety of questions including the students' predictions (hypotheses), procedural questions, questions about the results, and finally about developing a valid conclusion. Again the class might count the seconds out loud while the coin is held over the flame. Students should also feel the warmth of the coin and inspect the cloth. Many of the students will be very surprised with the results of this "counter-intuitive" experiment.

At this point the class should be asked what kind of material is often used in which to heat things on a stove. The teacher might hold up a copper or steel pot to help focus this discussion. Questions such as, "Why is metal often used?", or "What is it about metals that makes them good materials in which to heat things?" should be asked and carefully discussed. At the same time a pot holder should be shown; its name written on the chalk-board and its function discussed. (Note: The pot holder and metal pot are somewhat analogous to the cloth and coin.)

Next, distribute the materials and have students work in cooperative groups of two. Be sure to provide them enough time for looking over the experiment and for asking any questions prior to performing it. (Note: I have found it better to use a low candle, e.g., a floating candle, for this experiment. Students only need to light it once and do not have to "worry about" blowing out the match each time it burns down. Also, it provides a more constant and uniform heat source.) Students should be encouraged to hold the coin over the flame for at least 30 seconds after which they should untwist the cloth and carefully feel the warm/hot coin.

When all the groups are finished, students might be encouraged to observe the cloths and coins from various groups. Everyone's attention should be focused on why these results were obtained. A summation of this discussion should be written for everyone to see, read, and refer to later.

Next, the teacher should hold up a piece of manila paper and ask the class what will happen if this paper is held over the candle flame. Again, hypotheses should be recorded for everyone to see and to be discussed by the class. Then the teacher (with student assistants) should perform this demonstration and involve the class in a discussion about the results.

Experiment 2: This should lead into the second experiment to be performed by the class, (See the handout, "Heating Water in a Paper Pan."). The teacher should again show each page of this experiment on overhead projector transparencies and discuss the directions and answer any questions about the procedure. Several models of these paper pans should be on hand for student reference.

A copy of the Scientific Method Format - Middle School, or Scientific Method Format - Upper School (Format A or B) should be distributed, one per group. Each cooperative group should be instructed to write up their experiment following these guidelines. A transparency of each of these should be shown and discussed with the class prior to its distribution.

At the conclusion of this experiment, the teacher should facilitate a general discussion about the students' results, and again note the general points on the chalkboard.

## Comments

The lab reports could be redistributed to different groups in order for others to compare and contrast their reports with those of their classmates. The teacher should also look them over.

It is vital that a discussion of controlling variables is had and frequently repeated when necessary. Students need not only to understand this concept but also be able to apply it in a variety of experimental settings.

Science processes should be an integral part of all science instruction. Students with and without specified disabilities need constant practice in: observing, noting details and patterns, comparing/contrasting, classifying, measuring/quantifying, questioning, hypothesizing, using the tools of science, experimenting and performing fieldwork, collecting and recording data, organizing and analyzing data, drawing valid conclusions, reporting/communicating their findings, working in cooperative groups (collaborating), and creating/inventing their own experiments.

As with any science class, students should be encouraged to follow-up these specific experiments with others that they design and execute. This should be done frequently so that these important problem-solving and life skills become as well-developed as possible.

## General Suggestions for Teachers

1. Have students keep a notebook or portfolio with their written accounts and drawings of things they have observed, experiment reports, or journal accounts of specific activities.

2. Encourage students to generate their own hypotheses and identify variables and controls when they are planning and executing their experiments. Provide them with numerous opportunities to develop their own scientific methods when problem solving.

3. Relate concepts to the students' experiences whenever possible and encourage all students to participate in the science activities, whether it is a discussion or experiment.

4. Provide frequent opportunities for students to use science equipment of varied types and to become familiar with its operation.

5. Encourage questions. Curiosity and the desire to understand are invaluable attributes not only in the educational process but throughout life.

6. Give students frequent practice in using the metric system, especially because of its global emphasis in science, math, and technology. Continually strive to make concepts more comprehensible by relating them to the students' own experiences, whenever possible. For example, light travels at the speed of 300,000 km. per second. That means that light could travel approximately 62 times back and forth across the contiguous United States in one second!

7. Instill enthusiasm for learning and an appreciation for the beauty and complexity inherent in science. Be a good role model.

8. Perform experiments in advance so as to discover some of the possible hazards and/or problems that might arise for the students and then can be anticipated.

9. Develop responsible, scientific attitudes in your students, such as: caring for our planet and all its inhabitants; making judgments based on sufficient information and observations - not "jumping to conclusions" seeking logical reasons for the explanation of cause/effect situations; and wanting to share knowledge and information in order to help others.

10. Plan and run a science fair in order to provide students with the opportunity to more fully develop their scientific approaches when investigating and reporting on their topics of choice.

# References

*Science Curriculum*. (1993) Northampton, MA: Clarke School for the Deaf.

Wood, R. W. (1990). Physics for Kids. Blue Ridge Summit, PA: TAB Books.

# Heat Conduction of a Coin

## — Materials —

- ☐ coin (quarter or half dollar)
- ☐ old handkerchief
- ☐ small candle or match

Twist the handkerchief around the coin so that a single layer of the cloth is stretched tightly across the flat side of the coin. Hold this flat side over the flame of the candle for a few seconds.

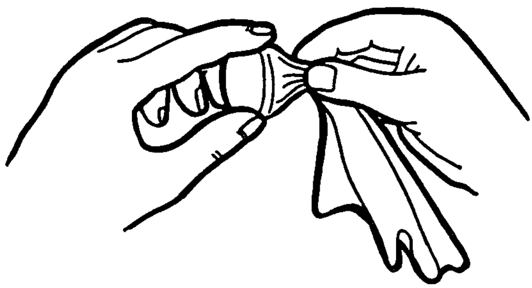
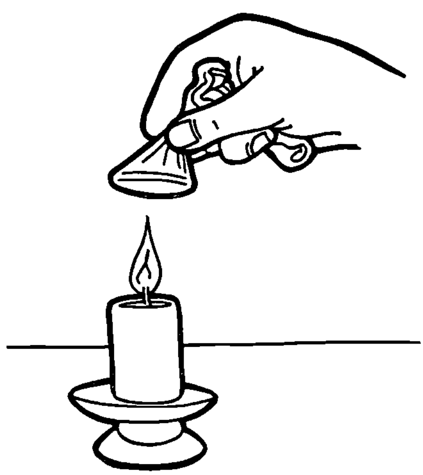


Fig. 9.1. *The cloth must be tight against the coin.*



*Note:* Activities have been adapted from *Physics for Kids* published by TAB Books, Blue Ridge Summit, PA.

# Heating Water in a Paper Pan

## — Materials —

- ☐ sheet of paper
- ☐ 4 paper clips
- ☐ water
- ☐ candle and matches

Fold the edges of the paper to form sides about an inch high. Fasten the four corners with the paper clips. Pour about one-half inch of water in the paper pan. Using both hands and being careful not to burn yourself, hold the pan of water over the candle flame.

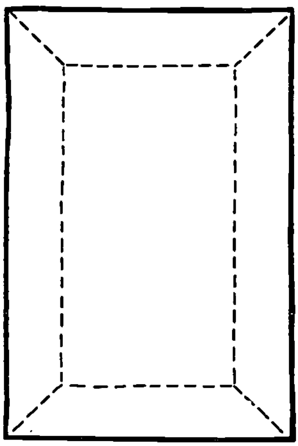


Fig. 17.1. *Make the pan by folding a piece of paper.*

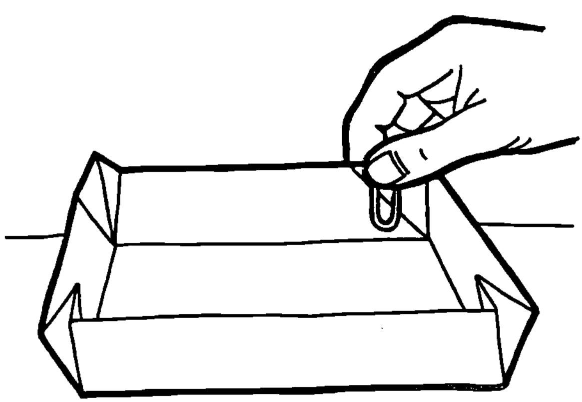


Fig. 17.2. *Hold the corners in place with paper clips.*

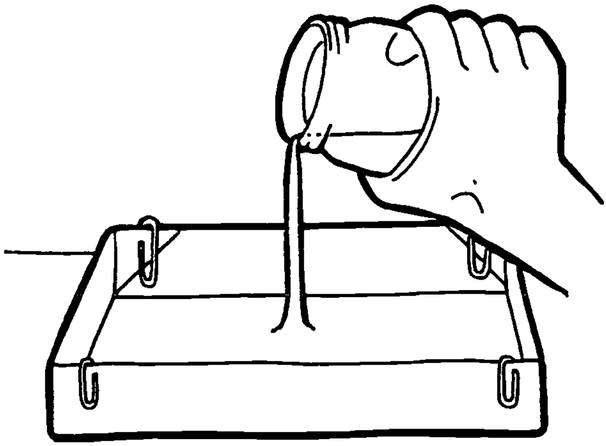
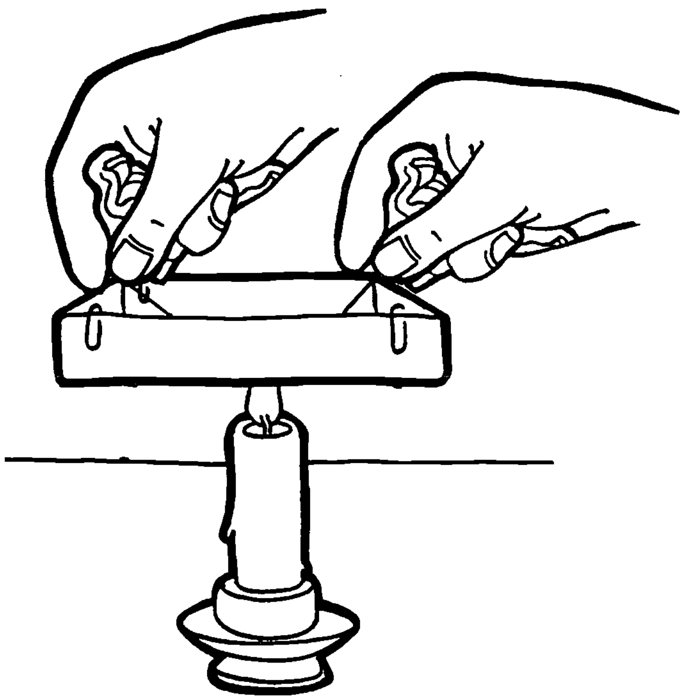


Fig. 17.2. *Hold the corners in place with paper clips.*



## Scientific Method Format — Middle School*

Hypothesis:

Test:

Results:

Conclusion:

*Use data sheets as necessary.

## Scientific Method Format — Upper School*

### Format A

I. Question *What are you trying to find out?*

II. Hypothesis *What do you think willhappen? This should be your best idea.*

III. Equipment *What materials do you need to perform this experiment? Make a list of the materials that were used in your experiment.*

IV. Procedure(s) *Write a list, in order of the steps that need to be performed to accomplish the experiment. Identify variables and controls.*

V. Result(s) *What happened? Explain what occurred, i.e., what you observed.*

VI. Conclusion(s) *Explain why the results were obtained.*

**Use data sheets as necessary.*

## Scientific Method Format — Upper School*

### Format B

1. What do you want to find out?
   Purpose

2. What do you think will happen?
   Hypothesis

3. What do you need to use?
   Materials

4. What will you do to find out? *Identify variables and controls.*
   Procedures

5. What happened?
   Results

6. What did you learn?
   Conclusions

**Use data sheets as necessary.*

# Guidelines For Teaching Science To Students Who Are Visually Impaired

Benjamin Van Wagner, Ed.D.
Professor of Science Education
Fresno Pacific College
Fresno, CA

Paper presented at the
1994 Working Conference on Science
for Persons With Disabilities

March 28-29, 1994
Anaheim, CA

This article provides helpful guidelines and ideas for teachers when a visually-impaired student enrolls in their science classes. Review aspects of visual impairment and prepare yourself with a positive and optimistic attitude. Hopefully, you have had prior notification of a visually-impaired student enrolling in your science class. Guidelines to keep in mind include:

1. Remember all students can succeed in science.

2. Students with disabilities can benefit from participation in science classes.

3. Serving their needs is often much simpler than one might expect.

4. They can be an asset to the class and make cooperative learning meaningful.

5. There is no substitute for a positive attitude and helpful, inspiring, mentoring role.

6. Persons with disabilities can enter and succeed in many different careers in science.

*Science Success for Students with Disabilities*, foreword.

Familiarize yourself with each student's Individualized Educational Plan (IEP). This should be on file since the IEP is mandated by law.

Meet with the student to develop a relationship and learn what the student's particular needs will be. Is the student partially sighted or totally blind? Ask students what they will need.

Orient the student to the total barrier free classroom/lab environment: furniture, materials, sinks, hood, open spaces and safety equipment. If the room arrangement changes during the semester, be sure to inform the student so as to allow reorientation. An orientation and mobility specialist may be available through the school district or state rehabilitation office to assist in the classroom orientation. Discuss in detail the science classroom safety rules and emergency procedures including the emergency evacuation routes. Stress the use of safety goggles while doing specific experiments. Even totally blind students need to protect their eyes, especially if they have glaucoma.

Academic planning and development of alternative teaching ideas are vital before the semester starts. Discuss the student's preferred seating and lighting conditions.

Decide what alternative printed materials may be needed in the form of Braille, large print, disc or tape. Advance warning and lead time is needed to produce these media, including handouts and exams throughout the semester. Recording for the Blind converts printed text materials free, and loans recordings or computerized books in disk format that provide access through Braille or speech output to blind and print-impaired persons (American Chemical Society, 1993, p. 10). Recording for the Blind has an extensive collection of science textbooks on tape, and will record any book not yet available (American Association for the Advancement of Science, 1991, p. 22). Braille Book Bank coordinates the duplicating and transcribing of college math texts and scientific tables. Inquire of your special education expert or the nearby college disability support office if there are local transcribing groups.

Discuss what adaptive equipment the student will be bringing to class and what may be located in a resource room. such as Braille; tape recorders, computerized reading equipment, speech output computers, Optacon, closed circuit TV, magnifiers, talking calculators, etc. A student who is blind may rely on Braille or computerized reading equipment such as the Versabraille (tactile), Kurzweil or Arkenstone systems (with synthesized speech). Students who are partially sighted may use their residual vision with the help of adaptive equipment such as low-tech magnifiers or closed-circuit TV enlargers (AAAS, 1991, p. 22).

Inquire about computers with output in Braille or synthesized speech, and videotapes with Descriptive Video Service (DVS), a new technology that offers visually-impaired viewers an auditory description of portions of a film. DVS is a new technology that makes television accessible to visually-impaired audiences (Access to Science Literacy, 1991, pp. 13 and 28).

