National Aeronautics and Space Administration

Space Science Is for Everyone:
Creating and Using Accessible Resources in Educational Settings

LESSONS FROM THE FIELD

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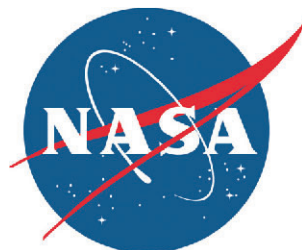College of Charleston

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FOREWORD

By Robert Shelton
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My epiphany regarding the realities of education in science and math for kids with disabilities came in the fall of 2001 during a visit to a residential school for the blind when I was confronted by an unpleasant reality that I had not considered before. The students were bright and motivated, and the staff members were doing the best they could with the resources available to them, but when the school counselor informed me that she didn't think that attending college was even a remote dream for these kids, it flew in the face of my 40 years of experience as a blind person who had been offered—and subsequently accepted—numerous opportunities to pursue a career as a research mathematician. Over the following months and years, it dawned on me that most children with exceptional needs were being shunted away from the science and math courses that would provide them with the tools necessary to compete in the modern world.

Two years later, while working on a tool for accessible mathematics, our Learning Technologies team at the Johnson Space Center was introduced to Cass Runyon of the Southeast Regional Clearinghouse (SERCH) and the Exceptional Needs workshop. Here was a group of people who weren't only talking about full access to science. They were bringing educators together with NASA scientists to address situations that required adaptation for persons with disabilities. The challenges were great, but the creative energy devoted to overcoming them was greater. In case after case, we found that adapting hands-on science for kids with disabilities didn't dumb down the content, but instead enhanced the scientific experience for all learners by focusing on concepts as opposed to peripheral mechanics. In the case of our own project, exposure to educators and other NASA developers served to widen both our perspective and work focus so that at the end of the day our product was a more realistic one that hit the broadest possible audience and found applications that otherwise would have never been considered. Educators and developers worked together to zero in on the science and devise alternate means of presentation and interaction. In so doing, they created educational products that work better for everyone.

We have travelled a very great distance in the last six years. The message of the Exceptionals Space Science Materials for Exceptional Needs workshop (ENWS)—that science is an intellectual activity that can be pursued independent of physical abilities—has spread through schools, colleges, and advocacy organizations. There have always been scientists with physical disabilities, but overcoming the "kid with an issue" syndrome still remains a challenge. The intended legacy of both this project and group is to gain universal acceptance for the wisdom that providing every child with the educational opportunities to fully utilize their capabilities benefits not only the child, but society as a whole.

Part of being scientists involves readjusting our notions of what is possible. This book is a primer on how to start the ongoing process of improving expectations and outcomes to meet the challenges of tomorrow.

MARTHA THE MOTH

By Sarah Lyles Long
Fifth grade student, Whitesides Elementary, Mt. Pleasant, South Carolina
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Once there was a caterpillar named Martha. She was an ordinary, homely caterpillar with colors of gray and tan, like a dead fallen leaf. Caterpillars around her all had bright, glowing colors, like a new rainbow. The other caterpillars would tease Martha, calling her names like "ugly bug" and "caterpoop." One handsome caterpillar named Butch was particularly cruel. "Hey Martha," he'd yell, "you're so ugly, you'd even make a stink bug sick."

Martha thought to herself, "I can't wait until the day I become a beautiful butterfly." Finally, the time came when Martha excitedly wrapped herself in a cocoon, dreaming of the day she'd emerge with glorious wings. However, one day Martha did appear with wings, and her dream turned into a nightmare. Martha's metamorphosis hadn't resulted in a butterfly. Instead, Martha was a dusty gray moth. To add to her misery, Butch had emerged near her with wings of splendor. As the two creatures clung to a tree trunk, Butch continued his bullying. "Look! Martha's a moth! She's still ugly! Loser!" Martha was devastated.

Suddenly, a dark shadow covered the tree trunk and a great whooshing sound rushed by as a huge black crow plucked Butch right out of the tree. Martha's tears of sorrow turned to tears of joy as she realized that her dull appearance had saved her life. From then on, Martha was no longer ashamed of her plainness, and she outlived all the other caterpillars who had teased her.

The End

INTRODUCTION

As an educator or parent, have you ever found yourself in a situation in which you were working with a person with disabilities and the material or curricula you were using was not accessible? If so, you are not alone. Understanding the disability type and the necessary adaptations or accommodations for your students are only part of creating a successful outcome. Another component involves designing fun activities to match the content while engaging the learner. Integrating into the curriculum resource(s), universal design, and universal instructional design promotes accessibility in the learning arena.[1] Universal design is "a framework for integrating flexible, usable, and accessible teaching and learning technologies with inquiry- and standards-based" science, technology, engineering, and mathematics (STEM) curricula. This technique promotes the use of learner-centered technologies, which "supports multiple learning modalities, including visual, auditory, kinesthetic, and tactile," as well as accessible field experiences.[2]

Over the past seven years, SERCH convened seven highly successful "Exceptional Space Science Materials for Exceptional Students" Workshops. The Workshop offered professional development training and resources for the teachers of students with disabilities, science educators (both formal and informal), and product developers who are working to make Earth and space science concepts more accessible for persons with disabilities. The purpose of SERCH is to

Nearly one-fifth (19.3%) of the U.S. population age 5 years or older—just under 50 million people—has some form of disability.[3] Over 6.5 million of these persons with disabilities (PWD) are children eligible for elementary or second-ary education.[4]

- familiarize educators of exceptional students with the wide variety of standards-based space science educational support materials available from NASA

- familiarize developers of NASA Science Mission Directorate (SMD) education materials with the diversity of exceptional classroom and audience needs

- evaluate several popular classroom materials from the different NASA SMD themes for use in exceptional education settings

- build a communication and support network of exceptional educators and NASA mission-related personnel

I am reminded of a childhood experience. When I was a little girl my father planted a row of peanuts beside my swingset. My little sister and I spent hours, days even, watching the peanut vines grow. We surveyed the plants and discussed their non-productivity as the peanut vines bloomed without any peanuts on them. Then one day my father silently pulled up the peanut vines, and clinging to the roots were so many peanuts. The awe and wonder I felt when I saw the peanuts! What a lesson he taught as he turned to his children and said, "Neither life nor people are ever as they seem. Don't just look at the surface but at the root. That is where you will find the answers. You must search for the peanuts. You'll never know what you may find."

SERCH—the awe, the wonder! You are definitely "PEANUTS"!

—Nancy Wooten, Workshop participant

The Workshop focused its efforts on several disabilities, the definitions of which are included below.

Deaf/Hard of Hearing (D/HH): This term indicates the loss of the ability to hear, ranging from a mild to severe functional loss of hearing to total deafness. Solutions involve alternate methods of accessing auditory information and communication through speech including hearing aids, assistive listening devices, visual systems, audio loops, captioning, American Sign Language (ASL), or a combination of these methods.[5]

Blind/Visually Impaired (B/VI): This term indicates the loss of the ability to see, ranging from a mild to severe functional loss of vision to total blindness. Solutions involve alternate methods of accessing text, graphics, and the Internet, as well as those for observing environmental changes such as braille, tactile graphics, large print, electronic visual aids, auditory formats, or a combination of these methods.[5]

Orthopedically Impaired (OI): This disability affects movement, ranging from gross motor skills such as walking, to fine motor movement involving manipulation of objects by hand.[5] The Disabilities, Opportunities, Internetworking, and Technology (DO-IT) program uses the term "Mobility Impaired" when referring to individuals with this disability.

Learning Disabilities (LD): A neurological disorder, LD results in difficulty with input and/or output processing of information, leading to a large discrepancy between intelligence and achievement. There are many specific forms of LD, including visual perceptual, auditory perceptual, integration, and language and motor disabilities. Though Attention Deficit/Hyperactivity Disorder can occur concurrently with LD, these are not the same disorders.[5,24]

Attention Deficit Disorder (ADD)/Attention Deficit Hyperactivity Disorder (ADHD): These are complex behavioral and neurobiochemical disorders that affect one's ability to attend and concentrate due to inappropriate levels of inattention, hyperactivity, and impulsivity.[5]

Autistic Spectrum Disorders (ASD): Autism is a bio-neurological developmental disability that generally appears before the age of three and impacts the normal development of the brain in the areas of social interaction, communication skills, and cognitive function. Individuals with autism typically have difficulties in verbal and non-verbal communication, social interactions, and leisure or play activities.[6] ASD are also known as Pervasive Developmental Disorders. These disorders range from a severe form known as autistic disorder, through pervasive development disorder not otherwise specified (PDD-NOS), to a much milder form known as Asperger syndrome.[37]

Based on the seven workshops, the expertise of the participants, and product testing in classrooms around the Nation following these workshops, we offer this guidebook—or collection of helpful hints and resources—as a tool for STEM educators who are working with persons and students with disabilities. Some activity descriptions are supplemented with case study examples addressing a particular disability. In addition, contributing educator-authors provided a variety of lessons learned from formal education (PreK–12), homeschool education, and informal or "free-choice" education (science centers, museums, and planetariums) learning venues.

EDUCATORS:

Many of you may feel a bit anxious when a person with a disability enters your classroom, facility, special event, or program. Even so, it is important to extend respect in this situation as your attitude and actions will be the model for their peers and the public to follow. If you are in a classroom setting, it is critical that you take the time to read the student's Individualized Educational Program (IEP) or 504 Plan. In these documents, you will discover the student's methods of communication, which should guide your interactions with the student.

This section on etiquette is not all-inclusive. Rather, it will highlight some of the more universal and important issues of etiquette. A few Web sites will follow where you can obtain more indepth information.

General Tips for Interacting with Persons with Disabilities

- First and foremost, people with disabilities deserve to be treated with dignity and respect.

- People with disabilities are individuals with different personalities, different preferences about how to do things, and different effects from their disability. To find out a person's preference, ask.

- Because you cannot see a disability does not mean that it doesn't exist. Many disabilities are not readily apparent.

- Speak directly to the person with a disability rather than to an assistant, attendant, or sign language interpreter who may be accompanying him or her.

- When referring to people with disabilities, put the person first. He is a person who is blind; she is a person who is learning disabled.

- If you wish to assist the person with a disability, ask how you can help before you act and then follow their instructions. Don't be embarrassed or offended if they decline your assistance.

- A service animal is a working animal; therefore, avoid distracting, petting, or feeding it. Doing so may compromise its responsibility to the person.

- For classroom educators planning field trips, let the venue know ahead of time that you have a student with a disability. Since many facilities can accommodate students with disabilities in their programs, advance notice and pre-planning may help to avoid embarrassing situations, leading to a successful field trip experience for all.

- Be alert to the possible existence of architectural barriers or environmental hazards in places or areas a person with a disability may want to enter.

- If you use electronic presentations as part of your program, be willing and prepared to share your presentation in hard copy and other alternate formats.

- Classroom tasks, events, and programs change constantly. Keep the lines of communication open.

Learning Disabilities

- When communicating, be thorough, direct, and specific. Ask questions to ensure the student understands. Allow adequate time for a response.

- Give frequent and constructive feedback.

- Allow adequate time to learn certain skills.

- Whenever possible, notify the person of changes well in advance.

Sensory Disabilities (Vision and/or Hearing Impairments)

People who are visually impaired have individual variances for accessing text depending on the nature and severity of their vision loss. Those with residual vision also are affected by lighting and other environmental factors. For instance, one person may need increased lighting while another may be functionally blind with too much lighting.

People who are Deaf use ASL and often identify with the Deaf Community. People who have a profound hearing loss or are hard of hearing may not know ASL, instead communicating through a variety of assistive listening devices.