Involve the special education itinerant teacher or specialist in deciding what additional equipment may need to be borrowed or purchased, for example, Braille or talking thermometers, light probes, liquid-level indicators, voltmeters with audible readout, talking balances, Braille or large print labelers. Some of these items are available from your state educational disability depository or from organizations such as the American Printing House or Science Products.

Label necessary glassware, chemicals, and equipment with Braille or large print. Use sandpaper labeling for hazardous chemicals.

Promote hands-on science lessons in cooperative learning groups. Use a classroom peer or aide if necessary. Use a buddy system in performing experiments. Encourage the student to participate as much as possible. Direct experiment involvement may not be possible in some instances but the visually-impaired student can develop leadership skills by doing the thinking and directing the experiment. The aide may do the actual manipulation, but the student should direct the experiment and interpret the data collected.

Accommodate the student in class by speaking clearly, writing legibly, and reading orally what you put on the overhead or board. Use large print for partially sighted students. Be specific with content and do not speak in generalities.

Use real objects when possible so the student can touch them. Professional or handmade models are the next best thing to the real object. As much as possible transform the abstract into a concrete tactile learning mode. Be creative in making simple tactile models with clay, yarn, macaroni, or beads. Raised line drawings can be made using card stock paper and a tracing wheel available in fabric stores. Sketch the drawing on the paper and then place the paper on a rubber pad and firmly trace the lines with the tracing wheel. Elmer's Glue Color is excellent for making raised line drawings. Untouchable objects and microscopic specimens can be made visual with etchings in a pan of clay or making a raised line drawing. Describe such modified materials in a consistent fashion, for example clockwise or left to right. Be sure the verbal descriptions are clear and specific. Readers can help describe graphic information that may be difficult to make visual or to portray on a computer screen.

Foster the development of self esteem in the student. Allow the student to assume all roles in the cooperative learning group. Allow them to be involved and develop responsibility. Do not promote dependency but encourage the asking of questions. It is important for them to ask for help when needed. Help the student take charge of their learning. Involve the student in the planning and implementation of adaptations. Foster success and not failure in the student. Offer frequent praise. Monitor the student's progress daily. You may want to establish a special portfolio to help monitor and evaluate the student's progress. Allow extra time for assessments; it may be necessary to use the assistance of a reader/writer.

Use curricula that automatically include everyone in the class and that integrate the total school program. Remember that any adaptations and models you make for the visually-impaired student will also help all your students - especially those concrete learners.

Relax and have fun in sciencing.

Notify next year's teacher that they will have a visually-impaired student in their class. Encourage them in the positive aspects of the challenge. The effort and extra time expended with a visually-impaired student in your class is well worth the honor and praise of being seen as a professional teacher.

# Bibliography

Barrier Free In Brief—Access to Science Literacy, (1991). Washington, DC: American Association for the Advancement of Science.

Barrier Free in Brief—Laboratories and Classrooms in Science and Engineering, (1991). Washington, DC: American Association for the Advancement of Science.

Teaching Chemistry To Students With Disabilities, (1993). American Chemical Society Committee on Chemists With Disabilities.

Weisgerber, R. A. (1993). Science Success For Students With Disabilities. Reading, MA: Addison-Wesley Publishing Company.

Partial List Of Helpful Resources And Agencies

American Council of the Blind (ACB)
1010 Vermont Avenue, N.W., Suite 1100
Washington, DC 20005

American Foundation for the Blind (AFB)
15 West 16th Street
New York, NY 10011

American Printing House for the Blind, Inc.
1839 Frankfort Avenue
Louisville, KY 40206

American Thermoform Corporation
2311 Travers Avenue
City of Commerce, CA 90040

Apple Computer, Inc.
World Wide Disability Solutions Group
and Alliance for Technical Accessibility
20525 Mariani Avenue
Cupertino, CA 95014

Arkenstone, Inc.
1185 Bordeaux Drive, Suite D
Sunnyvale, CA 94089

Blazie Engineering
109 East Jarrettsville Road, Unit D
Forest Hill, MD 21050

Braille Book Bank
Braille Materials Production Center
National Braille Association, Inc. (NBA)
1290 University Avenue
Rochester, NY 14607

Braille Technical Tables
National Braille Association, Inc.
c/o Mrs. James O. Keene
31610 Evergreen Road
Birmingham, MI 48009

Center for Multisensory Learning
Lawrence Hall of Science
University of California
Berkeley, CA 94720

Council For Exceptional Children (CED)
1920 Association Drive
Reston, VA 22091-1589

Descriptive Video Service (DVS)
The Caption Center
WGBH
125 Western Avenue
Boston, MA 02134

National Association for the Visually Handicapped
222 West 31st Street
New York, NY 10010

National Federation of the Blind (NFB)
1800 Johnson Street
Baltimore, MD 21230

Raised Dot Computing, Inc. (RDC)
408 South Baldwin
Madison, WI 53703

Recording for the Blind (RFB)
20 Roszel Road
Princeton, NJ 08540

Science Products
Box 888
Southeastern, PA 19399

Sensory Aids Foundation
399 Sherman Avenue
Palo Alto, CA 94304

Sewell Metal Processing Corporation
4125 58th Street
Woodside, NY 11277

Smith-Kettlewell Eye Research Institute
Mr. William Gerrey
2232 Webster Street
San Francisco, CA 94115

Telesensory Systems, Inc.
455 N. Bernardo Avenue
Mountain View, CA 94043-5274

Xerox Imaging System, Inc.
9 Centennial Drive
Peabody, MA 01960

# Measurement for Students Who Are Visually-Impaired

by Ben Van Wagner

Linear measurement is vital in many active learning experiences of math and science. Students with special needs, especially those who are visually-impaired, encounter difficulty with measurement. Adapted tactile measuring instruments are needed for these students. Here are directions for constructing a tactile meter stick and then a list of AIMS measurement activities adaptable for visually-impaired students.

One useful tool is a tactile meter stick. To make it, photocopy and tape sections of a meter tape (or use the one provided in Vol. V, No. 1, p. 15). If possible, copy onto card stock or yellow transparencies. Cut the tape sections apart and glue them onto a meter-long piece of pine 1 x 2 cm (1/2 x 1"). Using a heavy-duty stapler, place a staple on each centimeter line. Visually-impaired students can now measure by counting the number of staples.

As with sighted students, have the visually-impaired students practice by measuring common school objects and furniture. As they do, encourage them to brainstorm ways they may solve other measurement problems such as finding area and volume.

To measure circumference and irregular shapes, use a piece of string. Measure the object with the string, and then place it on the tactile meter stick.

Here are some AIMS activities (Van Wagner, Ben. AIMS NEWSLETTER, March 1992, p. 16) on measurement which lend themselves for use with visually-impaired students:

| Activity | Newsletter Issue or Book |
|---|---|
| Super Tuber | Primarily Plants, p. 79 |
| Metrically Clipping | Hardhatting in a Geo-World, p. 38 |
| Are You a Square? | Hardhatting in a Geo-World, p. 41 |
| All Around the Apple | Newsletter, Vol V, No. 2, p. 6 |
| Now That's Using Your Head | Newsletter, Vol II, No. 3, p. 9 |
| Can You Believe It? | Newsletter, Vol II, No. 8, p. 24 |

When visually-impaired students have success in these and similar measurement activities, they gain self confidence in a skill easily transferable to real life. Now students will be eager to participate in other extended, hands-on learning experiences.

# Surf 'N Sand Toss for Students Who Are Visually-Impaired

(AIMS NEWSLETTER, April 1991, p. 10)

by Ben Van Wagner

Students being mainstreamed into math and science classes exhibit a variety of physical problems and learning difficulties such as mobility impairments, visual deficits, auditory impairments, learning disabilities, and mental retardation. Since all students are important, what is needed is a general approach to learning that is flexible; then, teaching strategies can be chosen to build student self esteem and cognitive skills.

The beauty of AIMS is that it is widely applicable for the students just described. Many mainstreamed students learn best through visual and tactile modalities. Memorization of factoids is even less justified for these students. Since the whole AIMS philosophy is centered on a hands-on approach, it is not surprising that AIMS investigations are very often just what is needed to teach basic science and math concepts.

When appropriate activities have been chosen, the next step is to decide what adaptations will be needed. Obviously, this will depend on the specific disability involved. If these mainstreamed students are to learn to their full potential, some may simply require more individualized attention or lengthened task time. Others may need instructions that are more precise, simple, or repetitive. Still others may need modified equipment or revised activity sheets for recording information.

The AIMS activity, "Surf 'N Sand Toss," (included in Finding Your Bearings and the AIMS Newsletter for July-August, 1990) is a good example of an investigation which can be adapted to meet a variety of needs. Here students toss an inflated beach ball globe 50 times in each of three trials, noting the percentage of times that the right index finger touches land or water. The Key Question of the lesson is "What percent of the Earth's surface is water?" (about 71 percent).

To modify the globe for visually-impaired students, you will need twenty BB's and some transparent plastic packing sheets with small bubbles. Before inflating the globe, manually insert the BB's through the valve; the rattling these make when the globe is tossed or passed will enable students to locate it. After inflating the globe, place the flat surface of the plastic sheet on the various continents and large islands; trace the outlines with a washable pen. Cut these out, wash off the pen marks, dry, and use a good quality glue stick to attach them to the globe. Students using this globe will discover tactually and auditorially the same things regular students discover visually with the original lesson and unmodified globe. Since the bubble plastic is transparent, the sighted students will still be able to observe the land masses. If the plastic loosens during use, you can easily reglue it.

You may need to adapt other parts of the investigation. Roll or pass the globe instead of tossing it, but provide it with a good spin each time to ensure randomness. Use only 4-6 students per globe instead of one globe for the whole class. Pair up sighted students as buddies with visually-impaired students. This has the added benefit of fostering socialization and friendships.

There is no denying that adaptations require thought and planning to be sure that needs are met and that students are all learning. Many teachers are proving, however, that minor changes in AIMS materials or procedures can produce wonderful results.

# Change Your State

## by Ben Van Wagner

"Change Your State" is a lesson to familiarize middle school students with the terms and concepts of the states of matter, physical and chemical change, and endothermic or exothermic heat transfer. The hands-on lesson promotes constructivism and the science process skills. Best practice ideas will be modeled for teaching the lesson to visually-impaired students.

TOPIC —

Physical and Chemical Changes

FOCUS —

Students will become familiar with the terms and concepts of physical and chemical change and be able to distinguish between them.

Grade Level —

Sixth through Eight Grade

Math/Science Process Skills —

Observing

Collecting and Recording Data

Making and Testing Hypothesis

Comparing and Contrasting

Interpreting Data

Applying

***Science Framework for California Public Schools K-12**

Chapter 3 Physical Sciences

A-1 All matter has properties that can be observed, defined, and recorded. The matter around us exists in three forms or states: solid, liquid, and gas....Each of the states of matter has distinguishing characteristics (Themes—Energy, Patterns of Change, Scale and Structure). It is useful to make a distinction between those properties of matter that can be measured without changing the substance into another substance—physical properties—and those properties that are observed when the substance changes to another substance, known as chemical properties (Themes: stability, scale and structure).

**Science Project 2061 Benchmarks —**

Objects can be described in terms of the materials they are made of (clay, cloth, paper, etc.) and their physical properties (color, size, shape, weight, texture, flexibility, etc.), p. 76. Heating and cooling cause changes in the properties of materials, p. 77. When a new material is made by combining two or more materials, it has properties that are different from the original materials, p. 77. Energy cannot be created or destroyed, but only changed from one form into another, p. 85. Energy appears in different forms. Heat energy is in the disorderly motion of molecules and in radiation; chemical energy is in the arrangement of atoms, p. 85. Energy can change from one form to another, although in the process some energy is always converted to heat, p. 194.

MATERIALS —

Zipper lock bags, uniform ice cubes, graduated cylinders, beakers or plastic solo cups, large syringes, hot and cold packs, vinegar, baking soda, metric rule, balances and thermometers.

BACKGROUND INFORMATION —

The states of matter are liquid, solid and gas. Physical changes may alter the state of matter but cannot change the internal chemical composition of the substance, for example when ice melts, freezes or evaporates only a change of state occurs. Chemical changes do alter the chemical composition of a substance and usually result in new products, for example, when the reaction of baking soda and vinegar produces a salt and carbon dioxide. Heat transfer often accompanies chemical reactions. Endothermic chemical reactions absorb heat, while exothermic chemical reactions release heat. Many chemical changes occur in real life; not just in the chemical laboratory.

MANAGEMENT —

It is suggested that you use cooperative, heterogenous groups to do these lessons.

PROCEDURES —

1. Constructivism

   Students and teacher reflect about prior experiences on the topic of states of matter. What is meant by the states of matter?

2. Review lesson-Great Ice Cube Melting Race)

   Encourage students to observe and compare ice cubes. They should measure and collect data on size, shape, mass, texture and temperature.

   Student cooperative groups compete in an ice cube melting race. Put a new ice cube in a zipper lock bag. Which group can melt the ice cube the fastest? Make a hypothesis and carry out your plan. Students record their results on the Melt a Cube data sheet.

   Students measure and record the volume of their resulting liquid. Why are there discrepancies in the volume amounts from the differing groups?

   Discuss if this was a physical or a chemical change. How do they know?

3. Chemical Reaction-Baking Soda and Vinegar

   Students measure 1 level spoon full of baking soda and place it in a zipper lock bag. Be sure to use a plastic knife to level off the soda in the spoon. Zip the bag closed except for one corner. Using a syringe collect 10 ml of vinegar and add it to the zipper lock bag. Close the bag immediately.

   Student record their observations—Be sure to use touch, sight, and hearing. Students compare their results with their neighbor cooperative group.

   Discuss as a class what happened and why? Answer the question: Did this reaction cause a physical or a chemical change and how do you know?

4. Hot and Cold Chemical Change-Endothermic and Exothermic Reactions

   Pass out the hot packs. The students should click the metal disc in a hot pack, observe and record the results. Pass out the cold packs. The students should activate a cold pack, observe and record the results. Discuss the class data. Distinguish between the concepts endothermic and exothermic.

5. Summary Discussion

   Where in real life and in nature do we see examples of physical and chemical changes as well as endothermic and exothermic reactions?

EXTENSION IDEAS—

1. Design and carry out an experiment to keep an ice cube from melting. Use the Keep A Cube data sheet.

2. Do the SAVI/SELPH Acid Test Lesson.

3. Discuss what is HEAT. Design and carry out experiments to prove your hypothesis.

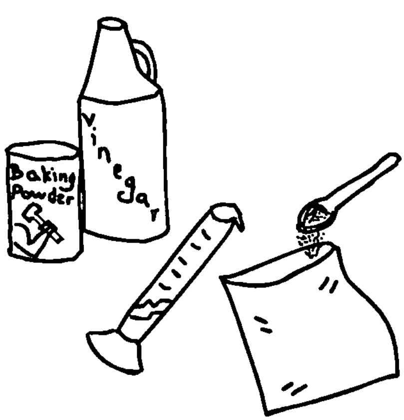
4. Design and carry out experiments with the hot and cold packs. How can you determine and record the temperature either given off or taken on? How could you increase or decrease the temperature given off or taken on?

# Baking Soda and Vinegar Data Sheet

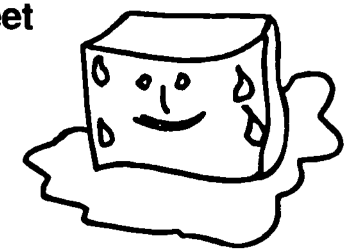
1. Place 1 level spoon full of baking soda into a zipper lock bag.
2. Add 10 ml. of vinegar and close the bag immediately.
3. Record your observations.

4. Discuss what happened. Why?

5. Did this reaction cause a physical or a chemical change? Why?

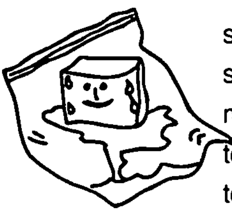


# Ice Cube Data Sheet



1. Observe and measure your ice cube.

2. Describe the physical features of your ice cube.



size
shape
mass
texture
temperature

3. Predict how many minutes it will take to melt an ice cube in a zipper lock bag.

_______________ minutes

4. The ice cube melted in _____________ minutes.

5. Measure and record the volume of water in the zipper lock bag that melted from your ice cube.

_______________ ml.

6. What did your group do to melt the ice cube?

7. Why are there differences in the liquid volume of water melted from the ice cubes in the various groups?

# Watch Your Pack Data Sheet

1. Obtain a hot pack.
2. Click the metal disc in the hot pack.
3. Observe and record your results.


4. Obtain a cold pack.
5. Activate the cold pack.
6. Observe and record your results.


7. Discuss these reactions in terms of heat transfer.

# Suggestions to Practicing Teachers

# Suggestions to Practicing Teachers from Participants in the Working Groups

The following is an edited summation of input from the working groups at conference. Equity issues permeate all aspects of reform, and educators in American schools continue to teach in ways that do not respect the uniqueness within individuals. Observations of educational practice provide clear indications that equal treatment being fair treatment is perceived as being appropriate in too many science classrooms at all levels.

**Question 1**

What do you feel are the most significant barriers that influence quality and equity of learning opportunities for a student(s) with a disability in a classroom?

1. Attitudes of students and teachers, both pre-service and in-service, which affect what is done/not done in the classroom. A change of attitudes can be affected by the following:

   a. Students encouraged to be successful in science learnings; adjustment/adaptation of science activities to promote this success.

   b. Teacher stereotypes of students with learning disabilities as "unable to do it" validate the students' own perceptions of low ability.

   c. Provision of model programs/teachers for working with students with disabilities.

   d. Provision of training and practical experience in science methodology, as well as working with students with learning diabilities for pre-service, in-service teachers.

   e. Release time for teachers to network with other successful teachers regarding resources, technology, conferences to gain awareness and "how-to" knowledge.

   f. Time to work with learned disabled students by reducing teacher/student ratios. This can be accomplished by increasing number of adults or decreasing class size.

2. Research on the needs of different learning disabilities, how they are displayed in students, and how to work with these students to improve science learning.

   a. Effective, authentic methods of evaluating science learning for all students.

   b. Identification of all students with learning disabilities in order to help them learn better. Try to catch those who are able to disguise their disabilities.

   c. More research based on model programs/teachers to disseminate effective curricula/strategies and help the "regular" classroom teachers.

d. Research on how students with learning disabilities actually learn with regard to myriad variables: pace, learning based on type of disability, correlation to modality teaching, style of teacher and learner, amount of integration, etc.

3. Teacher training

a. Special education teachers need more science education course work.

b. Regular education teachers need science education AND special education course work.

c. ALL teachers need to feel secure in teaching ALL areas of science content.

d. ALL teachers need release time for networking, brainstorming, and sharing.

e. Integration of methods and curriculum courses at the university.

f. A required internship/participation experience with a person who has a disability. This benefits the schools student/teacher ratio as well as sensitizing the teacher.

g. Team special education teachers with regular education teachers in the classroom.

h. Encourage attendance at technology awareness workshops to familiarize teachers with technological aides.

i. Train teachers to communicate directly with the individual and not the paraprofessional or interpreter.

j. Persons with disabilities need to be sensitized to other types of disabilities.

k. Teachers need to attend diverse inservices and courses, not just field specific inservices and courses.

4. Support from colleagues, administration, parents, and school communities.

a. Materials resource guide, with contact person.

b. Facilities assessment in laboratories.

c. Financial support to do adaptations.

d. Network to gain information

e. Release time to share techniques with others.

f. Sensitize teachers and administrators

g. Include college text books' information on disabilities and methods.

h. Use legal tools/avenues to implement accessibility adaptations in all schools.

i. Locate model programs/classrooms and document proven evaluation systems or strategies.

j. Teacher-in service with successful practicing teachers.

k. Additional help in the classroom

l. Research to develop new/appropriate texts, curricula and model programs to help schools change practices, even if only in small increments.

**Question 2**

What do you feel are the most significant opportunities that influence quality and equity of learning for a student(s) with a disability in a classroom?

1. Resources for the classroom teacher to do a better job teaching.

   a. Additional adults in the room to reduce student/teacher ratios.

   b. Time and money to attend conferences such as this one.

   c. Role models among colleagues or experts in the district or elsewhere, available for in service/model teaching.

   d. Role models of persons with disabilities who are successful in a career field of science to demonstrate to students that success is possible.

   e. Parents, community resources, and volunteers who can develop better teaching and use the legal system to advocate for students with learning disabilities.

   f. Technology to aid teachers in finding/using resources.

   g. Anything that can motivate students and teachers.

2. Inclusion is an opportunity for all to learn—students in the classroom, students with learning disabilities, teachers in the classroom, parents, administrators and community resources.

   a. Patience, kindness, and flexibility reap many rewards.

   b. Improved pedagogy will benefit ALL students.

   c. Smaller class sizes will benefit ALL students.

d. Exploratory style (learning cycle) methods will benefit ALL students.

e. Provide pre-exposure to the lesson of the day.

f. Provide written or auditory tapes of directions for the lab.

g. Allow extra time for completion. Set up a learning station with the necessary equipment, and directions for a lab. It may be displayed as long as needed.

h. Put the disadvantaged (ie. students with disabilities) at an advantage by making them group leaders (i.e. giving them power over their locus of control).

i. Conference with the student about what s/he needs to "do" the science.

j. Improved, exploratory science pedagogy (learning cycle) benefits ALL students.

k. Contact AAAS organization or Virgina Stern for a list of scientists with disabilities. Often they are willing to serve as role models or advisors on adapting classroom space and science equipment.

3. Education is an opportunity for all educators to learn essential information on teaching science to students with disabilities. The plan of action we chose was the Reachout Workshop Model.

We chose to educate via inservice development workshops for practicing teachers. The Reachout Workshop Model will become the mechanism to disseminate the information to other schools. The focus of the inservices will be to create:

a. Attitudes recognizing the need for better communication between science teachers and special educators,

b. Strategies to build better communication between science teachers and special educators, and

c. Strategies to better serve the disabled population within the science classrooms.

A group would be formed from the participants of the Working Conferences of the last two years. This group would consist of both science teachers and special educators. They would meet together several times to decide on:

a. how to break down communication barriers,

b. strategies that have worked for communication building,

c. strategies that are beneficial to special needs students, and

d. how to present the material to other schools.

This group would become the nucleus of the Reachout Workshop Model. The nucleus group would be divided into several smaller groups. Each of the small groups would go out as a reachout team to other schools to provide inservices for them. Every team would first conduct a pilot workshop to test out the material. After the evaluation results of the pilot workshops were gathered, the nucleus group would reassemble to discuss the data, make recommendations and refine the materials.

The inservices would consist of four, day-long workshops. The first workshop would be during the beginning of the school year. The next two workshops would happen throughout the school year. The final workshop would be held at the beginning of the following school year.

The first workshop would plant seeds of cooperation, awareness of needs, and concrete methods to employ in the classrooms. During this workshop, the reachout team would help the school to set goals that could be obtained before the next workshop. Finally, the reachout team would train a self-selected group from the school to oversee and be the core leaders for their school. The core leaders will eventually bcome local resource leaders for neighboring schools.

The second and third reachout workshops would consist of providing "booster shots" to the core leaders and teachers, and assist in their work: evaluate old goals, establish new goals, provide a format to discuss what has worked and what has not, develop new strategies for working with the students with disabilities, and help with problem solving for the problems that have surfaced between workshops.

The final workshop would help the staff to recognize how far they have come over the last year, evaluate the goals set last year, help them establish new goals for the upcoming year, and prepare the core leaders to be resource people for neighboring schools.

We would hope that because there would be a long-term commitment, the teachers would have more time to practice what has been taught and make it part of their everyday teaching. Having in-house leaders may help teachers to feel more accountable for their decisions and more determined to accomplish the gols they set for themselves. The three follow-up workshops would provide feedback to the teachers and administrators on what was going well and how to solve problems the teachers have encountered. The reachout group would provide not only knowledge, but also encouragement to continue to meet their goals.

The group also felt that it would be necessary and appropriate to link the workshops with college graduate credit or staff development (inservice/continuing education) hours needed for recertification. Another important element of this workshop model is that it will need the support of the administration. If the administration supports these workshops, he/she is placing value on the need to learn more about meeting the needs of the students who have disabilities and open communications between his/her staff memebers. If the administration is behind the reachout workshops, he/she may see that the materials, time, and money are available for meeting the goals the school had established. The funding necessary for such a reachout workshop model could be provided by a grant from the US Department of Education or National Science Foundation.

It was obvious to our group that even though we have similar goals regarding our students, we see the process of accomplishing those goals differently. We come from different perspectives. This would also be true in most schools today. This reachout workshop model would help focus attention on the similar goals and help to create understanding and awareness for the different perspectives so that distrust and misunderstanding does not impede the teaching and the learning of the disabled and "regular" students in our classrooms.

4. *Attitudes:* Student learning is strongly influenced by social-emotional factors in the school and community. Educators and students often carry mistaken beliefs and attitudes toward students with disabilities. To overcome the barrier we must:

    a. Humanize the situation.

        1. Break down barriers in the classroom early on.

        2. Mix up the group.

        3. Use interview techniques to get to know each other.

    b. Empowerment.

        1. Empower students to participate in the classroom, and to achieve success in science.

        2. Empower the teachers to learn about and adapt for student with disabilities.

        3. Empower the school district/community/parents to become more aware of needs of students with disabilities. Use activists, advocates, and legal assistance to overcome barriers.

One scenario to address this issue includes bringing together administrators, science teachers, and special education teachers within a district. Add a student with one or more disability, and together work on a science activity. The learning done during a model session, such as those presented as best practice at this conference, would open up many future interactions.

This team would then develop an action plan for the district. Each participant could serve as a trainer of others in the school district to spread ideas. Technology could also be used to enhance this effort, using videotape of the activities of the team.

It is important to follow up with program evaluations to make sure that changes are happening within the classrooms and the district. Examples of best practices developed within the district could be used to in service others in the area, in other buildings, etc.

A second idea to address a larger audience for this issue would be to establish a clearinghouse (or develop a branch of the Eisenhower Clearinghouse at OSU) to disseminate best practice. This could be done through video, transcripts of videos taken in classrooms, review of written submissions, visits to sites of best practice, etc. Tours of best practice sites or videos of same could also be used to display model programs. Research information about these sites and best practice would be especially valuable for disseminating information, and including persons with disabilities in this research agenda is vital. An aggressive approach to dissemination should be established using whatever means are available.

A third scenario addressing the issue of attitude would be to develop a conference, beginning with the head of special education in each state. State science groups and affiliates should be involved in developing the conference. Expenses for attendance should be covered to encourage participation. In return, conference participants would be required to provide in service/training workshops to others at their district or regional level. An adjunct to this conference would be lobbying for a permanent board position on the state board for a person familiar with disabilities.

**Summary**

The following list summarizes suggestions generated through the working groups:

1. ADAPTATIONS

    a. Adaptations in the general school environment must be made to meet mandates.

    b. Adaptations in special areas such as laboratories must be made to allow full participatory access for students with disabilities.

    c. Adaptations must be made to facilitate participation through the utilization of emerging technologies.

    d. In addition to physical adaptations, social emotional, and instructional adaptations are necessary.

2. ASSESSMENT

    a. Alternate forms of assessment need to be developed.

    b. Appropriate guidelines for the use and modification of assessment procedures need to be developed.

    c. Guidelines in the use and misuse of assessment data need to be developed.

    d. Ethics and responsibilities in the use of assessment information needs to be developed.

3. ATTITUDES

    a. All teachers must perceive a responsibility accommodate instruction for individual differences.

b. All teachers must assume responsibility for addressing issues relating to student socialization.

c. All teachers must assume responsibility for interacting in a manner which respects the dignity and importance of every student, encouraging feelings of self-worth and a sense of responsibility within the learner.

4. COMMUNICATION

a. There needs to be improved communication through networking.

b. There needs to be improved communication between special educators and classroom teachers.

c. There needs to be improved communication between teachers, administrators, and central office.

d. There needs to be improved communication between school officials and parents.

e. There needs to be improved communication between school faculties and higher education faculties.

d. There needs to be improved communication between government agencies and practitioners.

5. HIGHER EDUCATION

a. Programs of teacher preparation at all levels are inadequate in preparing teachers for students with special needs.

b. Expertise is lacking in programs of teacher preparation. Few teacher education programs have professional faculty with sufficient experiences, preparation, science content knowledge, and interest to prepare prospective and practicing teachers to meet the needs of students with disabilities in science.

c. Required field experiences in working with students with disabilities are lacking in programs of teacher preparation.

d. Departments of regular and special education tend to be isolated rather than interactive.

e. Science faculties tend to be uniformed and often lacking in willingness to make accommodations for students with disabilities.

6. INCLUSION

a. Although strongly supported by research, the inclusion as mandated by legislation is not being implemented in school setting.

b. In cases where inclusion is being employed there are not sufficient personnel to insure quality programming for students with disabilities in the regular classroom.

c. Material and instruction resources are not being provided to the extent necessary for quality instruction in classrooms where inclusion is being employed.

7. INSTRUCTION

a. Classroom instruction does not reflect effective application of the research base on effective schools and best practice.

b. Teacher autonomy, along with inadequate clinical support, perpetuates situations in which students must learn in settings that are not responsive to individual needs.

c. Accommodation for individuals differences is lacking in general classroom instruction.

d. Instructional strategists and opportunities for coaching to improve teaching within the classroom are almost non-existent.

e. There are few programs of teacher induction where beginning teachers receive peer support and guidance in improving instruction.

f. Inservice programs lack follow through and implementation.

g. Science textbooks and resources to support instruction are lacking in quality and suggestions for teachers in responding to the special needs of students with disabilities.