Blind and Visually Impaired

- Address the person by using their name and giving yours.

- Be explicit with your directions and avoid place referent pronouns. For example, rather than saying, "Watch this," say, "Watch what happens when the ball is rolled down the 30-degree incline."

- Excuse yourself when you are leaving the company of a person who is visually impaired so that he or she is not left speaking to no one.

Deaf and Hard of Hearing

- When in doubt about the person's communication preference, ask.

- Gain the person's attention before speaking.

- Shouting or exaggerating your speech does not improve communication.

- Rephrasing rather than repeating yourself is a more effective way to ensure that your message is understood.

Matthew was a second-grade student who was deaf, gifted, had severe ADHD and a conduct disorder—and was cute as a button. He was a true challenge to all ... It took me several months, but I did learn that dealing with his behavior took my "letting go" and trusting him to do what was needed ... He learned that he could cooperate, while I learned that it wasn't necessary to keep tight controls on such students.

*—Adair Teller
Workshop participant*

Orthopedically Impaired

- If a person uses crutches, a walker, a cane, or another form of assistive equipment, offer assistance with coats, bags, or other belongings.

- Some people with paraplegia, quadriplegia, or other disabilities may have difficulty writing or holding a pen. Although you should not assume so, the individual may want or need your assistance in with tasks. In order to ascertain the situation, ask how you can best assist him or her.

- When conversing with a person who uses a wheelchair or scooter, position yourself so that you are at eye level in front of the person. It is permissible to sit or crouch down.

- Think of the wheelchair as an extension of the person's individual space. Do not lean or hang on a person's wheelchair or scooter, or use the conveyance to carry your belongings.

- People with mobility impairments have a broad spectrum of physical capabilities. When in doubt, ask.

Attention Deficit Disorder/Attention Deficit Hyperactivity Disorder

- Communicate in direct, clear terms. Be patient, specific, and consistent. Apply structure whenever possible in communication and work tasks.

- Clearly state expectations, policies, and procedures.

- Ask clarifying questions throughout the conversation to ensure that the person understands. Repetition may be necessary.

Autistic Spectrum

- Remember that the person may have difficulty making eye contact and interpreting nonverbal cues, such as facial expression, gestures, and tone of voice in social settings. Direct, specific, and clear communication is important.

- Behaviors exhibited by those with autism include sensitivity to touch, sounds, light, or color; focusing or fixating on particular objects or topics of discussion; quietly talking to himself or herself frequently throughout the day; and social awkwardness or shyness.

Speech and Communication Disabilities

- If the person's speech is difficult to understand, do not hesitate to ask him or her to repeat what was said. Never pretend to understand when you do not.

- If a person chooses to communicate using assistive technology, such as an augmentative communication device. be patient with the speed of the technology. Though not generally done, some individuals may not mind having his or her sentences finished by you in order to ease communication. However, it is imperative to confirm this is acceptable before doing so.

What is Assistive Technology, or AT?

For many people with disabilities, AT allows access to formal and informal educational programs. They may enter your classroom or facility with devices as simple as alternative writing tools or special software programs to more sophisticated computerized devices.

As a classroom educator, you don't have to become an expert on a student's AT, but you do have to become familiar enough with it to include it in the student's educational experience. It is critical that you take the time to read the student's IEP or 504 Plan. In the IEP, you will discover the student's best method for presentation of materials, special programming, accommodations, and AT devices. Different than the IEP, the 504 plan will delineate the accommodations and modifications needed to access the regular curriculum.

As an informal venue educator, your task may be a bit more perplexing since persons with disabilities often just show up on your doorstep. You can prepare yourself for the possibility of a person with a disability entering your program by learning about accommodations and, more specifically, universal design for learning. For example, make your handouts and signs available in large print for those visitors who may be visually impaired, a best practice that will also benefit senior citizens who attend your program or event. In general, when scheduling programs, a good rule of thumb is to ask if any special accommodations are needed.

Many educators may be intimidated by AT, but there are many available resources to provide you with assistance. Usually the student is your best resource, providing a great deal of insight about how to use AT and informing you of his or her proficiency on AT. In addition, you can meet with an AT specialist, other related service providers, or the student's parents to find out the purpose of the AT. Every state has some sort of AT resource program that has been funded under the Assistive Technology Act of 1998. For a state contact list, visit *http://www.resna.org/taproject/at/statecontacts.html.*

Remember, AT may be the student's greatest instrument for working independently and achieving success in the classroom or informal learning environment. Becoming an advocate of the student's AT is going to translate into positive outcomes for both you and your student.

TIPS FROM THE TRENCHES: PARENT & EDUCATOR TESTED AND APPROVED

What is Universal Design?

Universal Design of Learning (UDL) provides a "framework for integrating flexible, usable, and accessible teaching and learning technologies with inquiry- and standards-based" STEM curricula. This idea promotes the use of learner-centered technologies, which "support multiple learning modalities, including visual, auditory, kinesthetic, and tactile," as well as accessible field experiences. UDL does not single out any one learner as needing accommodations that differ from the rest of the students.

The Alliance for Access to Science, Technology, Engineering, and Mathematics at DO-IT has defined the following eight methods for incorporating UDL principles when developing educational resources:[7]

Inclusiveness. *Adopt practices that reflect high values with respect to both diversity and inclusiveness.* Many students cannot or will not artiulcate their needs. UDL should use methods that make learning easy and accessible for everyone. For example, on your syllabus, invite students to meet with you to discuss disability-related accommodations and other special learning needs.

Physical Access. *Ensure that activities, materials, and equipment are physically accessible to and usable by all students. Furthermore, the safety considerations of all potential student characteristics should be addressed.* Examples of this method include developing safety procedures for all students, including those who are blind, deaf, or wheelchair users; labeling safety equipment simply, in large print, and in a location viewable from a variety of angles; and repeating printed directions orally.

Delivery Methods. *Use multiple accessible instructional methods.* Use a variety of modes to deliver content, motivate, and engage students, such as lectures, collaborative learning options, hands-on activities, Internet-based communications, educational software, field work, etc. Keep in mind the four basic learning styles: auditory (students who learn best by hearing), visual (students who learn best by seeing), tactile (students who learn best by touching), and kinesthetic (students who learn best by activity and movement).

Information Resources. *Ensure that course materials, notes, and other information resources are flexible and accessible to all students.* For example, choose printed materials and prepare a syllabus early. This will give students the option of beginning to read materials and work on assignments before the class begins, as well as allowing them adequate time to arrange for alternate formats, such as books on tape.

> *"According to some researchers, students who do well in school tend to be the ones that learn either by listening or by reading. The focus on these two senses, especially at the high school level, tends to play havoc with the tactile and kinesthetic learners. Because so much of what happens in classrooms is focused on the auditory and visual modes, students who prefer tactile and kinesthetic modes are actually handicapped."*
>
> —Jack Hassard[8]

Interaction. *Encourage effective interactions between students and the instructor. Ensure that communication methods are accessible to all participants.* Assign group work for which learners must support one another and that places a high value on different skills and roles.

Feedback. *Provide specific feedback on a regular basis.* For example, allow students to get feedback on large projects by turning in parts of it before the final is due.

Assessment. *Regularly assess student progress using many accessible methods and tools, then adjust instruction accordingly.* An example would be assesing group/cooperative performance as well as individual achievement.

Accommodation. *Plan for accommodations for students for whom the instructional design does not meet their needs.* For example, know how to get materials in alternate formats, reschedule classroom locations, and arrange for other accommodations for students with disabilities.

UDL: Best Practices

Depending on familiarity with the subject matter, educators may feel overwhelmed by the large amount of available NASA data, or they may feel there is not enough time to incorporate a meaningful experience into their existing classroom structure or curriculum. Therefore, in order to ensure for broader access and use among educators, Workshop participants worked directly with NASA developers to incorporate UDL strategies into the development of educational products. In doing so, participants have developed a list of best practices for the various disability types.

Workshop participants also encouraged NASA product developers to incorporate UDL approaches and strategies in the development of STEM educational materials. These products promote a more inclusive and effective approach of STEM for all learners, not just those with disabilities.

UDL and Learning Disabilities

Educators, through the methods and materials they use in classrooms or free-choice learning environments, either enhance student opportunities to learn or present barriers to student understanding. Inclusionary classrooms present a particularly challenging environment for even the most seasoned science educators because of the wide diversity in student abilities, modes of learning, and successful educational experiences. With this in mind, Workshop participants developed a protocol of best practices for students with learning disabilities. What follows is not an exhaustive list, nor will each strategy be used with every student.

Teach to the four learning styles. These styles are kinesthetic, auditory, tactile, visual. Studies show that student achievement increases when students receive instruction in their preferred learning style.[9]

Teach to strengths. A constructivist perspective necessitates that student engagement in the learning process is essential if they are to succeed in science, especially with the current atmosphere of standards and accountability. Therefore, use the natural abilities and talents of your students as a foundation for learning. Recognize their skills. Emphasize what students can do rather than what they cannot do—which improves self-esteem and enhances learning opportunities—and provide instructional content based on student interests.

Provide multiple forms of assessment. Assess student knowledge and conceptual understanding by using alternative assessments as well as appropriate traditional testing methods in order to gather a complete picture of the abilities of students with learning disabilities.

Alternative assessment tools include, but are not limited to:
- notebooks, diaries, journals
- portfolios
- drawings
- oral questioning
- concept maps
- projects and performance tasks
- posters
- educator observation
- student self-reflections
- dioramas
- anecdotal notes

When implementing formal assessments as appropriate, consider the following guidelines:
- Increase time and decrease the number of questions.
- Adjust reading level to student ability.
- Decrease the number of choices on multiple-choice questions.
- Provide word banks for short-answer questions.
- Encourage educator collaboration/team teaching.

Collaboration requires that educators work together to develop instructional practices that are favorable for all students in the class. Collaboration is likely to be influenced by the grade level and the culture of the institution.[10]

When I think of "special needs," I think of students who do not learn in our traditional model of schooling, but need a form of instruction suited to their individual needs. In other words, if a student isn't learning, is it because of a deficiency in the student or in the methods and models of instruction? Learning is best facilitated when teachers focus on student strengths rather than their weaknesses.

—Julia Olsen Workshop Participant

Strategies

Specific strategies that have been shown to be especially successful for students with learning disabilities include:

- **Chunking:** Through chunking, content is reduced to simple elements. These components are then integrated and students engaged in tasks that will require them to apply and generalize.

- **Previewing, cueing, prompting:** Students with LD tend to have problems with short-term and working memory. Address this situation by placing emphasis on important details and ensuring that students have the prior knowledge and prerequisite skills to understand and make connections with new material.

- **Use of technology:** Computerized modules anchor instruction by allowing students to revisit problem situations and gain meaningful understanding of the topic they are learning.

- **Peer-to-peer collaboration**

- **"Ticket out the door":** Make students responsible for self-evaluating their learning ("One thing I learned today was…"), either for the day and/or by asking a question that can be addressed during the next class period.

- **Use of essential questions:** Essential questions guide student inquiry and lead to higher order thinking.

- **Vocabulary building and use:** Examples of this include foldables.

- **Know-Want-Learn (KWL):** Identify what students know, what they want to know, and what they have learned.

- **Scaffolding:** Model the desired learning strategy, then let the students take responsibility.

- **Mixed ability groups:** Pair non-impaired with impaired learners, mix together different types of learners (tactile, kinesthetic, visual, and auditory), or match up different levels of ability.

- **Graphics organizers and study guides:** Advance organizers, visual displays that graphically depict lessons, and study guides all highlight critical content information so student learning can be reinforced through different media.

- **Note-taking strategies**

Teaching to All Students

Student anxiety decreases when clear opportunities for success exist. The research literature shows that, given the right learning environment, many students with disabilities could perform at a cognitively higher level than reading scores would initially indicate.[11] Strategies for creating such an environment include emphasizing reading skills, teaching higher order thinking skills, re-teaching content using a variety of approaches, ensuring that all students are participating, and creating an effective connection for all students.[12]

Since many students have difficulty distinguishing between relevant and irrelevant information, cueing, prompting, and directing student attention focuses cognitive resources on the most relevant material. Giving students time to rehearse and elaborate on new information and providing them with opportunities to practice material under different conditions and with different tasks helps promote comprehension and the transfer of learning.

A major issue in education centers is how best to provide an equal and excellent education to all students. The current national emphasis on explicitly specified educational standards and high-stakes testing places a tremendous amount of responsibility on both educators and administrators to ensure that all students achieve at the same high levels. The resulting tension between equality and excellence may torque the unease many educators feel regarding inclusion. However, opportunities for success for children with learning disabilities also enhance the opportunities for success among all students. For example, middle school philosophy, which focuses educational practice on the unique needs of early adolescents, advocates the following general framework for education: assuring relevance in curriculum to the outside world, maintaining intellectual depth and authentic purpose, and utilizing student physical energy and need for social contact as positive qualities for learning rather than regarding them as liabilities. Unfortunately, simply adopting educational standards for all students does not automatically ensure acceptable academic achievement for diverse students. Inclusionary students, in particular, often see little relationship between the science they are exposed to in schools and that of their own lives, despite the fact that science and technology deeply affect nearly every area of society. Therefore, using teaching methods that both promote sound educational philosophy and incorporate specific strategies and adaptations for students with disabilities will be beneficial to all students.

CASE #1
Space Weather Action Center (SWAC) | Sun-Earth Connection Education Forum

http://sunearthday.nasa.gov/swac[13]

Audience: The primary target audience is focused on grade levels 5–8. However, the program can easily be adapted to grade levels 9–12.

Imagine being able to monitor the progress of an entire solar storm from the time it erupts from our Sun to its eventual sweep past our small planet, which affects enormous changes in our magnetic field.

Through the Space Weather Action Center program, students can quickly learn how to create easy-to-make space weather learning centers in the classroom to monitor and report the progress of a solar storm. SWAC establishes sustainable student information resource centers with up-to-date online information based on current and archived NASA data. Above all, SWAC serves as a comfortable introduction to space weather that is both fun and easy to use.

SWAC students embark on their journey tracking a solar storm by following some simple step-by-step directions on how to collect and analyze data from current space weather resources. Those resources are divided into four topic areas that direct students to collect data that will answer the following questions:

- **Sunspot Regions:** Do sunspot regions exist today that could be a source of solar storms?

- **Storm Signals:** Have radio signals been recorded today due to a flare or coronal mass ejection (CME) that could affect Earth?

- **Magnetosphere:** Has there been a measurable disturbance in the Earth's magnetic field?

- **Auroras:** Have auroras been seen within the last 24 hours due to a solar storm?

As students interact with the data and content in each section, they will complete

- journal entries that document their exploration and results

- group data collection sheets for their SWAC station

- news reports in order to share their finding with the class

The SWAC approach is specifically designed to address educator concerns by introducing users to space weather concepts through the use of a familiar and very common classroom teaching strategy: the development of a classroom-based learning center. These learning centers, constructed out of available classroom materials, are generally placed in easily accessible sections of classrooms offering students a separate space to revisit topics of interest or reinforce selected skills. As an educational hook, learning centers tend to focus on exciting themes and ideas ranging from ancient cultures to solar system exploration. Each new SWAC learning center will provide exciting inquiry-based learning experiences while encouraging students to investigate NASA's cutting-edge science.

The SWAC approach takes the learning center concept to a new level by requiring each center to be constructed around one computer with an Internet connection, transforming each learning center into an up-to-date information hub providing instant access to current and archived NASA data.

By following a few basic steps, end-users can quickly transfer all data and information to specified data collection sheets. All of the newly acquired NASA data is then transformed into regularly scheduled news reports that can ultimately be presented through a variety of accessible media, including inexpensive video editing software and/or already existing school-based broadcast studios. As an additional part of the learning experience, students are also encouraged to design action centers with readily available art supplies and downloadable

NASA imagery. This artistic approach instills a sense of student ownership and establishes NASA as both a scientific and visual point of interest in the classroom environment.

Is the data difficult to understand? Simply put, no. The design of the SWAC program introduces users to the basic steps, data links, and tutorials needed that will enable them to monitor the progress of a solar storm and evaluate its impact on Earth's magnetic field.

Swac Adaptations for Persons Who Have Learning Disabilities

In one case study, an educator reported that 100 percent of SWAC student teams reached the endpoint of individual oral classroom presentations, a prelude to the multimedia broadcast that was successful in numerous technology-rich environments. However, under conditions of limited technology resources, presentations are a more reasonable outcome toward which to work. Even then, a key modification that made this achievement possible required adding additional layers of supervised and monitored student engagement with the material. That is, in classes with many presentations made by students with multiple learning disabilities, success required that these students were first directed to

- employ directed reading of study guides for use with SWAC tutorials (modification #1)

- work in collaborative learning teams that conducted research within the content area and studied for a formal assessment (modification #2)

- use mixed-ability learning groups to practice collecting, interpreting, and reporting data (modification #3)

In classrooms with large numbers of students with learning disabilities, prior experience with the SWAC activity suggests that multiple layers of facilitated engagement are necessary to ensure that students are not faced with the challenge of interpreting data and communicating results before they are ready to do so.

Multiple layers of facilitated engagement afford all students—not just those with LD — greater opportunity to fully connect with the material, thereby reducing the possibility that some students will be left behind. Furthermore, formal assessments and communications practice within mixed-ability groups give students exposure at the depth necessary to synthesize reports out of meaningful understanding. Most important, unprepared students cannot get lost by parroting back conspicuous catch phrases that maintain the illusion of full participation.

For a myriad of reasons, any student can have an off day and require additional time to absorb material. More important, a wide range of students with disabilities are accommodated by being given additional time for authentic engagement, synthesis, and practice. If classroom management is carefully constructed, those faster-moving students can use the additional time afforded to students with LD for opportunities to provide team leadership, co-teaching, and explore extensions provided to the gifted & talented.

Taken together, the most universally adapted presentation of the learning options emphasizes

- student choice

- the discovery and leveraging of individual student strengths

- an intermediate pause in which students are given the opportunity to declare the mission accomplished by their completion of a task uniquely suited to their strengths

- celebrating victory and inviting students with learning disabilities (and other disabilities) to engage the standard elements of the lesson in an ongoing quest to develop their expertise by building on the strengths just demonstrated

- tasking a specialty team of tech-gifted students to produce stock footage of the most common space weather conditions. With this resource in place, the entire class of space meteorologists are given opportunities to make predictions from data on different days and, as needed, select the appropriate stock footage to run in the school's morning Intranet Webcast

Becky Knaub was born blind, never witnessing a starry night sky or even the Moon rising over the horizon. Becky learned the constellations as did the rest of the class by using her tactile planisphere of the night sky. When it came time for the highly touted and competitive shootout, Dr. Hurd doubted whether Becky could make it through one or two rounds. Finally, it came down to two students and one of them was Becky! After several rounds back and forth, Becky dealt the final blow by correctly finding an object that the other student could not find in the allotted time!... It is moments like these that make the extra time involved to make sure all students are included in learning all worth it!

—David Hurd
Workshop Participant

Blind/Visually Impaired

Many materials that one might use to accommodate students who are B/VI are already available in the classroom. Take a moment and think about how you verbally describe what is going on in your classroom, whether it be assignments, graphs and charts, notes, or even discipline issues. Accurate and detailed descriptions are paramount for helping all learners, including those who are B/VI. For example, if you show a picture of a planet, provide a rich verbal description to help auditory learners better comprehend the material. Approach this as if drawing a word picture of something invisible to the naked eye, such as an atom. Encourage your students to apply this method to those concepts that are visible. Another technique is to have everyone put their heads down on the desk then describe something in the room. Can all your students find the object when you have finished? What did you leave out that might have helped?

Effective accomodations include using a large font size and one that is easy to read, like Arial, Verdana, and Tahoma for your next lesson plan. Keep in mind that not all visual impairments are alike, and different visual impairments need different adaptations. Consult parents and specialists to assess each student's personal and specific needs. You may also want to make your entire class aware of the the courtesy rules for those with the different disabilities

and the fact that every case is different (concerning the individuality of all students). A small session on orientation and mobility for the students is often helpful.

Consider using materials and objects with which you can make tactile graphic representations of pictures or diagrams to facilitate the learning of your students. The quickest way to make a tactile graphic is to use simple things like string, glue, wikki sticks, puff-paint, and different textures (e.g., sandpaper, felt, Styrofoam). One thing that every educator should have in his or her desk is a tracing wheel such as those used by seamstresses. These allow an image or diagram to be easily traced with the wheel in order to make a simple and cheap raised graphic. Tips for using a tracing wheel include:

- Simplify the drawing as much as possible.

- First trace the diagram with a marker and then turn the sheet over before using the tracing wheel. That way, when it is turned back over on to the correct side, the "bumps" will be protruding up from the paper, and the graphs and charts will be oriented correctly.

- Use the thickest paper available.

For more complex tactiles, nearby universities or resource centers for the blind and visually impaired will have a thermoform machine to make masters that "mold" the graphic onto plastic paper. This is ideal for long-term use and is reproducible.

Three-dimensional models of objects are ideal for science. The models need not be elaborate, but rather just representations of the desired concept. The key here is that the students have to get their hands on it, get actively involved, and explore the model themselves through their sense of touch.

Look online for books, publications, and other tactile graphics that have been printed in Braille and produced professionally. The American Printing House for the Blind (APH) is a good resource, along with universities and other institutions that work with students who are blind.

Your students are often your best resource when allowed to devise and develop the best practices for their learning needs. Also, their peers can serve as advocates to their learning when paired up or put on a team in which all members are participants and treated equally.

Remember that many B/VI students use AT to access information, and therefore are often best qualified in using it. If they do not have ready access to AT, or are not able to use it efficiently, then it is time to contact their parents.

Below are some Web sites that offer more information regarding current assistive technologies.

JAWS
http://www.freedomscientific.com/fs_products/software_jaws.asp [14]

Math Trax
http://prime.jsc.nasa.gov/mathtrax/ [15]

NASA Xsonify
http://spdf.gsfc.nasa.gov/research/sonification/sonification_software.html [16]

Earth+
http://prime.jsc.nasa.gov/earthplus/ [17]

CASE #2
Active Astronomy | The Origins Education Forum

Audience: Middle school physical science and high school physics and astronomy students.

While most students are familiar with the rainbow of colors that make up visible light, they often have little understanding of the light from the other portions of the electromagnetic spectrum—gamma rays, x-rays, ultraviolet light, visible light, infrared light, microwaves, and radio waves. Students may not realize the important role played by non-visible light in their everyday lives. For example, TV remote controls, car-locking systems, and some grocery store check-out scanners use infrared light to signal between devices or read barcodes. Computers use infrared light to read CD-ROMs. Night vision goggles register infrared light (also known as heat radiation), as do search-and-rescue monitors that look for the heat given off by someone lost in the wilderness at night. The Active Astronomy kit is intended to supplement lessons on light electromagnetic radiation; it is not a stand-alone curriculum.