8. LEGISLATION

a. Few educators are aware of legal responsibilities concerning the rights of persons with disabilities.

b. State departments do not provide adequate guidance to practitioners regarding responsibilities following legislative acts which impact teacher and administrator roles and responsibilities.

9. RESEARCH

a. Knowledge of effective approaches to instruction for learning based on the type of disability is lacking.

b. Little research has been conducted to examine reasons why scientific fields have a severe underrepresentation of persons with disabilities as practicing scientists and science educators.

c. Research concerning pace, style, amount of integration, instructional methods, modalities, etc., is lacking.

d. Research on the effectiveness of teacher induction and in-service to teachers is lacking.

10. TECHNOLOGY

a. There is a gap between existing technologies and the use of these technologies in schools.

b. Teachers and school personnel are unaware of existing technologies, and often lack financial resources to acquire them for students with special needs.

c. There are not effective mechanisms for training of students and teachers in the successful use of new technologies to support instruction.

# Participant/Presenter List for Working Conference on Science Education for Students with Disabilities

Anaheim, CA March 28-29, 1994

Maria Anderson
Purdue University
261-7 S. River Road
W. Lafayette, IN 47906

Nancy Ayers
3109 Hillsdale
Las Cruces, NM 88005

Kathy Ball
123 Snyder Hall
1475 Gartner Ave.
St. Paul MN 55108-1095

David F. Bartlett
Old Village School
405 West Main Street
Northville, MI 48165

Judith Bazler
Lehigh University
309 Coppee Hall
Bethlehem, PA 18015-3165

Dr. Mary Louise Bellamy
11250 Roger Bacon Drive, #19
Reston, VA 22090

Richard Birmele
35 Linden Ave, #511
Long Beach, Ca 90802-5062

Winslow S. Burleson
SETI Institute
2035 Landings Drive
Mountain View, CA 94043

Suzette Burton
Hancock High School
7084 Stennis Airport Drive
Bay St. Louis, MS 39525

Waheed Butt
Overland High School
12400 E. Jewel Avenue
Aurora, CO 80012

Leslee Carter
University of South Florida
210 S. Moody Ave, #2
Tampa, FL 33609

Dana Caseau
Sch. of Ed/.& Human Development
Dept. of Special Educ. and Coun.
5310 N. Campus Drive
Fresno, CA 93740-0003

Casey Casenhiser
Las Vegas City Schools
1620 8th St.
Las Vegas, NM 87701

John F. Cawley
State Univ. of New York at Buffalo
593 Baldy Hall Box 601000
Buffalo, NY 14260

David Christensen
Price Laboratory School
University of Northern Iowa
Cedar Falls, IA 50613-3593

Herbert Cohen
Arizona State University
Division of Curriculum and Instruction
Tempe, AZ 85287-0911

Roni Eilene Cooper
141-19 78th Road, Apt. 3N
Flushing, NY 11367

Ace and Charlotte Cossairt
University of Wyoming
College of Education, Box 3374
Laramie, WY 82071-3374

Monroe Cravats
York Coll. of the City Univ. of NY
94-20 Guy Brewer Blvd.
Jamaica, NY 11451

Dr. Donald R. Daugs
Utah State University
Department of Elementary Education
Logan, UT 84322-2805

Janet Mansfield Davies
Colorado Christian University
180 S. Garrison
Lakewood, CO 80226

Judy Egelston-Dodd
Nat. Tech. Inst. for the Deaf, RIT
23 Lomb Memorial Drive
Rochester, NY 14628-0887

Kathy Frame
11250 Roger Bacon Drive, #19
Reston, VA 22090

James J. Gallagher
2007A South Street
Philadelphia, PA 19146

Paul K. Grogger
Univ. of CO, Dept. of Geology
P.O. Box 7150
Colorado Spring, CO 80933-7150

Dr. John Guyton
Murray State University
Dept. of Elem. & Second. Education Wells Hall
Murray, KY 42071-3305

Lisa S. Hluza
Northside Elementary
1000 Ridgecrest
Angleton, TX 77515

Mrs. Linda Hoffman
Palms Middle School
10860 Woodbine St.
Los Angeles, CA 90034

Diana M. Hunn
The University of Dayton
Department of Teacher Education
Dayton, OH 45469-0525

Dr. Phyllis Kapuscinski
Faculty of Educ., Univ. of Regina
Regina, Saskatchewan
CANADA S4S OA2

Edward Keller, Jr.
West Virginia Union
University of West Virginia
Morgantown, WV 26506-6057

Michael Kelly
Westford Academy
30 Patten Road
Westford, MA 01824

Dr. Howard Kimmel
New Jersey Institute of Technology
University Heights
Newark, NJ 07102

Marjorie King
Jefferson Parish Public Sch. Sys. 501
Manhattan Blvd.
Harvey, LA 70058

Harry Lang
Department of Physics
Rochester Institute of Technology
1 Lomb Memorial Drive
Rochester, NY 14564

Thomas T. Liao
Department of Technology and Society
State Univ. of N.Y. at Stony Brook
Stony Brook, NY 11794-2250

Fred Mangrubang
Kendall School
Gallaudet University
Washington, DC 20002

Linda McCartney
RR 3
Eldora, IA 50627

J. Randy McGinnis
Univ. of Maryland at College Park
2311 Benjamin Building
Department of C & I
College Park, MD 20742-1175

Cindy McLeod
West Las Vegas Schools
P.O. Box 2888
Las Vegas, NM 87701

Katherine Norman
Department of Education
80 Fort Brown
Brownsville, TX 78520-4991

Fred Ortiz
Arroyo High School
4921 N. Cedar Ave.
El Monte, CA 91732

Mary Ann Pack
Descriptive Video Service
WGBH Educ. Found.
125 Western Avenue
Boston, MS 02134

Philip Palmer
Austine School for the Deaf
120 Maple Street
Brattleborn, VT 05301

Cherie Parks
Valley View High School
13135 Nason Street
Moreno Valley, CA 92555

Betty P Preece
615 N Riverside
Indialantic, FL 32903

Wayne T. Ramsey
10 Elm Avenue
Smithtown, NY 11787

Michael Rettig
University of California, Riverside
Department of Chemistry
Riverside, CA 92521

Catherine Riederer
Sheboygan Area Schools
2025 Menasha Avenue
Manitowoc, WI 54220

Jane A. Romero
Sarracino Middle School
P.O. Box X
Socorro, NM 87801

Linda Rosulek
Northeast Iowa Community College
HWY 50 South
Calmar, IA 52132

Harilyn Rousso
Girls Incorporated
30 East 33rd Street
New York, NY 10003

Elynn Severson
Fargo Pub. Sch, Lincoln Elementary
2120 9th Street S.
Fargo, ND 58103

Wanda Shaffer
3015 La Travesia
Fullerton, CA 92635

Michael E. Sixtus
Mar Vista High School
505 Elm Avenue
Imperial Beach, CA 91932

Coralee S. Smith
University of Missouri—Columbia
108 Townsend Hall
Columbia, MO 65211-0211

Sarah F. Smith
Northeast Middle School
5960 Brickstone Drive
Charlotte, NC 28227

Rich Sommer
Stevens Point Area High School
1201 North Point Drive
Stevens Point, WI 54481

Greg Stefanich
618 Schindler Educ. Center
University of Northern Iowa
Cedar Falls, IA 50614

Joseph Stepans
P. O. Box 3992
Laramie, WY 82070

Virginia Stern
Directorate for Educ. and HRP
Amer. Assoc. for the Adv. of Science
1333 H. Street NW
Washington, DC 20005

Frede L. Stier
Wasilla High School
HC04 Box 9743-B
Palmer, AK 99645

John R. Stiles
University of Northern Iowa
Department of C & I
Cedar Falls, IA 50614-0606

Robert Storm
Clarke School for the Deaf
47 Round Hill Road
Northampton, MA 01060

Laureen Summers
Directorate for Education and Human
Resource Programs, AAAS
1333 H. Street, NW
Washington, DC 20005

Judith K. Sweeney
Northern Rhode Island Collaborative
2352 Mendon Road
Cumberland, RI 02864

Mary Jean Takes
520 Maryland Avenue
Waterloo, IA 50701

Gloria H. Thompson
1013 Chaplin Street, SE
Washington, DC 20019

Susan Trocciola
Columbia Grammar and Prep. School
4 W. 93rd Street
New York, NY 10025

Cheryl Turlin
M. H. Weeks Science/Math Magnet
4201 Indiana
Kansas City, MO 64130

Jill Uhlenberg
1 Price Laboratory School
19th and Campus St.
Cedar Falls, IA 50614-0611

Carolyn Van Norman
Jefferson Parish PSS
501 Manhattan Blvd.
Harvey, LA 70058

Ben Van Wagner
Science Education
Fresno Pacific College
1717 S. Chestnut Ave.
Fresno, CA 93702

Robin Vernuccio
645 West End Ave. #3B
New York City, NY 10025

Sue Ellen Walbridge
U.S. Department of Energy
1000 Independence Avenue SW
Washington, DC 20585

Lisa Smith Webb
Shiloh High School
2185 Red Rose Lane
Loganville, GA 30249

Robert A. Weisgerber
American Institutes for Research
P.O. Box 1113
Palo Alto, CA 94302

Hazel W. Wilson
MESC—Dauphin Island Sea Lab
P.O. Box 369
Dauphin Island, AL 36528

Virginia Witherspoon
712 Owens Drive
Huntsville, AL 35801

H. David Wohlers
Department of Science
Northeast Missouri State University
Kirksville, MO 63501

Emily Young
Louisiana State University
#1E Fraternity Circle
Baton Rouge, LA 70803-0301

Mary Kohlerman
4201 Wilson Blvd.
Room 218
Arlington, VA 22250

# CONFERENCE EVALUATION FORM

## A WORKING CONFERENCE ON SCIENCE EDUCATION FOR PERSON WITH DISABILITIES

## MARCH 28-29, 1994

In order to evaluate this NSF-sponsored project, we would like you to fill out this questionnaire about the conference activities. Your input will be valuable to help us determine whether we have reached our goals.

Thank you.

Greg Stefanich and Virginia Stern
Conference Coordinators

## SECTION I — FACILITIES

A. Facilities: Good ___ Fair ___ Poor ___
Comment(s):

B. Assistance for Persons with Disabilities: Good ___ Fair ___ Poor ___
Comment(s):

## SECTION II — BACKGROUND INFORMATION

A. Check the basis for your primary interest in this conference:

1. ____ Science Educator
2. ____ Scientist
3. ____ Parent
4. ____ Student
5. ____ Special Educator
6. ____ Career Educator
7. ____ Counselor
8. ____ Other (Specify)

B. Check the disability of greatest interest to you:

____ Visual ____ Auditory ____ Orthopedic
____ Learning Disabled ____ All

C. Please rate the following:

| | Poor | | | | Excellent |
|---|---|---|---|---|---|
| Opening General Session | 1 | 2 | 3 | 4 | 5 |
| Model Lesson (Motor/Orthopedic) | 1 | 2 | 3 | 4 | 5 |
| Model Lesson (Visual) | 1 | 2 | 3 | 4 | 5 |
| Model Lesson (Hearing) | 1 | 2 | 3 | 4 | 5 |
| Model Lesson (Learning Disabled) | 1 | 2 | 3 | 4 | 5 |
| NRC Science Standards | 1 | 2 | 3 | 4 | 5 |
| Discussion Sessions | 1 | 2 | 3 | 4 | 5 |
| Worksheets/Guides | 1 | 2 | 3 | 4 | 5 |

D. What did you hope to accomplish by attending?

## SECTION III — OUTCOMES

A. Did you achieve your purpose for attending the conference?

____ Yes ____ Somewhat ____ No

B. What part of the conference did you find to be most productive?
Please describe why:

C. What part of the conference did you find least productive?
Please describe why:

D. What did you perceive the goals of the conference to be?

E. Were these goals achieved? ____ Yes ____ Somewhat ____ No
Comments:

F. If a similar conference were held in the future, what change(s) would you recommend?

**GENERAL COMMENTS:**

# CONFERENCE EVALUATIONS QUESTIONNAIRE TALLY

## SECTION I

### I–A. Facilities

| Good | Fair | Poor |
|---|---|---|
| 56 | 14 | 2 |

Comments:

- Having all groups in one room was very distracting. On Day 2, the use of 2 rooms greatly helped.
- Obviously 2 groups in one room but then........
- Good except acoustics in room the 1st day, but Greg worked hard and solved the problem by getting 2 rooms the 2nd day. Thanks!
- Noise was a problem at times.
- had no problems with the facilities with respect to lodging. However, as far as WCH breaks, it did take a lot of time with the system set up and being disabled.
- This was a much better conference this year. More usable information. Better communication than last year.
- The first day was problematic.
- The adjustment day 2 made the workshop flow better.
- I'm really glad that you changed our facility to two rooms. It was much more conducive to listening and learning.
- Only problem was not being able to hear on Monday.
- Have specific locations for breakout meetings.
- A bit drafty/noisy, but good overall.
- The second day was better for I could concentrate on topic discussed. *THANKS* for getting the separate rooms!
- Room too large—difficult to hear when working in small groups.
- Poor first day. Good second day. Meeting was poor. Breakout rooms were needed for half group presentations and working group meetings. Lighting was poor. Presentations were driven by the video taping.

- Noise level much too high. Need separate rooms for concurrent sessions.
- It was fine!
- Acoustics, especially when there were multiple groups, was a problem on the first day, but then was quickly remedied.
- Lighting was a problem. Large space was nice. Groups could not separate (Day 2 was better—thanks, Greg!).
- Needed a little more privacy for groups on day I (? II ?) but otherwise fine.
- I appreciate your efforts to gain more space for Tuesday's sessions.
- It was very distracting to have two groups in the same room. 2nd day—great to have split up groups. Much easier.
- 1st day fair; 2nd day good. Thanks for solving the noise problem. Hotel is good.
- One exception on the first day. It was very hard to hear with the double sessions in one room.
- Improvement came when we divided into 2 rooms. I credit Greg S. for this.
- Perhaps more microphones around the room so participants can all be heard by the group.
- Need separate rooms for separate groups.
- Too big. Smaller break-out rooms would be better.
- Lighting could have been better.
- Much better @ day 2 in separate rooms. Acoustics Day 1 were very bad.
- Excellent. The extra room on T was great.
- A bit too isolated and far from civilization.
- We needed more areas/rooms for ABCD groups. "Playing" with lights and noise from other groups were very distracting and frustrating.
- Hard to hear 1st day. Bright film lights disconcerting.
- Good, except for noise.
- Meeting room set-up was less than optimum.

- 1st day—acoustics poor, esp. having 2 groups functioning in one space. 2nd day—better; spaces too large, no feeling of "group"; lost in large space.
- 1st day, poor; 2nd day, great.
- Having the adjunct lighting source in several sessions was a real help. It did take a while to become adjusted to the dim lighting.
- Ballroom not conducive to this type of conference. It was good to have the room (space), but acoustics were not great, and temperature was not generally comfortable.
- Medium for lecture room—split problem!! Hotel great.
- Better Tues. w/access to a 2nd room!
- Carpet very hard to propel manual wheelchair on. Bathroom (women's) upstairs—handicap stall not enough room to maneuver in.

**I–B. Assistance for Person with Disabilities**

| Good | Fair | Poor |
|---|---|---|
| 33 | 2 | 0 |

Comments:

- Each presenter remembered his subject disability—but participants with disabilities were of no concern in another group, i.e. big print in visual—no more big print period.
- Not affected but seemed to be pretty well taken care of.
- Unsure.
- Not applicable.
- Handout should address all disabilities—visual, hearing etc.
- Seemed great! Should have been more deaf people, I think.
- There were not any notebooks w/large print. Were there any in braille?
- N/A
- It was wonderful being allowed to work with the disabled in person. I learned so much by the interaction first hand, and I would love to see more interaction nationally.

- For someone like me with an auditory disability, the facility was devastating. Thanks for being responsive to this problem.
- Hotel and personnel well equipped to assist in any way necessary.
- I would want to know how the persons directly involved responded to this question.
- 2nd video not captioned; large print.
- From statements by Harry, Dave, and Laureen, all felt comfortable with the arrangements.
- I do not feel that I can comment on this. I do not have a disabilities [sic] therefore my awareness may not be as sensitive as need be to answer this.
- I am not disabled (yet); therefore, I cannot respond to this item.
- Good but none for persons with food problems (like diabetes, etc).
- I don't know how our "chair" folks got up and down the stairs.
- Good, I assume.
- Good, although I heard some of the people in wheelchairs commenting that it was hard to manipulate on the carpeting.
- The carpeting was very tough for wheelchairs.
- Need snacks for diabetics—e.x. fruit.
- I do not have a disability but I felt like the people w/visual impairments were not assisted in terms of handouts (should have been large print). If participants indicated visual impairment on their form, these changes should have been made.
- Everyone appeared to be well accommodated.
- I think there were several instances in which disabled persons with disabilities did not have opportunities, or who were overlooked i.e. some transparencies (cartoons especially) could have been duplicated for visually impaired; wheelchair access to tables, etc. *Assistance* was generally good, however.

## SECTION II

### II–A. Basis for primary interest in the conference:

| | |
|---|---|
| Science Educator | 52 |
| Scientist | 1 |
| Parent | 1 |
| Student | 1 |
| Special Educator | 16 |
| Career Educator | 2 |
| Counselor | 2 |
| Others: | 8 |

(list)
Museum Education
Principal
Regular classroom teacher
College Coordinator
Program Development
Marine Science Educator
Disabled individual
Service Provider
Special Education Department Chair
Advocate
My own personal disability
Research and Development

### II–B. Disabilities of greatest interest:

| | |
|---|---|
| Visual | 9 |
| Auditory | 11 |
| Orthopedic | 10 |
| Learning Disabled | 26 |
| All | 24 |

- I learned about all and maybe one day I will have students in these categories.
- My work is auditory (really all are of interest)
- All + mentally impaired.
- Learning Disabled (Developmentally delayed!)

**II–C. Various Ratings:**

| | Poor | | | Excellent | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Ave. |
| Opening General Session | 0 | 1 | 5 | 29 | 33 | 4.38 |
| Model Lesson (Motor/Ortho.) | 1 | 3 | 5 | 27 | 18 | 3.91 |
| Model Lesson (Visual) | 0 | 2 | 6 | 22 | 36 | 4.39 |
| Model Lesson (Hearing) | 0 | 1 | 10 | 25 | 32 | 4.29 |
| Model Lesson (Learning Dis.) | 0 | 3 | 15 | 24 | 19 | 3.96 |
| NRC Science Standards | 1 | 1 | 16 | 5 | 8 | 3.58 |
| Discussion Sessions | 0 | 3 | 5 | 22 | 35 | 4.37 |
| Worksheets/Guides | 0 | 1 | 9 | 30 | 25 | 4.22 |

- Harry's model lesson on hearing was great (5); the hands-on part had problems (2).
- Kudos to our facilitator, Judy!! (referring to "Discussion Sessions"
- [re: Model Lesson (Learning Disabled)] Too much noise. I really couldn't hear. [re: Discussion Sessions] We needed to focus on the issue at hand and not hear so many personal stories.
- [re: Opening General Session] Thanks for paper.
- [re: Discussion Sessions] Do more.
- NRC Science Standards—1; never showed (finally came at the very end).
- (All 5's) Thank you for a marvelous conference!!
- (No 5's) My hesitation to give an "excellent" rating was due to the a) lack of attention to safety in some of the activities, b) oversimplification of science content, c) in some cases, drifting off task during discussions. NRC Standards (3) rushed.
- NRC Science Standards—NA.
- NRC Science Standards—1; missing.
- Worksheets/Guides—3; need indexes and sequential pages (numbered). NRC Science Standards—NA.
- Opening General Session—Missed. Discussion Sessions—3; too time restricted. Worksheets/Guides—4; color coding is a start—now really organize the info.
- (All 4's) Acoustics

- Directions on small group rotation very confusing. I thought I understood but I guess I didn't since I got messed up Monday afternoon. Worksheets/Guides—4; sometimes confusing.
- Model Lesson (Visual)—4; good oral histories/I didn't think the hands-on presentation was applicable. Model Lesson (Hearing)—3; hard to hear, camera lights were disturbing.
- Model Lesson (Visual) and Model Lesson (Hearing)—4's; couldn't hear.
- Model Lesson (Visual)—no rating; unable to attend—conflict with presenting.
- Model Lesson (Learning Disabled) and NRC Science Standards—no ratings; wasn't here, couldn't attend.
- NRC Science Standards—3; the speech was too abbreviated, but the answers to questions posed by the audience indicated vast knowledge of the topic and high ability to make it understood.
- Discussion Sessions and Worksheet/Guides—5's; extremely helpful—kept us focused.
- Model Lesson (Hearing)—5; my favorite!

**II–D. What did you hope to accomplish by attending?**

- Gain usable information for the tracking of science for the hearing impaired. After the first session ended, my desire to learn more about ALL disabilities escalated.
- I came 3000 miles to learn and appreciate attitudes toward the disabled. I was well rewarded. I heard people talking about problems I am living.
- To go back to my school/classroom with strategies for dealing with the disabled students.
- I hoped to learn practical strategies for modifying hands-on jobs for students with disabilities. We are in the process of developing 3 lab manuals in biology that will include these modifications.
- Get information on science for disabled students and to incorporate into preservice program.
- Interactions/exchange ideas.
- I wanted to get some information on what is happening in terms of change and awareness and the strives currently in action—as well as being theorized. I also wanted to learn more about barriers and modalities of facilitation for specific disabilities.

- 1) Share ideas and strategies with a variety of educators, supervisors, and people in "the gamut of" fields where the issue of equal access to science education for disabled students impacts; 2) Collaboration with "kindred spirits" vis a vis the profession. My own personal development as a professional. Network as much as possible with professionals across the different disability areas.

- To be exposed to techniques used by other schools/teachers in dealing with students who have a disability.

- I hoped to learn about the challenges of educating students w/disabilities and innovative means of doing this effectively.

- Learn more what is available.

- 1) To find a working model for education. 2) To discover new ways of beefing up my program. 3) To see how I could become a player in the dissemination!

- Strategies to implement in my classroom with my students.

- To gain the knowledge that I need to effectively work with the disabled students in my classroom.

- Networking

- To get resources and classroom strategies. To connect with new expertise and ideas. To network with teachers and science professors who have successfully included disabled students in their classes.

- 1) To network with other professionals. 2) To learn techniques for providing program accessibility for science/technology classrooms

- To find ways of improving science instruction for disabled students.

- Increased awareness of disabilities and technologies exposure to enable me and others to work better with individuals of disabilities.

- To obtain information/experience (hands-on) on methods for enhancing science education for students w/special needs.

- Take home strategies/examples that would help me address the needs of my students now!

- Opportunity to meet w/other educators and exchange ideas, views. Gather information on educating students with various disabilities.

- I hoped to gain knowledge on how to teach more effectively in the classroom. I also wanted to get literature on supplies available. I am a field teacher and hoped to get information on new materials to use in the Field.

- Learn new techniques in working with students with disabilities. Providing feedback for colleagues wishing to hold a similar conference.
- Get ideas and strategies for teaching. Awareness of current issues.
- Networking with others involved in teaching persons w/disabilities.
- Increase my teacher effectiveness in my science special education classes and as dean of special education disseminate that information to all science teachers and spec. educ. teachers on campus. I was also hoping to learn (hands-on) use of technology out there!—computers and other equipment! that help people with disabilities!
- To become informed of curricular methodologies and resources dealing with disabled students. To become more personally aware of the feelings and experiences of disabled men and women. To meet people interested in improving science teaching for children with disabilities.
- See new methods and technologies that would assist the teacher in supporting students to reach their maximum potential in science despite the disability.
- 1) Info. on deaf ed. in science lab/classroom—Harry and Bob were great!
  1132) Mentally impaired ed. in science/lab classroom.
- Gain a greater knowledge about the learning disabled and pedagogical strategies which will enhance the learning of science by students with handicaps.
- Gain information. Make ties with people.
- A better understanding of the needs of educators of students with disabilities.
- I wanted to understand the needs of hearing impaired students, and find some techniques that I could use in the classroom to better teach these students.
- Learn, share, network.
- Learn how to incorporate disabled individuals into my classes. Learn more about the difficulties of the disabled.
- I hoped to become more aware and sensitive to people with disabilities.
- Wanted to determine "state of art" in research and practice in teaching disabled students. Also to make personal contacts in this area.
- Having experienced both deaf and blind students with no training, I had hoped to learn some methods as to how to work with these students.
- I hoped to begin my journey toward developing a knowledge base to better address the needs of the disabled in science. I also wanted to envision new research questions to investigate that would be meaningful.

- To meet people who are involved in teaching special students in reg. classrooms. To see "model" teaching by professions. To "rub elbows" with disabled teachers and scientists.
- Networking and collaboration. Resource materials. Dissemination models and plans.
- New ideas for developing hands-on science.
- Networking with persons knowledgeable about the topic. Acquisition of ideas on techniques, procedures, etc.
- To learn about teaching science to exceptionalities other than learning handicapped. By sharing ideas with my peers.
- Hear updates on the state of science education for challenged populations.
- A greater background and knowledge of good practice and policy to improve science ed for the disabled students in any district.
- Setting an overview of the broad range of work done in the field. Networking with colleagues who can share expertise.
- 1) To gain some teaching ideas, 2) to see how science educators/professionals are trying to reach more students with disabilities, 3) to pick up sources/resources for further assistance, 4) and to hear what others are doing and how they got started.
- I hope to learn new ideas to improve my teaching and to meet other people interested in these two fields.
- Greater insight into the needs of individuals who have a special challenge in obtaining a superior science education.
- I wish to become more knowledgeable and sensitive to the challenges of persons with disabilities and learn how to deal with them in the classroom and in interactive science settings.
- A greater understanding of problems students with disabilities face. Ways to help me help students that have disabilities.
- I hoped to interact with other professionals that teach science to students with disabilities.
- I wanted to learn how to address the needs of *ALL* students.
- Inservice. Empower fellow teachers and myself.
- Develop contacts and increase my awareness.

- I wanted to gain info specifically about working w/blind students in chemistry, and generally I wanted info about students w/disabilities for elem. ed majors. I wanted to meet people to make contacts for the future and also to get information.

- Develop awareness and sensitivity to other disabilities. Develop some strategies for dealing with a variety of disabilities.

- Info sharing.

- To develop strategies and theoretical frameworks to share with pre-service and in service elementary teachers.

- I hoped to gather ideas from experts as well as from persons with disabilities regarding "best practices" in all disability areas so that I can offer them to teachers in our area through science inservice.

- I had hoped to learn more about how to infuse disabilities issues into science methods courses, as well as to learn more about disabilities themselves.

- Meet other professionals who share this interest and commitment.

- Present and disseminate.

- Better understanding of how attitudes might change.

- How to improve teacher ed./preparation of fulltime teachers in awareness and attitudes for teaching science to persons w/disabilities.

- 1) Learn techniques to aid in my instruction to students with LD. 2) Increased info and exposure to increased inclusion at my school.

## SECTION III—OUTCOMES

### III–A. Did you achieve your purpose for attending the conference?

| Yes | Somewhat | No |
|---|---|---|
| 53 | 15 | 1 |

Comments:

- But I want MORE!!
- Yes, and more
- Yes [checked] and Somewhat [checked with] Field Work [written in]
- Yes [checked] Arrow to somewhat from "I was also hoping to learn (hands-on) use of technology out there! *Computers* and other equipment! that help people with disabilities!
- Mostly [written between "Yes" and "Somewhat" and circled]
- [Nothing checked.] I don't know that I came w/a purpose—I sure gained a lot!

### III–B. What part of the conference did you find to be most productive? Please describe why.

- The "Hands On" activities simulating the various disabilities.
- When the teachers of sessions were disabled themselves.
- Problem-solving in groups regarding current issues and the projected solutions—critical issues.
- Discussion sessions as a variety of view points were expressed.
- The model lesson on visually impaired students because we worked through the experience ourselves with excellent hands-on modified science equipment as a member of our group played the role of a blind student. we were able to see for ourselves the kinds of needs and problems this student would have.
- General session and small group sharing.
- Model lessons—reality.
- Then "hands on" followed by discussion—the adaptations.
- Discussions and presentations, although I feel smaller groups with more time allotted would be more productive. Presentations might have been richer with experience in terms of adapting first exercise to several disabilities as opposed to one.

- I liked the hands-on lessons I can use immediately.
- Discussions and group shares immediately following the group's activities. Especially the presentation of Ben Van Wagner which was completely "on target" and precipitated a very informative and thoughtful exchange by the group.
- The working groups when we discussed what we wanted to change and how.
- I found the LD Best Methods section the best—it was structured and explained well and reasonably complete and could be used for several _______________ (periods?).
- Discussion/small groups
- The hands-on by persons who had the disability.
- Awareness of problem or concerns of disabled students.
- Being instructed by individuals with disabilities—I could ask them questions that I would not feel comfortable asking in other situations.
- Discussion groups, sharing,
- Best paper was on LD (Norman & Caseau). Best demo was by Ben Van Wagner! Excellent organization & balance between science & vision impairment needs! Also "loved" F.A.T. City. The participants were great!
- The "Best Practice" sessions, because specific techniques for engaging students with different types of disabilities were discussed and modeled.
- Just meeting with those who do what you do was productive.
- The discussions—sharing ideas with others facilitates my ability to organize my own thoughts. Input from others pushes me to clarify my communications.
- Model lessons—they provided "hands-on" experiences and made us think about adapting lessons, etc.
- The Model lessons did provide usable examples that I could implement.
- Hands-on activities
- The sessions with the disabled teaching and explaining their methods that work in the classroom.
- The hands-on lessons that could be applied in the classroom. Meeting others and discussing techniques that work and what still needs to be done to help students with disabilities (small group sharing).