The four activities in the Active Astronomy classroom kit compare and contrast properties of near-infrared radiation to visible light. The larger context is the electromagnetic spectrum—the types of radiation including light that give us almost all the information we have about the rest of the universe beyond Earth. The Active Astronomy kit is intended primarily for use as an educator kit to support demonstrations by the instructor for the students but may also be set up and used as an inquiry-based lab for small groups. The four activities dynamically demonstrate

- the idea of different bands of radiation within the spectrum
- detection of visible and infrared light
- that infrared light bounces off a mirror like visible light
- that infrared light can be used to convey information from one location to another

Each activity guides the students through the following inquiry steps to explore light and the spectrum:

- View markings of various colors on paper of different colors through three light filters (gels); make predictions of what will be seen; and compare predictions with actual outcomes.
- Construct a detector circuit and project spectrum on screen using holographic grating to detect both visible and invisible light.
- Use an infrared light source (e.g., TV remote control unit), a visible light source (e.g., a flashlight), and the detector circuit to show that both types of radiation bounce off a mirror.
- Construct a transmitter circuit and connect to a CD player to show that the detector circuit receives the signal from the player across an air gap.

Upon completion of the four activities, students should gain an understanding that there are both visible and invisible light, that there are commonalities and differences between them, and that there are methods of detection for both types of light.

ACTIVE ASTRONOMY ADAPTATIONS FOR PERSONS WHO ARE BLIND/VISUALLY IMPAIRED

General Suggestions

- Provide Braille and tactile materials and equipment, such as paper and a tracing wheel.
- Have a variety of different textured materials on hand — such as sandpapers, corrugated cardboard, and felt — to represent the different parts of the spectrum in a tactile model.
- Modify materials for students with low vision.
- Provide handouts with modifications of all overheads.

Understanding waves and wavelengths

- Use a Slinky (or long spring) to demonstrate wave motion and wave form. Stretch the Slinky and begin pumping it up and down to create a vertical wave. Position the Slinky so that the troughs hit the floor and students are able to hear the frequency of the troughs as they hit the floor. Have students place their hands at the crests so that they feel the frequency of crests.

- Have prepared tactile image of a wave; use a tracing wheel to create a three-dimensional outline or raised impression of the wave.

- Ask students to make tactile images after completing the activity.

- Ask students to verbally describe the wave motion—the location and variation of the troughs and peaks.

- Provide a handout with modifications of all overheads.

Understanding the spectrum

- Show APH tactile of prism diffracting light.

- Allow students to preview the spectrum and equipment before class.

- In a darkened room, project spectrum onto white cloth; use a photocell detector or a student as equipment (e.g., a student serves as a color analyzer and tells the class the color he/she detects).

- Use a color analyzer to detect colors.

- Mark where different colors of the visible spectrum begin and end.

Understanding infrared light

- Explain that infrared is invisible to everyone, and that we only know infrared exists because we detect it using methods other than sight.

- Use different wattages of light bulbs (or heating and cooling pads) to simulate progression of energy across visible and infrared spectrum.

"*I have learned that a Hard of Hearing person nods their head and says "uh-huh" a lot, but that does not mean they understood you at all. They guess at what they have heard. It is hard to constantly ask people to repeat things. A child especially doesn't want to do that, so they will just fake it and pretend they have heard you. I have learned to speak slowly and clearly and have the person face me when I talk so my lips can be read visually. I have also learned that most adults do not know these things and move rapidly through life, not realizing that others do not always understand them.*"

—Nan Vollette, Workshop Participant

Deaf/Hard of Hearing

Because there is a continuum of severity of D/HH from mild to complete hearing loss, every child will require modifications and adaptations unique to their situation and particular educational needs. While not an exhaustive list of best practices, here are strategies that have been successfully used in classroom instruction and free-choice learning environments by educators and researchers who are participants in this project.

Principles for interactions

- Maintain face-to-face interactions and eye contact.

- Focus your articulation, diction, and verbal clarity for those students who read lips.

- Be aware of what is communicated through body language, hand gestures, and facial expressions.

- Make strategic seating assingments to minimize visual distractions, thereby allowing the student to focus on the educator and/or interpreter.

Utilize resources

- Specialists

  * Educators of the Deaf and Hard of Hearing within the school and local district

  * Schools for the Deaf within the state

  * Members of the Deaf Community

  * State and local agencies for the Deaf and Hard of Hearing

- Web sites
  * Gallaudet University
    http://clerccenter.gallaudet.edu/literacy/about/practices.html [19]

  * Dr. Harry Lang
    http://www.rit.edu/~comets/teachingemphced.htm [20]

Instruction

- Collaborate with the ASL interpreter, the educator for the Deaf, and the Deaf student.

- Deaf students should learn and use the ASL vocabulary of scientific terms.

- Teach to the four learning styles. Studies show that student achievement increases when students receive instruction in their preferred learning style. [9]

- Use educational technology, including captioning, ASL videos, and the Internet.

- Share educator notes with your students before beginning instruction.

- Use environmental cueing.

These modifications have a proven track record of effectiveness. Without them, Deaf and Hard of Hearing students will have little or no access to the general curriculum.

Some strategies are more beneficial than others, depending on the needs of the individual students. Due to the abstractness of STEM fields, developments in new strategies and technologies for instruction are ongoing, and it is incumbent on educators to provide the best opportunities possible for all students.

STANDARDS:

AAAS benchmarks 6–8:

The Sun is a medium-sized star located near the edge of a disk-shaped galaxy of stars.

The universe contains many billions of galaxies, and each galaxy contains many billions of stars.

The Sun is many thousands of times closer to the Earth than any other star. Light from the Sun takes a few minutes to reach the Earth, but light from the next nearest star takes a few years to arrive.

CASE #3
2-Inch Universe | Structure & Evolution of the Universe

http://www.cfa.harvard.edu/seuforum/learningresources.htm [21]

Audience: The activity was designed for a broad audience, including grade levels 6–12 classroom use, informal (museum) educators, and for educator professional development.

The Incredible 2-Inch Universe is designed to give a sense of size and scale of space, as well as to inform a hierarchical structure: solar system, galaxy, universe. Without this map, much of the more esoteric and exciting ideas in astronomy—black holes, the expanding universe, extra-solar planets — lose their context, particularly in regards to their inter-relationships. Concepts of size and scale become especially confusing at the boundary of the solar system; in student surveys, over 50 percent of students thought that Pluto was further than the stars, and a similar number of students were unclear as to the distinction between the terms "galaxy" and "universe." (Survey of 7,500 students in 37 States, grades 5–12, Harvard-Smithsonian study, pre-publication)

In this scaling activity, a 2-inch diameter disk is used to represent four realms—the Earth and Moon, Sun, solar system, and galaxies—and, in turn, provide a sense of distance between the planetary bodies. For example, in the "Realm of Our Sun," a 2-inch diameter pop-out is illustrated with an image of the Sun. Other objects are related to the Sun, such as the size and distance of the Earth, the distance to Pluto, and travel time of light between the planets. It has been found that all groups of learners have difficulty with scale changes, so where possible, the jump between realms should be made very clear-cut with closer ties brought to the previous scale realm. If possible, each scale realm may be better treated in different sessions with linking discussion.

This is a facilitator-lead activity whereby the audience is introduced to a scale model of the universe. At each scale realm, the audience is asked to predict or estimate the separation of the astronomical bodies in question based on the 2-inch diameter prototype (e.g., the distance of a scale Earth from a 2-inch diameter Sun). The facilitator can lead a discussion on the estimated separation distances, perhaps to gain a consensus. The scientifically accepted separation can be revealed or calculated, which can lead to an open-ended discussion on ideas such as size, scale, and the astronomical determination of distance.

The desired outcome is that students gain a better understanding for the hierarchical structure of the cosmos and vastness of space. In this way, the activity can be used to set the scene for discussions of more complex concepts, such as the locations of black holes, the search for extra-solar planets, and the expansion of the universe. The activity can also be used as a pre- and post-assessment on student understanding of size and scale, and how their internalized model of the structure of the universe has been modified by the lesson or workshop.

2-Inch Universe Adaptations for Persons who are Deaf/Hard of Hearing

When a classroom consists of students who are deaf, inclusion in the learning process enhances everyone's experience. Indeed, many hearing students are fascinated with sign language and welcome exposure to this form of communication.

Student participation can also involve, on a deeper level, both the hearing as well as the D/HH. Again, use of UDL within the classroom aids everyone's learning and expands a student's understanding of the way that learning occurs. So, for example, cut-outs of the 2-inch Universe can be embossed for a more tactile model.

Hard of hearing (HH) students, on the other hand, often fall between the education cracks because there may be no outer appearances of a disability. Hearing varies with tone and quality of sound. Depending on the reason for the hearing loss, students may, for example, suffer a severe loss of high tones and only a moderate loss of low tones. As speech tones vary according to the letter (consonants tending towards higher tones), a person can miss a letter in a word or part of a word, thus completely misunderstanding the meaning of the sentence. In a classroom, normal noises—paper shuffling, students whispering or chatting, bells ringing, or doors closing or opening—can create a barrier for the HH student. Heading outside isn't a good solution because sound travels with the wind and so may not make its way to that student's ears.

Because of such difficulties, the educator will need to pay sharp attention to how D/HH students communicate. Just as ASL is a body language, D/HH students tend to pay close attention to faces when they are listening. Clear diction is essential when communicating and getting the attention of a D/HH student.

A classroom may contain a student who is HH, but the educator, as well as the student, may not even realize it. Similar challenges face the ADHD student. Both HH and ADHD students learn more easily when material is offered in smaller pieces. This is one reason why UDL works for everyone.

In using UDL, the educator could present the program orally to the class and then have the entire class (hearing and D/HH) view the ASL video (*http://www.cofc.edu/LowcountryHall/accessible/matmods/modifications.htm*). This provides an opportunity to bring the Deaf culture into the classroom. Class discussion can be not only the 2-Inch Universe presentation, but also how ASL expresses thoughts and ideas through the use of hands and body.

It is vital to remember that ASL is a complete and autonomous language that uses most of the body to convey its message. Students in the Deaf Community who are learning both ASL and English often struggle with the written word as there is no written form of ASL. Also, it is important for us to remember that, for ASL speakers, English is not their first language. Use of print material is not always productive for this population.

In the action photos below and when watching the ASL video referenced above, note the use of body language and how the speaker talks slowly and looks at the camera so that viewers can read lips.

Photo by: Bruce Denis

Orthopedically Impaired

From 2000–2007, both formal and informal educators, along with product developers and NASA scientists, came together during the ENWS workshops to discuss strategies to improve orthopedically impaired student participation in science activities. Through orthopedic simulations, NASA educational materials were tested by participant teams. Below are the suggested modifications and improvements provdied by each team.

- **Learning Environment**

  * Display images and materials at proper levels.

  * Adjust classroom/learning environment so that it is devoid of obstacles.

  * Make materials portable.

- **Communication/presentation styles**

  * Integrate pictures and symbols.

  * Utilize assistive technologies.

- **Instruction**

  * Ensure that actiles and other hands-on manipulatives are conducive to students' range of motion, abilities, etc.

* Accommodate the four styles of learning (visual, kinesthetic, audio, and tactile).

* Adapt workloads.

* Assign durable, hands-on products.

* Use assistive technologies.

- **Other accommodations:**

  * Avoid confusion and frustration by chunking and frequent monitored breaks.

  * Make use of student aid and peer-to-peer interaction.

These suggested modifications will enhance the educational experience by allowing the orthopedically impaired child to become more engaged in the learning process, thus increasing their chances of success. Furthermore, a more accessible classroom environment will ensure their safety during the learning process.

All students benefit from activities that engage the whole child. Even though modifications were suggested for students with orthopedic impairments, activities that accommodate all student needs and learning styles will enhance the overall success for all learners.

CASE #4
Sense(s) of Scale | Solar System Exploration Education Forum

http://www.cofc.edu/LowcountryHall/accessible/matmods/SolarSystem100yd.pdf [22]
http://www.cofc.edu/LowcountryHall/accessible/matmods/ssbead.pdf [23]

Audience: These activities were designed for a broad audience, including grade levels 6–12 classroom use, informal (museum) educators, and for educator professional development. While each activity can be used for all ages and grades, adjustments may need to be made depending on the level of the learners.

As the forum title implies, Solar System Exploration Education is committed to providing learners a better understanding of our local area in space: our solar system. Sense(s) of Scale is a set of activities for helping learners get their minds around the vast distances in space, which can lead to discussions about space travel and solve the inherent problems that arise when working with scale models that combine size and distance. The learner should come away from any of these scale models with a better understanding of the relative distances among the planets and the Sun and each other, the order of the planets from the Sun, and the fact that the Earth is just one of many planets. Students should also gain the knowledge of how to design and/or create a model that conveys this information.

Although many models have been used in conjunction with the Sense(s) of Scale unit, here we are focusing on two that serve similar purposes and address similar standards of learning. They are the "Solar System on a String" and the "100-Yard Solar System" (most schools have a football field or practice field where they can carry out this demonstration) activities. Both of these will highlight the relative distances of the planets from the Sun and reveal the remarkable distances among the planets, how close the four inner planets are to each other and to the Sun,

and how far away the outer planets are from each other and from the Sun (it should be noted for these activities that Pluto is referred to as a planet).

100-Yard Solar System

Imagine shrinking our Sun down to the size of a nickel. In comparison, the planets would be specks of dust with Jupiter being about the size of a BB.

This activity is best done outside and, if available, on a football or practice field. The students march off the distances. A roller tape for measuring distance is ideal for this activity. A selected student holds the nickel and represents the Sun. If on a football field, this student would stand on one goal line. Other students are then posted at each planet distance and are assigned numbers that represent increasing distance from the Sun (e.g., 1 = Mercury, 2 = Venus, 3 = Earth, 4 = Mars, etc.). Students are asked to remember their assigned number so they can sound off their planet when called. For example, if 4 is called, then the student who was assigned this number will call out "Mars." Calling off the numbers randomly helps them understand (audibly) the distances. It is also impressive to pause at 6—Saturn — and note that it takes

about seven months to go from 3 (student calls out "Earth") to 4 (student calls out "Mars"), and about seven years to go from 3 (student calls out "Earth") to 6 (student calls out "Saturn"). This gives both a visual and audible representation of the distances in our solar system.

Solar System on a String

Whereas the 100-yard Solar System activity is educator-directed, the Solar System on a String activity asks students to construct their solar system model using the string, beads, and relative distances to the Sun given in astronomical units (AU). The suggested scale used is 1 AU = 10 centimeters. Therefore, the distance for Earth is 1 AU with a scale value of 10 centimeters, and the distance for Mars is 1.5 AU with a scale value of 15 centimeters.

> **STANDARDS:**
>
> National and State standards drive much of our teaching. With that in mind, both of these activities were specifically built around three standards. Although they meet others (even in areas such as language development), these three are very important to help students better understand these standards. In addition, we purposely picked a standard from all three levels spanning grades K–12, including Mathematics Standard 14 (uses the design process to solve problems), grades 9–12 Benchmark 7 (understands the process of creating a scale model); Science Standard 3 (understands the composition and structure of the universe and the Earth's place in it); grades 3–5 Benchmark 2 (knows that the Earth is one of several planets that orbit the Sun); Science Standard 10 (understands forces and motion); and grades K–2 Benchmark 3 (knows that the position of an object can be described by locating it relative to another object or the background).

Sense(s) of Scale Adaptations for Persons Who Are Orthopedically Impaired

Let's look at some modifications you might use when conducting these activities with students who have mobility impairments.

100-Yard Solar System

- Allow a peer to walk alongside a student in a wheelchair or accompany a student who has an irregular gait and in order to help them count the steps (perhaps sequential counting is on their IEP).

- You or the student could measure and pre-mark where the different planets will be and they can find the designated location.

- Someone in a manual wheelchair may want to count the pushes involved to get from one planet to another. Remember, it's not necessarily the accuracy but rather the concept—the four inner planets are much closer to each other and the Sun than the outer planets are to each other and the Sun—that is the focus.

- If you are concerned with accuracy, or you want a more challenging math adaptation, then you could turn the wheelchair into an accurate measuring device or odometer

by measuring the distance covered by a portion of one wheel revolution and equating that with an astronomical unit (AU = distance from the Sun to the Earth). For example, if 0.5 of a revolution comes out to be about 7.5 feet, then 0.5 of a revolution will equal 1 AU. Therefore, using our key above, 2.5 revolutions should equate to 5 AU or just over 37 feet, which would be about the distance to Jupiter.

- Those students who are unstable or may have limited endurance can serve as the inner planets.

- Students in motorized wheelchairs could shout out the name of the planet as they go by it. Everyone will hear that it's a long time between those last planets.

Of course, this activity can be changed slightly to address the fact that planets are not really in a straight line while still being appropriate for the orthopedically impaired student. Do this by putting your Sun student in the middle and giving precut lengths of string to the students. Have the student-planets then walk away from the Sun in random directions, until the distance is such that the string is tight.

SOLAR SYSTEM ON A STRING

- Use pom poms or large beads and string with twist ties or pipe cleaners to keep the beads in place.

- Use marked clothespins.

- Use different (contrasting) colored rope, yarn, or string between the planets so the distances can be easily seen and calculated.

- Use a calculator and a peer to scribe for those students who have trouble holding a pencil.

The modifications suggested are not exhaustive, but they do allow the student with orthopedic issues to be an active participant rather than a passive onlooker. You may think of other modifications that will benefit other learners, such as allowing the student that "bounces off the walls" to run the full 100 yards while the planets call out their name when he or she passes by them.

Attention Deficit Disorder / Attention Deficit Hyperactivity Disorder

If you are exposed to children in any way, especially as an educator, you are familiar with the terms Attention Deficit Disorder and Attention Deficit Hyperactivity Disorder and their affects on behavior and education. According to most resources, ADD/ADHD affects about 5 percent of all children and 3 percent of all adults in the United States. Most educators will probably feel that this figure is low. If one takes into account children and adults who don't personally have ADD/ADHD but are in some way impacted by the disorder, the percentage is much higher. For example, a poorly behaved child who disrupts the entire class takes the teacher's time away from other students. Many parents and educators are resistant to the use of medications to treat ADD/ADHD because of the many side effects the medicines can cause.

ADD and ADHD are diagnostic labels given to children and adults who have demonstrated significant problems in the following four main areas of their lives:

- inattention

- impulsivity

- hyperactivity

- boredom

Adaptations for ADD/ADHD

Most students with ADD/ADHD are helped by supports or changes known as adaptations.

Children with ADD/ADHD need consistent rules that they can easily follow. When a child follows the rules, they should be praised for positive behavior.[25]

Have you ever been working on something important when a song pops into your head? Then that leads you to think of something else, like flying, which leads to play with your remote control glider? Next thing you know, it's dinner time and you haven't finished the homework you started two hours before. That's what its like to have Attention Deficit Disorder. I know because I've had ADD for as long as I can remember. For me, ADD means that I can't focus at times when I really need to. It's something I will live with for the rest of my life. And it's no fun!

—Jack, a sixth-grade student with ADD[24]

Tips for Parents:

- Create a schedule. Make sure your child has the same routine every day. The schedule should include homework time and playtime. Post this schedule in a prominent place in the home.

- Help your child organize everyday items. Work with your child to have a place for everything. This includes clothing, backpacks, and school supplies.

- Work with your child's teachers in developing an effective educational plan.

Tips for Educators:

- Learn more about ADD/ADHD. The resources and organizations at the end of this guidebook will help you identify behavior support strategies and effective ways to work with the student.

- Figure out what specific things are hard for the student. For example, one student with ADD/ADHD may have trouble starting a task, while another may have trouble ending one task and starting the next. Each student has different needs.

- Post rules, schedules, and assignments. Clearly stated rules and routines will help a student with ADD/ADHD. Follow set times for specific tasks. Call attention to changes in the schedule.

- Show the student how to use an assignment book and a daily schedule. Also teach study skills and learning strategies, and reinforce these regularly. Ask parents to reinforce and follow up with an assignment book, schedule, and homework.

- Help the student channel his or her physical activity (e.g., let the student do some work at the board, standing up, sitting, or laying on the floor; create rhythmic movement opportunities, such as standing and clapping out the syllables while reviewing vocabulary words; provide special cushions that allow for controlled wiggling in the chair). Use visual, tactile, and kinesthetic activities whenever possible. Provide regularly scheduled breaks.

- Give step-by-step directions, and be sure that the student is following the directions. Give instructions both verbally and in writing. Many students with ADD/ADHD also benefit from doing the steps as separate tasks.

- Work together with the student's parents to create and implement educational strategies tailored to meet the student's needs. Regularly exchange information about how the student is doing at home and at school.

- Have students do work on the computer.

- Hold high expectations for the student, but be willing to try new ways of doing things. Be patient. This will aximize the student's chances for success.[24]

- Students with ADD/ADHD may also require support for controlling impulsive behaviors. This may involve verbal reminders from the educator, picture cues of the target behavior, or paraprofessional support, especially during daily transitions.

Educators with students who have ADD/ADHD will likely find themselves adapting their teaching methods. They may also find that the changes made to accommodate their students with ADD/ADHD also helps the other students in the classroom learn more effectively.

Autism Spectrum

Students with autism spectrum disorders have a wide range of abilities and needs. Students with autism may also have specific areas of expertise that can be helpful to other students in their classes. Students with autism may be twice exceptional—that is, both autistic and gifted. They might also be both autistic and cognitively impaired. There seems to be no exact cause or cure for autism spectrum disorders.

According to the State Department of South Carolina and National Parent Advocacy, the diagnosis of autism has risen 500 percent just in this past year. This is making a huge impact on the educational field. The question is, "Are there really many more children with autism, or are they just being diagnosed earlier?" The answer is probably a little bit of both coupled with the fact that the educational system is now recognizing and attempting to service students on the whole spectrum of autism, which accounts for many more students. Teacher education in this field cannot keep up with the demands to provide appropriate, scientifically based educational programs. More than ever before, the average educator is feeling overwhelmed by the number of students who have a huge range of needs.

An area that may be of concern is that of the relationship of these learners to sensory stimulation—either low tolerance to noise, smells, sticky textures, or physical movement; or seeking stimulation by touching or moving. An occupational therapist knowledgeable about sensory integration disorder can offer helpful adaptations for sensory differences.

Students with autism generally have some degree of language impairment. Without explicit teaching, they may not understand the meaning of words and phrases indicating position (e.g., "between," "next to," or "in front of") or how to use social language. They may be able to read yet unable to understand what they have read (hyperlexia). Some students with autism do not speak at all, but rely on augmentative and alternative communication (AAC). Because of the language impairments and the differences in sensory needs, many children with autism have behavioral concerns as well. Often anxiety disorder, auditory processing disorder, and ADD are connected with autism. Some students may also have strong food aversions that, combined with their sensory differences, make meal times in large cafeterias a challenge.

As a beginning step to establishing the necessary accommodations for an autistic student, an inventory must be taken of specific likes, dislikes, and situations that may be too much to handle. Begin by having the student communicate what the best possible day and the worst possible day would look like for him or her. Using this information, staff members can specially adapt certain situations for the student. Students with autism often do well with a very predictable structure in which they are given advance notice of any changes. Written or picture schedules and various picture supports that depict modeled behavior may help with controlling anxiety and other behaviors. Indeed, some with autism think in pictures and will therefore respond well to picture supports even if they can read.