- The model lessons provided actual practice and examples of "how to."
- Discussion sections. There was so much interchange of ideas that these discussions could easily go on for twice the scheduled time allotment.
- Information of hearing disabled and the F.A.T. City and Problem Solver videos. I have a deaf child who is not in the proper class placement, and I was given names of persons who can help me help this child!
- Model lessons and ensuring discussion—Why? Because they gave me concrete ways of sharing what I learned with my preservice classes, inservice workshops, and colleagues, especially those in special education. The videos were excellent also.
- Seeing presentations from fields outside of deafness to help me deal with deaf students who are multiply disabled.
- Listening to and learning from personal experiences of disabled educators and scientists. Hands-on labs: learning of modifications that are *useful*.
- Discussions. A excellent exchange of ideas. Thought provoking. [typed as written]
- Area presentations and discussions.
- The best practice session because they helped to demonstrate useful methods of teaching.
- Networking—meeting new people who are involved with disabled students. And last, but not least, bring something concrete (stodvy) [?] back to my school.
- Model lessons.
- Discussion sessions. Gained specific information that I can use.
- I received insights from each session. discussion groups are always beneficial for me. Insights: All students benefit from working with and learning beside people with disabilities. There are many learning styles within a classroom that need to be addressed. Disabilities that are not visible (learning disabilities) makes it extremely difficult for that student to get their needs met.
- Discussions and lunches. More candid. More insight into what is really bothering and motivating people. The hearing session was also enlightening (Lang* and Storm are really good).
- Visual; hands on experience; good tips for the visually impaired.
- Resource sharing: these can be incorporated into developing our "expertise" in developing a Best Practice of science for disabled people.

- *ALL*
- Discussions sessions because of opportunities to network and learn about methods /materials.
- Hand-on activities and group discussion.
- The visually impaired and deaf sessions—really got their points across in their modeling of best practices.
- Not the sessions—most productive was being with—on a person to person level—people with various disabilities.
- The model lessons. They were great but could have been a bit longer. I was [nothing written after this in this section]
- Group sharing discussions. Visual and auditory presentations—direct, focused, practical.
- Small groups, also presentations of best practice ed by scientists with disabilities that showed ____________________ [large black writing]. Films also great.
- 1) Finding out about researches available, 2) inner [sic] acting with other people who are or work with people with disabilities. It's always good to hear someone else's "story." I really got a lot out of Harry Lang's presentation. He has a wonderful way of helping a hearing person understand some some [sic] of the needs of non hearing person.
- The group discussions were very helpful for we really talked about problems and solutions.
- Small group sessions. They presented an opportunity for me to become aware of concerns of disabled individuals from a variety of viewpoints.
- Greg's *Common Thread* was stimulating. I could have listened to him all day. I really enjoyed the hands on visually impaired lesson. I learned a lot. The LD film FAT CITY was wonderful. Perhaps 2 showings would have been helpful as I had to leave during some of it.
- Sessions were lessons were shared and taught. [typed as written]
- Meeting people with disabilities, and seeing how they have adapted and achieved success.
- Meeting others and being allowed to interact and network.
- Best practice lessons.

- Meeting other people with similar interest. Structure which facilitated dialogue [guessed at last two words].
- The contacts made were very helpful. I was glad to meet people who are very encouraging and positive.
- Some of workshop and discussion groups. Practical information and informal, open sharing.
- Handouts and attendee list.
- Discussions. Wide responses from many geographical areas!
- I thought the group discussions were very productive. Somehow, from all the dialogue, major issues regarding the science education of persons with disabilities surfaced and strategies for solutions began to emerge.
- The ability to network, establishing professional ties was terrific. Not to downgrade the other aspects (which were also fantastic), this interaction was pleasant surprise.
- Discussion groups. I felt they brought us a step closer to collaborating/ implementing on a meaningful level.
- VI presentation.
- Discussions and workshops. Awareness of specials needs & perceptions of those w/disabilities (from workshops). Access to expertise and experience of others (from discussions).
- Group discussions—but we needed more time to complete worksheet questions! Opportunities to be in groups w/*very* diverse folks.
- Best Practice Models—I learned I do much already & need to change very little. (increased self-confidence!!)

**III–C. What part of the conference did you find least productive? Please describe why.**

- NONE! It is the first conference I have attended in which I felt that I wanted EACH segment to CONTINUE.
- I found all parts educational to me as a visually impaired person. Awareness was a highly.
- NA
- The hands-on part of the hearing impaired model lesson because the fire and cloth were a safety hazard and could create misconceptions with students. Also didn't seem to get across the important concepts clearly enough.

- Some of the presentations not enough time for sharing and brainstorming.
- None.
- Transition times.
- The actual manipulation of one lab in terms of one disability as opposed to discussing barriers of disability and allowances and materials available as well as modified labs in terms of the general classroom dealing with varieties of disabilities.
- The section on Learning Disabilities—it is of enormous import based on the sheer numbers of students with this involvement, and there wasn't enough specific information given. The section was more of a general all-round science lesson.
- Any lecture that did not include visual aids.
- In terms of potential, the work groups were very unformulated—a hodge podge of rapidly thrown together solutions. The issues undertaken takes time and more discussion. I think it should be further broken down in terms of objectives for each session.
- None
- None—It did not *drag* anywhere!
- Group session when participant have to address specific issues. Why? Many participant said the same things in every group session.
- Poor set up with two groups in same room on Monday.
- Nothing! Only criticism is lack of time and needs to mix and know people in other groups instead of staying in one.
- Discussion of Action Agenda. Much more time is needed to plan a plan of action.
- The hands-on activities. These activities were not motivated, safe and not connected all that well with a student's life.
- ?—all being in the same room all the time.
- End of session discussion groups. Simply pitted Spec. Ed. vs. Science teachers, where SE teachers are "suggesting" strategies that are totally impractical in a H.S. Science lab, with nothing useful being achieved.
- I feel all parts were productive in one way or another!
- NONE!

- I found it all interesting. It appears you improved upon last year's conference through the suggestions that were made.
- Sessions seemed to be "rushed."
- All were productive.
- None.
- I was disappointed that the first speaker on NRC Standards was late and felt he had to rush through his presentation. The question period was helpful.
- Discussion groups—dominated by a few and seemed to go in to general and futuristic terms—not what can the teacher do.
- Info. on L.D. children—I already have experience in this area from the school of hard knocks.
- 1 or 2 of the demonstration lessons...were not that well connected to the disability they were supposed to be highlighting.
- NRC science standards. Unrelated subject matter.
- The worksheets were not open-ended.
- None.
- The groups were too large. What was developed in the groups was very good but it could have been more productive.
- The activities were basic. I would like to take a theme (i.e. solar energy) and brainstorm ways to teach through the theme, so students get connection to everyday life. More time for hands-on would be beneficial.
- All parts were good. I probably got the least from the visual part, but I did learn valuable things there.
- Motor impaired. He (she ?) actually did not simulate this type of student.
- Time for developing networks. I did not have time or adequate opportunities to develop more than 1 or 2.
- Got something out of each session!
- The hands-on demos were good but I felt they consumed too much time. I wanted to spend more time with my peers just talking and sharing ideas.
- [written then marking through with a single line] Well, I think David Florio would have enabled us to pull things together.

- Learning disability and orthepedic motor—less focused, practical application.
- I'm not sure any of it was non productive however I had a little problem with brain overload half way through Tues. morning.
- It ended too soon. I would have liked to have worked more on developing plans.
- All aspects of the conference were productive.
- It was very hard to hear the hearing impaired lecture—the lights were blaring making it uncomfortable. It was hard to relate to.
- Sessions where noise was a factor.
- Some of the hands on demonstrations were a little weak. But, a few were very good.
- Large group sessions. I think the personal interaction was helpful, and the large (whole) group sessions didn't really allow interaction.
- Just lack of time. More time needed.
- *Wasn't one.*
- I did not feel the activities were productive. There was not enough time to really see the purpose of the specific activity to help the targeted group. I was upset to not hear about *conceptual* understanding of science topics—they cannot be learned thru "discover."
- Being "talked to" rather than participating.
- NA
- Visual impaired workshop—lacked safety concerns—need inclusion of BD and ADD.
- Every aspect of the conference had value to me. I have quite a lot of ideas to take back to my district. I pledge to find ways to use them to help teachers through inservice training.
- The need to move equipment was counter-productive, detracting from the nature of the conference.
- Breakfast
- I really did not find any part unproductive. It was very stimulating and enriching! Thank you!
- Discussions where we are expected to come up with suggestions answers right then. (I need time to process individually—but this is a good start on processing the info for me.)

**III–D. What did you perceive the goals of the conference to be?**

- Enlightenment and heightened awareness of needs of both disabled science students and mainstream science teachers' concerns.
- To change attitudes. To cause waves and start people thinking and talking.
- To enhance science classes by being more cognizant of the need to accommodate handicaps.
- To get people at least talking about the problems and perhaps to come up with some possible solutions to perceived (?) problems.
- To help us better understand the problems and needs of students with disabilities, and do what we can to help solve these problems.
- Make us aware of science needs of the disabled students and educate us on strategies appropriate for disabled students.
- Enhance interaction.
- "Best Practice" in terms of educating disabled regardless of inclusion situation or special class situation.
- Becoming more aware of problems people with disabilities have in participating in science classes.
- As the group develops and hopefully continues to meet, share ideas and lend both our individual and group voice to being to *affect the changes necessary* to *insure* that *EVERY* student has equal access to the best possible science education. We were able to brainstorm both immediate and long-term (even "distant-term") objectives and try to find ways of gradually improving communication, practice, and training in the field.
- More exposure to technology and changes in sp. ed and science.
- This was unclear—both disseminating best practice and deciding how to effect the national future of disabilities ed. These goals were way to fragmented and un-stated.
- Awareness and to help D's....
- To aid the dissemination of sp. ed. ideas and to generate a model for a vehicle.
- Awareness of the needs of the disabled science students that aren't being met.
- To leave with an in-depth knowledge of the needs of our disabled students and methods of adapting the instruction for them.

- Awareness and networking
- Get experts together and gain momentum to spread the word. Pool own resources and support each other.
- Workshops for "best practice" modeling and instruction. Discussion of barriers and action plan.
- To share ways of teaching disabled students in science.
- Develop working strategies for approaching Science ed for people with disabilities.
- To provide information and experience on instructing students with disabilities in science.
- Provide training for Science teachers to better deal w/handicapped students in real-life situations.
- Gather and give information—give practical hands-on activities for disabilities covered.
- The goals I perceived were to learn more about the disabled and how to be productive with special students.
- Learning strategies for helping students with disabilities be successful in science and develop a "can do" attitude. learn how to conduct a similar workshop.
- Awareness of issues regarding science teaching for/to people w/disabilities.
- Information dissemination on disability.
- How to bring technology into the school DISTRICT and learn new information about various disabilities and experience/understand that disability.
- To raise our awareness of what science students experience as persons and as students in class. To collaborate on planning a future strategy for increasing teachers' awareness and action as persons with disabilities.
- Expose all of us to methods and materials which could enhance our teaching and student learning. Exposure to successful scientists with disabilities.
- To help me modify for ALL disabled students! This was a select population of disabled students who were addressed.
- A coming together of individuals, who for one reason or another are concerned with the learning of sc by children with handicaps and how to enhance this learning.

- Sharing, planning, building for a bigger push.
- To demonstrate best practices and how they can be applied in education of students with disabilities.
- To disseminate information, change attitudes of the participants (if needed) and use group dynamics to tackle some of the major issues in teaching science to the disabled.
- To develop, share and disseminate strategies for providing equal access for all students.
- To help participants understand the difficulties of educating the disabled. To have the conveners gain new insights into education of the disabled.
- I did not know what this workshop would entail when I created goals. I did receive better understanding of teaching students with disabilities. I am excited to go back to my school and share ideas for better meeting students needs.
- Raise sensitivity locally then nationwide to needs/methods of teaching disabled.
- Tips and education relating to the various disabilities.
- I perceived that the goals of the conference were related to the sharing of ideas and to construction of new ideas.
- To expose the participants to awareness, attitude change, and model teaching (inclusion) of disabled in sciences).
- #1 networking. #2 methods. Also awareness and resource availability.
- Sharing of "best practices" in science
- Raise the level of awareness about the problems, issues and provide some examples of solutions to some of the problems encountered through demonstrations of best practice.
- 1) Different than those stated in the original solicitation. 2) Seemed like we learned how to incorporate individuals with disabilities by doing hands-on sci. lessons into sci. education.
- To help people become aware.
- To provide these [arrow up to II-D.] (A greater background and knowledge of good practice & policy to improve science ed for the disabled students in any district.) plus to bring all these people together to share, network, learn from each other.

- To share info and build an army of advocates.
- One was the chance to dialogue w/people w/disabilities and hear what they perceive the general needs of people w/disabilities to be w/regard to 1) science and 2) over-all educational process.
- Finding better ways to teach science to students with different disabilities.
- To discover methods to improve the access of science education to disabled individuals, which would in turn lead to greater numbers of disabled individuals electing scientific field as career choices.
- A background and detailed experiences for teaching science to the disabled student, 2) to come up with *concrete* and specific ideas to be addressed in problems which occur when teaching the disabled student.
- Help teachers, to help students.
- This appears to be a new area of concern. I thought the goal was to get input from many people of varied backgrounds.
- To inform the participants about disabilities and what educators can do to accommodate students w/disabilities.
- Awareness. Education. Development of future action plans.
- Stimulate discussion, develop awareness, initiate grass roots action.
- Thru "discovery" to provide information and promote awareness of the work being done, and also to get teachers/others views on how to solve problems.
- To develop 'action plan' for next few years.
- Organizing a "push" in the area.
- Awareness, sharing—developing strategies.
- To find ways for educators to open the doors of science to all students, including students with disabilities.
- To develop strategies for meeting the needs of students with disabilities.
- To share specific instructions/strategies and synthesize best practices.
- Hands-on science.
- Defining barriers & issues of special education + coming up w/suggestions of how to approach these issues and resolve them.

- Improve delivery of science ed. to and by persons w/disabilities.
- 1) Practical skills to increase learning of students with disabilities. 2) Recruit/ encourage more people to increase sphere of influence of those interested in more/increased science education to students.