Tips for Educators:

- Most autistic children are visual learners. They respond well to visual daily schedules, as well as pictures coupled with print to reinforce daily rules.

- They need consistent visual clues to complete transitions from subject to subject, one area of the classroom to another, or one class to another.

I could open doors only if I did so creatively and innovatively. As time went on, students began to be diagnosed with autism. Although they were the same students, with the diagnosis came new methodologies and treatments. It required me to have an open mind and be willing to rethink what I was doing—again and again and again.

—Adair Teller Workshop Participant

- Many are overly sensitive to noise, so music may have an agitating rather than calming effect.

- Social skills need to be taught.

- Autistic individuals often think in concrete rather than metaphorical terms. Therefore, say, "Don't touch him," rather than, "Keep your hands to yourself." Say, "Be quiet," rather than, "Button your lip."

- As with all disabilities, AT should be considered for students with autism and/or auditory processing disorder.

LESSONS LEARNED

Through the Workshop experiences, collaborations between participants, and actual use of the Workshop outcomes in a variety of venues—from formal PreK–14 to homeschool to informal environments—we offer the following insights into proven accommodations in a given venue.

Formal Setting

A formal setting is defined as any classroom in any school district consisting of students, educators, staff members, and administration. Accommodations found to be effective for the student with disabilities in all classrooms include the following:

- **Preferential Seating**

  Preferential seating is effective not only for hearing impaired, but also for ADD/ADHD students and students needing special assistance and/or modifications with their work. Educators can redirect ADD/ADHD students back on task when they are in close proximity. Strategically organizing the classroom for a hearing impaired student enhances the ability and success of the student and the use of AT.

- **Preview Material**

  Students with disabilities benefit from being able to have materials such as vocabulary lists previewed in advance of being introduced in class. This helps promote both learning and self-confidence during classroom discussion, group work, and activities.

- **Small-Group Instruction**

  Small-group instruction supports both direct instruction and one-on-one instruction. Small groups can also be configured to teach to the students' strengths.

- **Graphic Organizers**

  Use graphic organizers such as KWL charts, concept maps, and word walls to preview and organize material.

- **Co-Teaching Model**

  The co-teaching model in a formal setting involves the special educator and the regular educator working as equals to assist all students, sometimes in a small-group setting.

- **Collaborative Pairs**

  Students who feel more comfortable with a peer helping them on a task are more apt to participate when working with a partner, asking their peer a question before asking the educator. Also, the pairs have a tendency to learn from each other such that, ideally, their differences can be instuctive.

Homeschool Environments

Teacher ratios, as well as acoustics in the classroom, are only a few of the problems that exist for a student with disabilities. Students with disabilities struggle with self-esteem, boredom, and isolation, which often results in behavior problems. Therefore, more and more families are opting for the home environment in order to meet the needs of these students. Dr. Steven Duvall, director of the School Psychology Training Program at Fort Hays State University in Kansas, compared the academic engaged time (AET) and basic skill development of students with learning disabilities who were home educated to those in public school special education programs. Higher rates of AET and greater academic gains were made by the home educated.[26]

This kind of research supports the home environment as the ideal location for a more one-on-one learning experience. Dr. Duvall states in his summary of his 1994 study: "Results of this study indicate that parents, even though they are not certified teachers, can create instructional environments at home that assist students with learning disabilities to improve their academic skills. This study clearly shows that home schooling is beneficial for special needs students."[27]

In his 1992 study, Dr. Larry Shyers, psychotherapist and Chairman of the Florida Board of Clinical Social Work, Marriage and Family Therapy, and Mental Health Counseling, showed that there were significantly lower behavior problems when students with learning disabilities were more actively engaged. With vision and hearing problems, as well as orthopedically challenged students, this engagement time is reflected in the kinds of accommodations provided to them. When comparisons are made between home taught students and those in the public/private sector, studies have revealed that academic engagement is key to their success.[28]

While not the goal of this document nor of the Workshop participants to evaluate one location for education versus another, parents' experiences as well as current research tends to show that productive learning takes place with a smaller teacher/student ratio in combination with accommodations for the challenges many students face. The adaptations reflected in the outcomes of the Workshop team will benefit the homeschool population by encouraging the application of UDL concepts.

Informal or Free-Choice Learning Environments

Informal, or free-choice, learning environments (science centers, museums, and planetariums) play an important role in educating the public about the world in which they live by using non-traditional teaching methods. Formal education settings (such as public, private, and homeschool environments) provide the basic framework from which science knowledge can be built. Informal learning environments provide experiences beyond the traditional classroom to foster an understanding of the applications of science to our everyday lives.

Most individuals spend more years as informal learners of science. If science education ended with formal schooling, many people would be unaware of new scientific research (advances in medicines and cures for disease), environmental issues (endangered species and ozone depletion), and new technologies (space exploration to the Moon and beyond). Overall, informal settings provide opportunities for the public to enhance prior knowledge of science and discover the interconnections among science, technology, and society.

Because of the importance of these settings to science education for all learners, many of the ENWS participants have been directors and/or educators of

free-choice learning environments. These participants have tested and used the following techniques at their home institutions to ensure that their science centers, museums, and/or planetariums are accessible and useable by all audiences.

EXHIBIT DESIGN

From ENWS workshops, ongoing discussions, and direct implementation of accessible practices, the following six recommendations for exhibit design were identified as practices that would enhance all children's perception of their world:

- Develop exhibits based on different learning modalities.

- Consider the use of UDL when creating new exhibits. For example, develop displays that are at standard heights and not protruding from the walls. (See UDL Practices.)

- Use well-described, picture-based explanations in conjunction with written explanations for persons who are B/VI.

- Provide tactile, interactive displays to explain concepts.

- Develop multi-sensory displays and interactive, hands-on exhibits.

- Offer assistive devices at no charge.

Keep in mind that, beginning with the first conception of a new exhibit, all modifications should be discussed and planned thoroughly. These modifications then become an integral component of the display rather than an addition or afterthought to it. When implementing UDL practices from the beginning of design, all participants—both those who have disabilities and those who do not—will benefit from these accommodations.

Workshop participants from the informal community have found that increasing the accessibility of their exhibits increases admissions to their learning environments. Furthermore, visitors who are immersed in interactive exhibits tend to better retain the information acquired during their free-choice learning experience.

VENUE PERSONNEL

Within the free-choice learning environment, receptionists, visitor services, and education specialists are often the first to make contact with their guests. Because informal education professionals are instrumental in making the initial experience welcoming and in providing devices designed to enhance the museum experience, they should be trained on the needs of persons with disabilities. Quality resources that offer ways to welcome, accommodate, and interact with visitors with various disabilities may be found at the Association of Science-Technology Center's (ASTC).[29]

EXAMPLE OF UNIVERSAL DESIGN

Cosmic Questions, a NASA/National Science Foundation (NSF) exhibit developed by the Harvard-Smithsonian Center for Astrophysics, widely employs multisensory exhibit components, thereby promoting the use of learner centered technologies and support multiple learning modalities. For example, the "Cosmic Kitchen" station describes the early universe through visual imagery coupled with rich auditory dialogue and sound effects. Both the dialogue and sound effects are closed captioned, and a tactile galaxy model is tagged with auditory labels. Development of docent activities on size and scale for the Cosmic Questions exhibit ultimately led to the development of the Incredible 2 inch Universe activity described in this guide.

Furthermore, when hosting educational programs at your free-choice learning environment, refer to the "Tips from the Trenches" section of this document to ensure that your presentations and activities are suited for all audiences.

Educational Toolkits

Inspired by the products demonstrated at ENWS, one informal venue created educational toolkits for NASA education guides, including that of Exploring the Moon, Active Astronomy, and Stardust. The toolkits contain the materials needed to complete the set of activities given in each of these guides. To enhance their usability by all audiences, the toolkits were modified based on suggestions offered at ENWS. These toolkits then became an easy, fully contained resource available to educators (not limited to but including public, private, and home-school educators).

In the case of the Active Astronomy guide, which focuses on detecting infrared light, the toolkit now encourages educators to emphasize the fact that no one can see infrared light, regardless of their vision. Therefore, when using the activities within the kit, educators should refer to wavelengths by their numerical value and not just the color. For example, educators should explicitly say that the red color we see in the visible spectrum has a wavelength of approximately 650nm and infrared light has a wavelength of 750nm, which is too long to be seen with the human eye.

The Free-Choice Learning Environment Under the microscope

In planning for educational learning experiences in free-choice learning environments, it is important to create a multi-sensory experience related to the various contexts in which people learn. The Contextual Model of Learning theory examines the concept of a total museum experience as one that involves personal, social, and physical interaction among visitors. These combined interactions establish a framework to understand learning in free-choice environments.[31]

Strategies

The goal of science centers and museums is to plan and design learning environments that accommodate the physical context of all visitors while supporting personal and social interactions with museum exhibits and programs. For this reason, discussions were hosted to determine how free-choice learning environments could embrace the contexts of learning for visitors with disabilities. From these discussions came the following strategy recommendations for accommodating various learning contexts.

Personal Context

Because studies have shown that visitors experience greater conceptual growth if they are educationally motivated or entertained, the challenge for educators lies in developing educational tools that will stimulate and engage all visitors in free-choice learning environments. Visitors arrive with various expectations, learning styles, and abilities; furthermore, they bring their prior knowledge and experiences that can influence their construction of knowledge.[32] Some strategies that accomodate such a wide swath of personal backgrounds include:

- Develop pre- and post-activities.

- Perform front-end/formative evaluations to ensure the exhibit's relevance to the audience.

- Ensure programs and activities are grade/ability appropriate by creating flexible programs that can be adapted by educators and docents.

- Conduct home educator workshops that address how to adapt materials.

- Institute educator/docent training programs that provide instruction on serving varied audiences.

- Provide lab activities that utilize simple materials and procedures.

Inclusion and diversity is the impetus for programs such as the Explainer program at the New York Hall of Science. The program has witnessed an increasing interest and response from applicants with disabilities. These individuals are employed in a variety of areas throughout the facility, from conducting demonstrations to designing recommendations. The implementation of projects that utilize persons with disabilities as ambassadors is an initial step to opening the door for inclusion within the free-choice learning environment.

—J. Radzilowicz [30]

Social Context

While the personal context defines the expectations and prior knowledge visitors bring with them to museums, the social context determines how visitors engage in learning within the free-choice learning environment. Here students are presented with opportunities to interact with both peers and adults so they may learn more as a result of these interactions than they may have on their own.[33] Studies have shown the important of giving students ownership of their learning experience during museum visits and allowing them to select their own area of investigation. Such open-ended experiences —as listed below —encourage reflection and give students personal incentives for learning.[34]

- Offer a variety of program types for visitors.

    * auditorium (can be intimidating)
    * classroom (a familiar setting that allows for hands-on activities and provides opportunities for students to ask questions and interact with their peers)
    * demonstrations (allows for individualized interactions)

- Facilitate peer interaction by designing exhibits to function as a team/group experience.

- Incorporate hands-on activities and audience participation into programs.

Physical Context

Our physical environment is one of the main factors that drive our daily lives. The choices we make about how we utilize our time are determined by factors such as the accessibility and familiarly of the activity being undertaken and the ambience of the facility in which the activity occurs. In the case of free-choice learning environments, the whole museum provides the enviornment, or physical context, in which learning occurs.

Research indicates that learning interferences occur due to the physical context of museums. Since museums are typically unfamiliar learning environments for students, they must be familiarized with the museum and steps must be taken to reduce distractions.[35] Therefore, prior to visiting the museum, it is important to orient teachers and students to the whole museum environment, which includes the facility, exhibits, and programs. Steps for doing so are included below.

- Make sure the arrangement of the program space accommodates all visitors.

- Have museum materials (maps, guides, etc.) available in various formats.

- Provide visitors with a detailed orientation upon arrival.

Further Information

The information contained within this section is not intended as the definitive guide on making free-choice learning environments accessible, and it does not cover the legal obligations of informal venues. We encourage you to visit the ASTC Web site[29] section on Accessible Practices where you will find their suggested process for making museums accessible, including resources such as access surveys for your institution.

PROGRAM SPIN-OFFS: EXAMPLES OF SUCCESS

Through Workshop experiences, participant collaborations, and a passion for making others aware of the accommodations available for persons with disabilities, a number of spin-off activities have been developed. Some of these activities are highlighted below.

Audio Voyage #1: Shuttle Mockup | Sun-Earth Connection Education Forum (SECEF)
Troy Cline

SPECIFICS: This is a podcast on the importance of space weather as it relates to our exploration of space

TARGET AUDIENCE: General public and grade level 6–12 students

With the podcast revolution taking a firm hold on the Internet community, SECEF decided it was time to join in the fun. We started developing podcasts in 2006 on the Sun-Earth Day Eclipse theme as a way to broaden our audience base. As new podcasts are made available, our users are notified automatically by their software, and the podcasts are downloaded for them to experience at their convenience. All of our podcasts can be found on the Sun-Earth Day (SED) home page, as well as in iTunes under "Sun-Earth Day."

One of our newest types of podcasts is called Audio Voyage. An audio voyage is a very descriptive tour of a chosen location complete with background sounds. To kick off the new series, we started with the Space Shuttle as a means to discuss the importance of space weather as it relates to our exploration of space. Below is the podcast description for our first Audio Voyage.

"Join me today as I climb into the middeck of a real Space Shuttle mockup at NASA's Johnson Space Flight Center in Houston, Texas. Accompanying us is Adam Flagan, a member of the technical maintenance, mechanical, and crew systems. Adam is also an instructor in the Space Shuttle program. For the next 18 minutes, Adam will walk us through a high-fidelity mockup of the Shuttle's crew compartment chamber and give us a quick peek into how today's astronauts are able to take care of their most basic human needs in space: food, clothing, and shelter."

The Sun-Earth Day podcasts target the general public. However, due to the influence of ENWS, we now include descriptive audio complete with transcripts.

Cynthia Hall from SERCH connected us to Jim Allan, the Webmaster & Statewide Technical Support Specialist Texas School for the Blind and Visually Impaired. Jim provided several pointers on how to give a descriptive audio tour complete with meaningful background sounds. The supporting SED podcast page includes several Shuttle diagrams for those listeners interested in following along. Future Audio Voyages will include content related to the SED theme, such as SEC mission launches, labs, tours of NASA clean rooms, and eclipse locations (i.e., audience reaction to the eclipse in Side, Turkey).

This experience has had a tremendous impact on our podcasting team, transforming the way we will be doing podcasts in the future. Our goal is to include one descriptive Audio Voyage each month and a new series of storytelling podcasts complete with background sounds and transcripts.

How very blessed and humbled I am to have been part of a group in which everyone worked passionately toward the same end and practiced what they preached, which is that it is not good enough for someone to just be included. They must also be valued.

—Carol Olney Workshop Participant

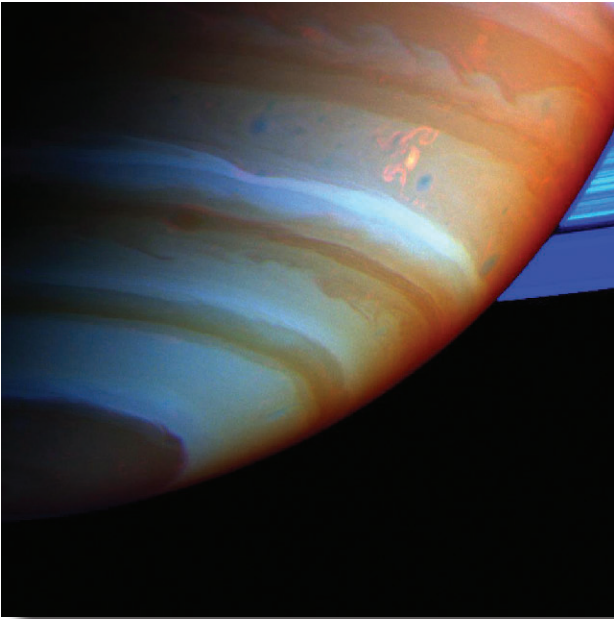## Science with Special Needs | Jessieville Middle School
Nancy Hendrix

Photo by: Vijñana

SPECIFICS: This activity is very simple and emulates the lessons learned from SERCH.

BACKGROUND INFORMATION: This activity takes one week with each of my classes. Each class is given brief instructions about expectations and divided into "families" made up of five to six members. Each member draws a piece of paper explaining the disability they will experience for one week. At the beginning of each class, they must put on their simulator and take a seat at their desks.

At this point, instruction takes place as it normally would. I write on the board and the overhead. I talk as I normally would in my classroom. I ask the students at the tables to help each other. I give assignments. I also have them do some type of group project that requires them to work together.

TARGET AUDIENCE: My middle school students and parents who want to become involved.

This activity is a result of my relationship with ENWS in that I probably wouldn't have developed it if not for my experiences with ENWS over the last five summers.

There have been several outcomes from this activity. Most significantly, the students are more aware of the way they treat others with disabilities. They are more caring and want to help others, which is really remarkable for middle school students. They also realize that everyone has a learning style so that, even though they may not have a special need, they may learn better from one style than another.

I also have to say that since the faculty at my school has participated in this activity, they have a new way of thinking about how to help students with disabilities. They realize that these students really want to learn but just do so differently than the conventional methods.

We still have a long way to go, but I feel that we have made a difference to our students, parents, and community.

Care for a Coke on Pluto? | Edinboro University Planetarium
David Hurd

SPECIFICS: This activity teaches that the weight of an object (in this case, a can of pop) is dependent on a planet's mass. Therefore, a can of pop on different planets has a different weight than it does on Earth.

BACKGROUND INFORMATION: Using an empty soda can for each planet, fill with the corresponding amount of weight (in this case, pennies were used).

TARGET AUDIENCE: General public and grade levels 6–12 students

This activity was modified to include Braille numbers on the soda cans in order to accomodate those who are blind or visually impaired. In some instances, those who are blind or visually impaired have been able to detect slight differences in weight even better than their sighted counterparts. Participants gain a better understanding of the various sizes of planets in our solar system, the relationship of size to gravity, and the weight of objects on the various planets. All audiences responded positively to this activity.

Just How Big? | Edinboro University Planetarium
David Hurd

SPECIFICS: These activities—all derived from presentaitons at ENWS workshops—are designed to help participants gain a better understanding of relative sizes and distances of things in our solar system and galaxy.

TARGET AUDIENCE: General public

One of the activities of the Just How Big? program was adapted from a demonstration made by Simon Steele of Harvard Institute for Astrophysics at an ENWS workshop. In this activity, an Oreo cookie is used to represent the size of our solar system. Participants are then asked to come up with reasons why an Oreo cookie is or is not a good representation of our solar system and to make guesses as to how big our galaxy would be on this Oreo cookie scale. This is an inquiry-based activity and usually takes about 40 minutes to complete. This was one of several activities in the Just How Big? program used to give the audience a better idea of the grand scale of our galaxy and solar system with respect to size and distance.

Another activity, "The 100-Yard Solar System," is described on page 27 of this document.

In the final activity, "The Moon, Bigger than Life," participants learn why stars appear so small in the sky when compared to the Sun while simultaneously learning how an object will appear smaller the farther away it is from the viewer's point of reference. Using a tactile model of the Moon posted on the wall, participants move away from the Moon and feel spheres in descending sizes in order to tactily depict the Moon becoming smaller the further away they move. In addition, this activity is particularly suited to demonstrating to those who are blind or visually impaired that which is intuitively obvious to sighted individuals because of their visual experience. Audiences learn to appreciate the vastness of space by experiencing a realistic depiction of the position, size, and distance of objects in space. This program, held for 80 participants, was very well received, and it was requested that the program be repeated again next year.
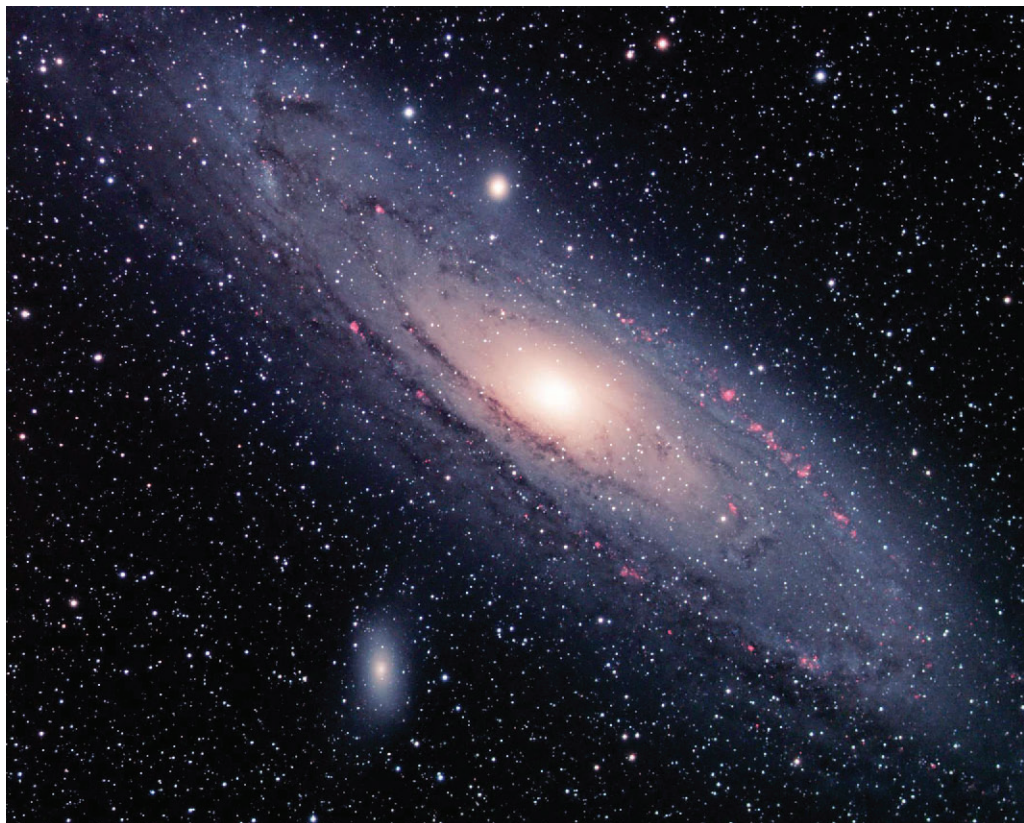
Photo by: Don McCrady

Science and Language Learning | Edinboro University Planetarium
David Hurd

SPECIFICS: This is a paper that was presented about the connection between the process of doing science and language development in children

TARGET AUDIENCE: Attendees to Great Lakes Planetarium Association annual conference in Grand Rapids, Michigan, 2005

ENWS found that inquiry based science education is possibly the most effective way of presenting science because learners are engaged and participating. It has also been noted (Robin Hurd, et al.) that inquiry based science parallels and enhances early language development and vice versa. This paper suggests that science teachers incorporate inquiry science and/or science notebooking into the classroom and encourage their students to ask questions, seek answers, and communicate their findings. Studies have confirmed that these methods enhance the academic achievement of all learners.