**III–E. Were these goals achieved?**

| Yes | Somewhat | No |
|---|---|---|
| 49 | 20 | 1 |

Comments:

- Yes, many innovative ideas were shared.
- I found a lot of Idealism vs The Reality of the situation. I'm not sure the participants were homogeneous in their goals/expectations.
- More time needed to brainstorm implementation of ideas.
- While separating disabilities for presentation is useful for creating knowledge base, however, I think that if we are truly to address "best practice" we might consider doing exercises as a group of all disabilities for better assimilation of "in the class" knowledge and reality.
- ...we've certainly made *more* than a *few* inroads—By identifying what we need to do first and foremost. But I still feel mired in the idealistic vs. practical implementation.
- I am interested in seeing how we can use computers in my sp. ed classroom.
- No—neither was effectively achieved. Best Practice was informative but could have and should have been exemplary on the Nat. Scean some good ideas were brought up but not a lot of discussion & building of ideas was undertaken, nor was this possible due to the unstructured nature of the workgroups. [typed as written]
- Final group reports were extremely cohesive.
- Many good ideas were shared but I feel that I barely touched the tip of the ice berg.
- Excellent participants! The quality of suggestions was outstanding. Nice gender balance.
- Much more work needs to be done to further appropriate educational methods for teaching people with disabilities. teacher, students, administrators, & the public at large need to realize education IS for everyone.

- See [answers] B & C above!
- This is the first conference I have attended on the disabled and I *WILL* go back to my school and give an in-service at local and state level *HOPEFULLY IN MARINE SCIENCE*.
- Somewhat. Some excellent ideas were presented, but they need organizing, refinement and synthesis—and funding.
- Somewhat. Would have liked for more Deaf participants.
- Somewhat. Covered L.D., M.O., D.H.H., V.I. and I have all of these children plus emotionally disturbed, ADHD, Autistic, Downs, M.R., etc...in a regular ed. setting—I'm a science teacher—no Sp.Ed. experience.
- Yes+. I got a lot of information, had my sensitivity raised somewhat, and hopefully have established the seeds of some useful networking.
- Yes. To a large degree, they were.
- Somewhat. We needed *at least one* more day. We needed smaller discussion groups. No more than 10 people. Brainstorm the opening discussion session by writing inf. on large pads on walls.
- [nothing checked] My goals were different than what was directly addressed in workshop. I will process information and apply it to my situation. I sure I have learned many useful tools.
- Yes. I especially will use the visual and hearing impaired tips. Films on LD were excellent.
- Yes. I also appreciated the 2 videos at the end of the session on Monday?
- Somewhat [checked with] mostly [written and circled with check mark].
- Yes. The agenda manifests the implementation of procedures designed around these goals.
- Yes. I had assumed that special educators would know the 'hows' of delivering lessons to special needs students, but the demo lessons proved there are still and always new things to learn. Thanks.
- Somewhat. It is easy to make suggestions. We all know where the problems lie. The goal would be in implementation and reaching out to the general teaching population as a whole for more acceptance, creativity in dealing with students w/disabilities.

- Somewhat. We were "presented" to pretty well, but there was not a very good format [? word] to share experience and success and frustration.

- Yes. I think the goals *will* be achieved...this is just a beginning.

- Yes. There were many excellent strategies for encouraging good science for students with disabilities.

- Yes. A beginning of how this might be accomplished. Now to implement these ideas.

**III–F. If a similar conference were held in the future, what change(s) would you recommend?**

- More time for the simulations *and* more time for collaboration/summary sessions.

- Everything was great. discussion was stirred and attitudes were changed.

- More time allowed for brain storming among the participants.

- Perhaps dividing into 2 groupings: 1) Demonstrable—physical handicaps; 2) Learning disabilities which are not immediately obvious.

- More hands on model lessons, especially with help for how to address needs of students with learning disabilities.

- More time for small group sharing; limit the worksheets and the issues.

- None.

- Bring teams of administrators, science teachers, special education teachers and a person with a disability.

- Presentations addressing comments in Section II, D. ("I wanted to get some information on what *is*....). Smaller discussion groups and/or with more time—the discussions and group as a whole were *extremely* well facilitated and organized. I just think we run the risk of loosing great points and ideas by cutting them off.

- All participants should have at least a *basic* understanding and/or "working knowledge of the specific disability groups we address. I am not implying experts only, mind you, but those without even working definitions *slow up* discussions (the time for which is *precious*) and often lead the discussions somewhat astray. *More emphasis on what we can *realistically* implement!

- More clear directions on organization of the day.

- Focus on either of these [two goals of disseminating best practice or how to effect the national future of disabilities ed] but not both on the same time frame. Make the presentations of best practice more dramatic.

- Everything's fine.
- *MORE* of the same! This represented a fine model!
- Send out questions to be addressed before the conference.
- Make sure that each instructional setting is quiet and conducive to our learning. Send out questions to be addressed before the conference so we could think about them and come prepared to express our thoughts.
- Two things: 1) Do it with satellite (distance) pick-up at 5 or 6 sites; live and interactive! 2) Send a team of participants from each school: administrator (principal), two teachers (high school and elementary/science and special educ) so they can return with a better chance of impact.
- More time to develop an agenda for change.
- Separate rooms for each group.
- Have it one day longer including more working discussions and plan development which will enable better immediate dissemination of ideas that are developed during this workshop. Train Trainers to do this as a consultant on a National Level—in ALL school districts.
- At least 1/2 day in small group discussions—we didn't have enough time. Have Science teachers teach a lesson—on the spot adaptation after learning about methods for assisting students with disabilities in science classroom. Next 2 1/2 days add school administrators, College of Education chairs.
- Don't mix the two groups of teachers if you expect either group to truly benefit. It was both frustrating and useless to attempt to discuss the problems of a 30+ science lab with someone who knows little about science or about working with large numbers of students in one classroom.
- Add information on mental impairments the same way V.I., H.I., motor, and L.D. were presented.
- Take roll at each session—it seemed to me several participants were absent 2nd day during the morning. There are many teachers that *would* be present full-time! Maybe a sign-in sheet! Don't finish early—I would like to spend all of the time to learn more.
- Finding a location where small rooms would be available for sharing in groups. Have people with disabilities share more of their personal experiences (motor disabilities presentation was good!). Provide lunch—gives people more time to share and become acquainted in an informal setting. Provide more time for sharing in small groups. Have vendor displays with new technology.

- More time for lessons and debriefing. Too Much movement from room to room or place to place.
- Definitely separate rooms for concurrent sessions.
- Spend more time meeting each other and discuss what's happening in schools around the nation and what is working in those schools and more on technological information and use.
- Smaller discussion groups, but with a variety of backgrounds. Perhaps persons could introduce themselves in each discussion group so that we could be aware of the variety within the group.
- Specific times for teachers of similar disabling conditions to get together. Relate benchmarks developed by NSTA to our [nothing more written]
- Broader range of disabilities presented—same format. This format was *very* effective. Bring/share time where teachers could bring info., videos, computer programs, etc. to share.
- It might of use to mail some/all of the readings to participants before the start of the meeting.
- 3 days. *Grantwritting*—brainstorm session (collaborative effort).
- Less disruption (i.e. movement) between sessions.
- More participants and more emphasis on hearing impaired students.
- Spend twice as much time in discussion sessions. Have the groups change so everyone discusses ideas with everyone else. Start at 0800 and go to 1700. Let's work more! Have everyone turn in their worksheets.
- Activities that can be directly applied to everyday life, personal life stories—what it felt like as a child growing up with disability? What it took to feel __________ strong and capable? How did you deal with disability? etc.
- A presentation by "Special Ed" teacher/group detailing their training/methods and how they hope to interact effectively with science teachers. Also I am somewhat surprised at the lack of discussion/criticism of Education Depts. and basic teacher preparation in science, not to mention science for disabled students. Probably one of the weakest parts of my campus is science education (training). Does not seem ever to have been a priority, and no change is in sight. Is there a move for National Standards in Science Teacher Education? If not, the voice of groups like this would be helpful in getting that started. (Florio hinted at this.)
- Better experiments. I do think the experiments were somewhat weak.

- 1) Add more time to sharing of ideas *after* each model lesson. **2) Incorporate "developmentally delayed" group into the model lesson . Was it included under LD? 3) Focus more on issues—mainstreaming and inclusion.

- Groups A, B, C, & D are still too large. Make smaller groups. Perhaps have a "catered meal" at lunch so participants can further network. Write the 2 lunch meals into the next grant.

- More networking planned. More equipment/resources available for examination. More "feedback" activities requested of participants.

- More innovative hands-on activities; more stories from scientists w/disabilities.

- 1) Have a two-hour Share-a-thon. Set up 20 (more or less) tables so that volunteers can talk about and illustrate some of the best practices. Also 2) Bring *teams* of science supervisor, science teacher, special education supervisor, special education teacher, a school administrator to a conference like this. The team would be charged with the responsibility of developing and implementing at least 2 or 3 workshops in their school district or region. 3) Change composition of the discussion/working groups to allow for more "cross-fertilization" of ideas.

- 1) More sessions and smaller sessions. 2) Letting attendees be the presenters to actually disseminate and share their expertise i.e. *lots* of mini presentations 40-60 minutes each. Social hour during or after the day sessions.

- Keep the group together a day longer—this might be tough to do, but a few more hours would have helped—or——break the ice the night before with a get-acquainted reception.

- More promising practices. Those small, inexpensive suggestions to modify materials to benefit students with disabilities.

- More, more, more small groups need to be longer. Also, consider holding the conference on a university campus so there can be more hands on. Finally, consider including the disability rights movement as a partner in your work. disability is a civil rights issue. I feel this could be more fully integrated and enable us to move further away from a rehabilitation/deficit model. Also some high school students with disabilities might benefit from participating and we would benefit from their expertise and energy.

- Separate rooms for small group activities. Better/simpler explanation of group rotation for Ed. Models. I would like to hear more from individuals w/disabilities—how did they "make it through" the system and what would they want done differently if they had it to do over again. [typed as written]

- I would continue to show practical hands-on lessons and also develop strategies to bring the ideas back to our communities.

- Have younger students who have a special challenge to exchange ideas as to how they can be better serviced in their science classes.
- Provide a graduated stipend so that high airfares from the opposite coast could be better met by teachers traveling from afar vs teachers from closer areas (esp. teachers that don't have districts helping to foot the bill).
- Allow more than 3 days.
- Stronger format for sharing input.
- Try to maximize small group interactions. Have teachers come in pairs— one science and one special ed. teacher from the same school or district.
- More time devoted for each disability area.
- Maybe a session which would involve collaboration with other organization i.e. STE, NCTM, AERA, etc. for the purpose of building bridges etc. Maybe someday a reunion of all person who have attended this meeting over the years.
- I think it would be beneficial to meet/talk/discuss w/other participants in more depth than in our 4 groups. I would have liked to heard how different teachers address different aspects of the science curricula.
- Smaller meeting spaces. More time to develop small group awareness, etc, about each disability. More time in general—3 days instead of two.
- Better acoustics for hard of hearing.
- In place of having each working group move, have the speakers move to the group—4 people moving instead of 60 people "attempting" to change locations.
- The structure of the conference was excellent. It makes an effective blueprint for the evolving issue of teaching good science to students with disabilities.
- Extend it an extra day to better develop a plan of action, and perhaps have discussion of papers which would be read prior to the "panel/round table." Have it in a more intimate setting, if possible. The ballroom was not conducive to the greatest productivity.
- Yes.
- People who come, do home in-service and reply on followup.
- Individuals returning w/information how they used this information plus devising ways to help others resolve these challenges.
- More time for discussion!
- More time! (All the presenters commented about preparing for longer time but then not have the time.)

# Conference Evaluation

## General Comments

- This was the most valuable workshop I have attended in my 22 years of teaching. Thank you so much!

- I believe like Ben Franklin and Christ that groups should be held to no more than 12, so maybe 6 discussion groups instead of 4 might bring the more quiet members "out"! We still allow people who are not in touch with the problems to dictate the terms of the discussions. We need the disabled as spokespersons for their own folk.

- Job well done!

- I found the modeling approach to be worthwhile. I sensed that at times in group sessions people seemed to be holding back rather than saying what might have been total feelings on areas under discussion.

- I thoroughly enjoyed this conference and have benefitted tremendously. I now not only have a wealth of information and resources, but also many names of knowledgeable individuals I can call for help when I need it. I plan to stay for NSTA, but the 2 days of this conference might well prove to be more valuable to one professionally than all the remaining days of the NSTA conference combined! Thank you for the opportunity!

- I appreciate the efforts of Greg and Virginia and others for putting this conference together.

- Very beneficial.

- Great working conference! (Happy Face)

- I *REALLY* felt, however, that it was a spectacular opportunity for me. I was treated as a professional by some of the most respected members in the field, and I felt the contributions of 95% of the participants of the conference will help me in my own personal quest to educate, inform, and communicate the goals and objectives we've delineated as crucial to the changes we need *demand* for our disabled science students. Thank you, Virginia and Greg. I will travel anywhere anytime if I can do anything to further the work we've started the past 2 days! (Please don't forget me next year!) [No name on paper—lots of writing front and back]

- I am leaving with an excited feeling about special ed and science. It was great to meet people from all over the nation. I would love to attend again!

- I applaud the effort put into this conference and the accomplishments that were made. I hope you have more and that they are more focused and *REALLY* enforce and dynamic change either in the classroom or on the Nat. Scean. [typed as written throughout]

- Greg is Great!!! Excellent Coordinator

- Emily Young, LA I sincerely appreciate the opportunity to be a part of such a worthwhile group. I am developing a book on activities for these (people) disabilities. I was delighted to find out everything I've done so far can be supported!

- This subject should be addressed. Every student is entitled to opportunities that will enable them to become successful in the real world.

- I've realized that our methods of teaching science have changed. It was stated that there is a lack of disabled people in the field of science. That seems to me to be directly related to the fact that science used to be taught by the "read the book" method. Our special students often need remediation in the area of reading and it was felt that they could go for their individual reading lessons during science instruction—If they could read they would be able to catch up because our science was reading—This is no longer appropriate today because science is an active, hands on, process oriented subject. We will be seeing my disabled people in the science field in the future.

- Thank you!

- I appreciate the opportunity to have participated in this conference.

- I now know what I want to do my doctorate studies in. "The Educational Effects of Total Inclusion of Behaviorally Disabled Individuals on Non-Disabled Students."

- Obviously I would like to see the mentally impaired population as involved as those covered in this convention workshop. Also, perhaps A, B, C, D groups need to get together a few times. We didn't see too much of the whole group (3 days?). Discussion groups most important. Presenters were excellent—well informed, well prepared.

- Thanks to all for a wonderful conference and I did learn so much! * Maybe next conference—make a contract with each participant to do an in-service in their state, local area with same format having disabled students work with teachers.

- Motor Disabilities presentation was good!

- Overall this was well organized and was a worthwhile use of time.

- Excellent conference but the time frames were too short. Could use 3 days for this amount of information.

- We should look at California's Middle School Unit and provide at our next conference buses that will take participants to schools that are models of science classes that incorporate students with disabilities! We can learn so much by seeing such a class in action. Middle School Unit does that in exploring middle schools.

- Thank you for giving me the opportunity to attend, to learn, and to make new friends. Also, thank you for the copy of the proceedings of the conference held last year in K.C., and for the attentive and thoughtful telephone calls prior to the conference.

- I could have used more ideas to implement in my classroom. The ACS & AAAS have excellent lit. and I was impressed. The "barrier free" curriculum looked great. I loved the exposure to people from across the U.S. and the diversity of people represented.

- Thank you very much. Very worthwhile.

- It has been a very valuable 2 days.

- Very helpful!

- This was one of the most productive conferences I have ever attended. I will be talking about it for a long time. I will also be implementing some of the ideas which I picked up here.

- I have learned a lot. Although I am primarily interested in the motor-impaired the information I gained about the other disabilities will be very useful in the future. I intend to expand my investigations of educating gifted disabled student at all age levels and hope to initiate a specific program for these individuals in my local area. [typed as written]

- *Visually*—good activities. Excellent having one person blindfolded. It is important for all students to be taught through all senses. *Hard of Hearing*—I do not like to be taught as if I am a young child. I like to explore activities as an adult then relate this back to the classroom. It was beneficial to hear Harry Lang speak. I would have liked to hear his personal story as it related to his school life. Harry explained what Hearing Impaired Children miss through hot having hearing experiences (feelings, and concepts). This will helped me have better understanding. *Learning Disabilities* —Dana is an excellent presenter. He inspired me! More time what be great! Very enjoyable and I learned a lot from the other educators. Standards—I do not learn well from a facilitator who reads from overheads. I tuned out! [types as written]

- *Lang probably needs to use microphone routinely. **The "Special Ed" people seem to be getting serious criticism from science people. Is it their "fault"? Are they victims of the political system? Would be a useful subsection for presentation/analysis.

- Perhaps a team of a special education teacher and a regular science teacher should attend as a team.

- To Greg and other developers of workshop—*thanks* and continued energy to maintain this initiative.

- I like the structure of the program this year.

- Thank you for this opportunity. I would like to work with you to "pay back" your investment in me by producing workshop, I/s, & etc. to disseminate. [No name on paper.]

- Good conference!

- Thanks for allowing me to participate in this conference. It was/will be most beneficial to me.

- Thank you for an excellent conference. You have planted a seed which surely will grow and spread the message of good science instruction for *all* students. I'll keep you posted on how it goes at my school & I'll pass along any good ideas I come across. Thanks, again. Fred Ortiz.

- Maybe a group of science educators could attend a special ed conference or vice versa. I think the videotape would be super. It could be a tool for awareness and also a spark for a local teacher or group. I think the group process this year was great. The guide sheets were extremely helpful to keep us on task. Thanks for the checks so fast!

- Perhaps a large scale make and take format might be valuable. This was a fine conference—thank you for all your work in providing us with this opportunity to share, learn, and improve.

- Thanks so much for an excellent meeting.

- It was great having tables to use during presentations but their layout was *not* well suited for small group discussions. Great Groceries during breaks. Any transparencies use should have "hard copies" in packets or provided at the end of sessions. Some confusion as to length of Model Lesson segments. LD group thought they had an hour for presentation/lesson and another hour for discussion. It felt very rushed which was frustrating. (They did handle it fairly well, though.) Notebooks, booklet and hand-outs—really great and well organized/thought out.

- A great conference.

- The general consensus was that we all know where the problems lie. How do we reach out to the teaching population across the nation to disseminate ideas about teaching disabled children—mainstream and special ed—with science education that has worked and can work for them. (Broad Teacher Training/Networking of methods, ideas, lesson plans, etc.) I really enjoyed the hands-on workshops and feeling out new ideas. A lot of teachers seemed unaware of getting Special Education committees to advocate for their students. This is an important part of student advocacy and perhaps should be addressed. We have to get the message out on what we've discussed and learned...through networking, dissemination of information (computer, teacher workshops etc.). Thank you for this wonderful opportunity.

- This is a difficult task, and this conference is a big step forward. I appreciate the opportunity of participating.
- I learned a lot. If you have one next year, please invite me back. (no name on paper)
- Excellent—thanks for all the hard work, Greg and Virginia. Include next time a general round table introduction of each participant and their role.
- I hope you/we can act on the ideas generated. I look forward to working with *you* in the future. I also think you need, if you aren't, to identify through this process a group of individuals to participate in an e-mail think tank. I have many more ideas... J. Guyton (over) Need to invite NRC to join us in and learn from us. I get the idea they desire to pass the buck instead of addressing the issue....I hope I am wrong.
- At times there seemed to be an agenda in place—almost like ideas were already decided on. I think some of the ideas decided in groups were very important. Teacher training is vital in the success of change in the classroom.
- (Thanks for a busy two days.) Have students with various disabilities attend and provide demos with these students or find videotaping of students with disabilities and use in presentations. We need more "reality."
- I liked the name tags with locations and without official titles. Seems to empower the classroom teacher! When in group discussion, provide overhead/chalkboard/ large paper, etc. (computer and LCD panel!), so ideas can be viewed by group as ideas occur——ie, visualization of brain storming to provide list in order to prioritize. Swift solution to difficult situation of having 2 discussions at one time— Way to go! Great conference! Good representation from all groups. [typed as written]
- Thank you for inviting me to participate in this working conference. Your presenters were very informative and the atmosphere was friendly. I was inspired by many of the participants. Keep fighting for this type of conference. The impact will be powerful.
- Now, the dissemination of these great ideas begins! Where do we go from here? Don't let it die! How about a social hour at the end of each day?
- Well run, on-time, thought provoking, enriching. Super people. Thank you! The diversity was most appreciated.
- Excellent conference—much more than I expected in the way of gaining from each other.

- Greg is Great!!! Excellent Coordinator

- Emily Young, LA I sincerely appreciate the opportunity to be a part of such a worthwhile group. I am developing a book on activities for these (people) disabilities. I was delighted to find out everything I've done so far can be supported!

- This subject should be addressed. Every student is entitled to opportunities that will enable them to become successful in the real world.

- I've realized that our methods of teaching science have changed. It was stated that there is a lack of disabled people in the field of science. That seems to me to be directly related to the fact that science used to be taught by the "read the book" method. Our special students often need remediation in the area of reading and it was felt that they could go for their individual reading lessons during science instruction—If they could read they would be able to catch up because our science was reading—This is no longer appropriate today because science is an active, hands on, process oriented subject. We will be seeing my disabled people in the science field in the future.

- Thank you!

- I appreciate the opportunity to have participated in this conference.

- I now know what I want to do my doctorate studies in. "The Educational Effects of Total Inclusion of Behaviorally Disabled Individuals on Non-Disabled Students."

- Obviously I would like to see the mentally impaired population as involved as those covered in this convention workshop. Also, perhaps A, B, C, D groups need to get together a few times. We didn't see too much of the whole group (3 days?). Discussion groups most important. Presenters were excellent—well informed, well prepared.

- Thanks to all for a wonderful conference and I did learn so much! * Maybe next conference—make a contract with each participant to do an in-service in their state, local area with same format having disabled students work with teachers.

- Motor Disabilities presentation was good!

- Overall this was well organized and was a worthwhile use of time.

- Excellent conference but the time frames were too short. Could use 3 days for this amount of information.

- We should look at California's Middle School Unit and provide at our next conference buses that will take participants to schools that are models of science classes that incorporate students with disabilities! We can learn so much by seeing such a class in action. Middle School Unit does that in exploring middle schools.

- Thank you for giving me the opportunity to attend, to learn, and to make new friends. Also, thank you for the copy of the proceedings of the conference held last year in K.C., and for the attentive and thoughtful telephone calls prior to the conference.

- I could have used more ideas to implement in my classroom. The ACS & AAAS have excellent lit. and I was impressed. The "barrier free" curriculum looked great. I loved the exposure to people from across the U.S. and the diversity of people represented.

- Thank you very much. Very worthwhile.

- It has been a very valuable 2 days.

- Very helpful!

- This was one of the most productive conferences I have ever attended. I will be talking about it for a long time. I will also be implementing some of the ideas which I picked up here.

- I have learned a lot. Although I am primarily interested in the motor-impaired the information I gained about the other disabilities will be very useful in the future. I intend to expand my investigations of educating gifted disabled student at all age levels and hope to initiate a specific program for these individuals in my local area. [typed as written]

- *Visually*—good activities. Excellent having one person blindfolded. It is important for all students to be taught through all senses. *Hard of Hearing*—I do not like to be taught as if I am a young child. I like to explore activities as an adult then relate this back to the classroom. It was beneficial to hear Harry Lang speak. I would have liked to hear his personal story as it related to his school life. Harry explained what Hearing Impaired Children miss through hot having hearing experiences (feelings, and concepts). This will helped me have better understanding. *Learning Disabilities* —Dana is an excellent presenter. He inspired me! More time what be great! Very enjoyable and I learned a lot from the other educators. Standards—I do not learn well from a facilitator who reads from overheads. I tuned out! [types as written]

- *Lang probably needs to use microphone routinely. **The "Special Ed" people seem to be getting serious criticism from science people. Is it their "fault"? Are they victims of the political system? Would be a useful subsection for presentation/analysis.

- Perhaps a team of a special education teacher and a regular science teacher should attend as a team.

- To Greg and other developers of workshop—*thanks* and continued energy to maintain this initiative.

- I like the structure of the program this year.

- Thank you for this opportunity. I would like to work with you to "pay back" your investment in me by producing workshop, l/s, & etc. to disseminate. [No name on paper.]

- Good conference!

- Thanks for allowing me to participate in this conference. It was/will be most beneficial to me.

- Thank you for an excellent conference. You have planted a seed which surely will grow and spread the message of good science instruction for *all* students. I'll keep you posted on how it goes at my school & I'll pass along any good ideas I come across. Thanks, again. Fred Ortiz.

- Maybe a group of science educators could attend a special ed conference or vice versa. I think the videotape would be super. It could be a tool for awareness and also a spark for a local teacher or group. I think the group process this year was great. The guide sheets were extremely helpful to keep us on task. Thanks for the checks so fast!

- Perhaps a large scale make and take format might be valuable. This was a fine conference—thank you for all your work in providing us with this opportunity to share, learn, and improve.

- Thanks so much for an excellent meeting.

- It was great having tables to use during presentations but their layout was *not* well suited for small group discussions. Great Groceries during breaks. Any transparencies use should have "hard copies" in packets or provided at the end of sessions. Some confusion as to length of Model Lesson segments. LD group thought they had an hour for presentation/lesson and another hour for discussion. It felt very rushed which was frustrating. (They did handle it fairly well, though.) Notebooks, booklet and hand-outs—really great and well organized/thought out.

- A great conference.

- The general consensus was that we all know where the problems lie. How do we reach out to the teaching population across the nation to disseminate ideas about teaching disabled children—mainstream and special ed—with science education that has worked and can work for them. (Broad Teacher Training/Networking of methods, ideas, lesson plans, etc.) I really enjoyed the hands-on workshops and feeling out new ideas. A lot of teachers seemed unaware of getting Special Education committees to advocate for their students. This is an important part of student advocacy and perhaps should be addressed. We have to get the message out on what we've discussed and learned...through networking, dissemination of information (computer, teacher workshops etc.). Thank you for this wonderful opportunity.

- This is a difficult task, and this conference is a big step forward. I appreciate the opportunity of participating.

- I learned a lot. If you have one next year, please invite me back. (no name on paper)

- Excellent—thanks for all the hard work, Greg and Virginia. Include next time a general round table introduction of each participant and their role.

- I hope you/we can act on the ideas generated. I look forward to working with *you* in the future. I also think you need, if you aren't, to identify through this process a group of individuals to participate in an e-mail think tank. I have many more ideas... J. Guyton (over) Need to invite NRC to join us in and learn from us. I get the idea they desire to pass the buck instead of addressing the issue....I hope I am wrong.

- At times there seemed to be an agenda in place—almost like ideas were already decided on. I think some of the ideas decided in groups were very important. Teacher training is vital in the success of change in the classroom.

- (Thanks for a busy two days.) Have students with various disabilities attend and provide demos with these students or find videotaping of students with disabilities and use in presentations. We need more "reality."

- I liked the name tags with locations and without official titles. Seems to empower the classroom teacher! When in group discussion, provide overhead/chalkboard/ large paper, etc. (computer and LCD panel!), so ideas can be viewed by group as ideas occur——ie, visualization of brain storming to provide list in order to prioritize. Swift solution to difficult situation of having 2 discussions at one time— Way to go! Great conference! Good representation from all groups. [typed as written]

- Thank you for inviting me to participate in this working conference. Your presenters were very informative and the atmosphere was friendly. I was inspired by many of the participants. Keep fighting for this type of conference. The impact will be powerful.

- Now, the dissemination of these great ideas begins! Where do we go from here? Don't let it die! How about a social hour at the end of each day?

- Well run, on-time, thought provoking, enriching. Super people. Thank you! The diversity was most appreciated.

- Excellent conference—much more than I expected in the way of gaining from each other.

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

ERIC®

# REPRODUCTION RELEASE

(Specific Document)

EC305055

## I. DOCUMENT IDENTIFICATION:

Title: Improving Science Instruction for Students with Disabilities: Proceedings, Working Conference on Science for Persons with Disabilities

Author(s): Stefanich, G. (Dir.), Egelston-Dodd, J. (Ed.) (1995)

Corporate Source: Cedar Falls, IA: University of Northern Iowa

Publication Date: 1995

## II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following two options and sign at the bottom of the page.

☒ Check here **For Level 1 Release:** Permitting reproduction in microfiche (4" x 6" film) or other ERIC archival media (e.g., electronic or optical) *and* paper copy.

The sample sticker shown below will be affixed to all **Level 1** documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

**Level 1**

The sample sticker shown below will be affixed to all **Level 2** documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

**Level 2**

☐ Check here **For Level 2 Release:** Permitting reproduction in microfiche (4" x 6" film) or other ERIC archival media (e.g., electronic or optical), but *not* in paper copy.

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

*"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."*

**Sign here→ please**

Signature: Greg P. Stefanich

Printed Name/Position/Title: Greg P. Stefanich, Professor

Organization/Address: SEC 618, University of Northern Iowa, Cedar Falls, IA 50614

Telephone: (319) 273-2167

FAX: (319) 273-6997

E-Mail Address: stefanich@uni.edu

Date: 09/06/96

## III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, *or*, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:

Address:

Price:

## IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:

Address:

## V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

ERIC CLEARINGHOUSE ON DISABILITIES
AND GIFTED EDUCATION
THE COUNCIL FOR EXCEPTIONAL CHILDREN
1920 ASSOCIATION DRIVE
RESTON, VIRGINIA 22091-1589

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

**ERIC Processing and Reference Facility**
**1301 Piccard Drive, Suite 100**
**Rockville, Maryland 20850-4305**

**Telephone: 301-258-5500**
**FAX: 301-948-3695**
**Toll Free: 800-799-3742**
**e-mail: ericfac@inet.ed.gov**