The Accessible Zoo | Norfolk Public Schools
Gail Henrich

SPECIFICS: The zoo provides an opportunity to connect life sciences to space science, which is of specific relevance considering that NASA is researching the theory that comets may have supplied some of the raw material needed for life on Earth. More information on this study may be found at *http://news.nationalgeographic.com/news/2003/10/1002_031002_cometstudy.html.*

TARGET AUDIENCE: All grade levels and the general public

Persons who are blind and visually impaired may not visit zoos because of the perception that going to a zoo is a visually-based experience that involves just walking from exhibit to exhibit.

Building on the collaborative team approach of SERCH, Gail Henrich and Theresa Fanney, Education Director of the Virginia Zoo, partnered to provide the first Zoo Snooze—an annual event comprised of specially designed activities for B/VI students in grades 3 through 12. Students came to the Virginia Zoo with their long canes and low-vision devices. They met education animals up close, touching a chinchilla, snake, gecko, and kinkajou. Life-size bronze sculptures of a Galapagos tortoise, baby elephant, and baby rhinoceros were explored by inquisitive hands. Biofacts enabled students to gain a concept of scale when holding an elephant molar tooth, the skeleton head of a giraffe, and eggs of a variety of sizes from the robin to the ostrich. Each student used modeling compound to create an animal sculpture experienced through their eyes and hands. The culminating activity was going behind the scenes with the rhinoceros in which, after the zookeeper's talk, each student touched the rhinoceros.

Though the students did walk a lot—even going on a flashlight tour of the zoo at night to see what the animals both nocturnal and diurnal were up to— they experienced the zoo on their own terms. By putting science in our students' hands, we may be inspiring the scientists of tomorrow to explore the origins of the Earth.

Standard Touch | South Carolina Space Grant

NASA Initiative to Develop Education Through Astronomy and Space Science (IDEAS)—awarded September 2007

SPECIFICS: The objectives of the Standard Touch initiative are twofold: 1) to hold a meeting of key professionals (B/VI experts & educators, E/PO specialists, astronomy & space scientists, and NASA Education & SMD personnel); and 2) to develop a guidelines document that provides the following:

  * standards for creating Braille/tactile graphics that address space science concepts

  * guidelines for developing space science digital media-rich and making it meaningful for persons who are B/VI

  * a list of key resources for creating accessible educational products and another of where to disseminate them

TARGET AUDIENCE: Space science education/public outreach professionals and product developers with the eventual inclusion of the K–14 science education communities and informal science education institutions

In September 2006, the first working meeting was hosted at the College of Charleston in Charleston, South Carolina. With this meeting, a dialogue began regarding the development of standards and guidelines for producing rich and engaging space science educational products that are useful for all learners, particularly those in the B/VI community.

In our project efforts, we will affect and enable space science E/PO professionals and product developers to make their educational products more rich and meaningful to learners who are B/VI. This community includes flight mission E/PO programs, NASA SMD Support Network forums, and space scientists developing E/PO materials through Research Opportunities in Space and Earth Sciences (ROSES), Chandra, Spitzer, and the Hubble Space Telescope (HST) E/PO supplements.

The meeting in September 2006 brought together Braille/tactile graphics experts, education/public outreach professionals, and educators of students who are blind/visually impaired. Representatives were present from the following organizations: NASA-sponsored Central Operations of Resources for Educators (CORE), Texas School for the Blind and Visually Impaired (TSBVI), DePaul University, Boston Museum of Science, Rocky Mountain Braille Associates, View International Foundation, Inc., National Federation of the Blind (NFB), Tactile Learning Adventures, Region 4 Education Service Center, Norfolk Public Schools, Charleston County School District, Lowcountry Hall of Science and Math (LHSM), South Carolina School for the Deaf and the Blind (SCSDB), and SERCH.

The Standard Touch initiative was conceptualized and started by several members of the Special Needs Resource Group (SNRG) and Tactile and Technology Focus Group (TTFG), both of which were created at ENWS.

During the meeting in September 2006, information was collected on what standards and guidelines currently exist, who uses these standards and guidelines (such as those developed by the Braille Authority of North America and the World Wide Web Consortium), and what the existing distribution mechanisms are for them. Through our discussions with our meeting participants, we identified that specific uniform standards and guidelines for space science concepts

do not exist; therefore, there is a need for a streamlined process to facilitate the production of quality accessible education products. Further, we determined that our group would collaborate to create such a document to share with E/PO professionals within the Earth and space science community. This meeting was the first step in identifying the gaps and gathering information and ideas; there is still much to be done. Tasks have been assigned to meeting participants in order to expedite the completion of this important document.

SERCH has actively sought out further funding to support a second meeting, as well as to develop accessible space science examples using the Standard Touch guidelines. An award is pending from NASA's IDEAS initiative.

By enabling space science E/PO professionals and product developers to create accessible materials through the use of our Standard Touch guidelines document and key examples, we will ensure that their materials are a quality resource for educators and persons who are B/VI. Our Standard Touch guidelines document will advocate that space science E/PO professionals and product developers have their products reviewed and disseminated by NASA's Education Office, CORE, and the NFB National Center for Blind Youth in Science (NCBYS) Web portal. By using these existing and trusted dissemination networks, we will make certain that these quality materials are placed in the hands of our final target audience—learners who are B/VI.

Working Groups | Southeast Regional Clearinghouse

SPECIFICS: Working groups provide a means of collaboration among scientists, educators, and E/PO professionals working with persons with disabilities.

TARGET AUDIENCE: Scientists, educators, and E/PO professionals

The workshops, hosted by SERCH over the past seven years, have made a significant impact on the community of persons and students with disabilities, SMD E/PO personnel, professional educators, and product developers. Several important outcomes from the workshops include the development of SNRG, the Exceptional Needs Working Group (ENWG), and TTFG. SNRG provides NASA space science mission planners, principle investigators, and product developers with guidance, support, and product enhancement strategies to improve the usability of NASA products by audiences concerned with the education of individuals with disabilities. SNRG efforts provide preK–12 educators of students with disabilities with a connection to NASA and corresponding educational programs and products. ENWG is composed of educators and product developers interested in producing better NASA education materials for use in all learning environments. This working group collaborates via an established listserv to share ideas, thoughts, and announcements among the group. ENWS participants formed TTFG due to the increased number of persons working specifically with Earth and space

science content in the development of tactile graphics and technology programs for persons who are B/VI. The formation of this group aids in eliminating product duplication, enhancing the creation of new products, and centralizing products that are and will be created. The efforts of TTFG have been extended to develop a decision tree and guidelines document for creating E/PO products for B/VI and the Standard Touch (see Spinoff Standard Touch). By coalescing this highly innovative group and the products they create, TTFG provides a quality resource for educators of and persons who are B/VI.

SNRG, ENWG, and TTFG have provided a means of collaborating to develop and modify educational materials for students with disabilities Through these existing channels, past attendees can remain in contact with one another to share expertise and advice, coordinate presentations at local events, and review additional educational products.

EVALUATION AND DISTRIBUTION

On behalf of NASA, the Institute for Global Environmental Strategies (IGES) convenes panels of educators, curriculum and instructional design specialists, teacher trainers, national education standards experts, and space scientists to review new NASA space science education products. This review is a requirement for passing the NASA Communication Materials Review (CMR) in order to print and distribute NASA education materials. Products that pass the education product review will also be eligible for distribution through the NASA portal (www.nasa.gov), as well as NASA education workshops and national education conferences. Products that pass the review share the following qualifications: 1) have undergone review and field testing; 2) target a specific audience in content and design; 3) support National Education Standards; 4) incorporate a student-centered approach; 5) provide appropriate assessments; and 6) provide accurate references.

SUMMARY

All students will benefit from these activities because they utilize multiple leaning styles and multi-sensory approaches. We encourage you to be creative with your audience. Whether you're constructing an edible solar system, making your planets out of material that is representative of their composition, putting different sounds to the planets, or changing the texture of an image or scale of a font—you are really serving the needs of everyone.

A FINAL STORY

Robin Hurd

AccessScience, written for SERCH by a parent of four boys (three of whom have disabilities), is a set of stories that focus on children with disabilities learning math and science curriculum. Children are all different; children with disabilities may have learning differences that require teachers to rethinkthe usual methods of teaching science and math. But children with disabilities can grow up to pursue higher education and hold jobs in science and math fields. This is our final story.

AccessScience depicts the dream of the average, everyday science classroom being accessible to every student that enters it—that each student would not only be able to get in the doorway and find a place to sit, but would also find a community of learners to belong to, learn with, and learn from. *AccessScience* represents the hope that all students would be able to "act like scientists," wondering about the world around them and looking for answers to the questions they find.

"Notes From the 'Other' Teacher" acknowledges the somewhat radical flowerchild side of me, which knows that sometimes the best teachers are not those with a teaching certificate, but those who take the time to get to know others and can share the wisdom that will build character and knowledge. I hope that each of us has had a such a teacher, someone who has been able to teach us skills as well as the wisdom that we need for life.

For me, my grandmother was such a teacher. A stubborn, tough as nails farmwoman, Grandma had weathered the Great Depression, World War II, and family crises like alcoholism, an accident that left a child disabled, and the death of a son in Vietnam. She taught me how to cook, sew my own clothes, pluck a chicken, and work the garden. She also taught me how to cope with the unexpected events of life and solve my own problems. Even though she has passed, I continue to look to her as a teacher for the most important things. I often find mysef asking, "What would Grandma do now?"

My goal, my dream, is to be that kind of "other" teacher for my children. I want to be the one who has the insight to push for their independence, even though it may drive me crazy right now because it will result in a better life for them in the future when I cannot be there to take care of them.

I hope I have taught you the "cooking and sewing" of the teaching world: accessibility, adaptations, inclusion. I also have tried to impart you with a vision of what the future can hold for all the students in your classroom: successful and, yes, passionate interactions with the world of math and science that surrounds us all. I have presented challenges to the assumptions often made about the abilities of people with disabilities—that they can be the helpers, the leaders, and the information givers instead of always the ones who receive the helping and giving.

But I'm not your only other teacher. In your interactions with SERCH, you have met many: scientists who are passionate about probing the mysteries of the universe, those who are able to take technology and make it work wonders for their students, and teachers who are incredibly gifted at seeing the potential in everyone they meet.

Though you may not have noticed it, the other teachers were at work, building in you the wisdom that you will need for a future of success with the students you teach. Now, take time to ponder what they were really teaching you. More than tips and techniques, more than knowledge and facts, it was a passion to adapt, to improve, and to see every child learn and succeed. It is time for you to become one of these other teachers, passing on life's wisdom that your students will need to succeed. ■

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Other Resources

http://ehrweb.aaas.org/entrypoint/ Program from AAAS offering Outstanding Internship Opportunities for Students with Disabilities in Science, Engineering, Mathematics, Computer Science, and some fields of Business.

Courtesy Tips

1. http://www.nod.org/index.cfm?fuseaction=page.viewPage&pageID=27 The National Organization on Disability (N.O.D.).

2. http://www.dol.gov/odep/pubs/fact/comucate.htm U.S. Department of Labor, Office of Disability Employment Policy

3. http://www.unitedspinal.org/pdf/DisabilityEtiquette.pdf Quick overview that covers interacting with persons with disabilities over 17 different disability groupings.

4. http://eeo.gsfc.nasa.gov/disability/publications.html People With and Without Disabilities: Interacting and Communicating

D/HH

1. http://www.rit.edu/~comets/teachingtips.htm#infoteachers

2. http://www.agbell.org/DesktopDefault.aspx?p=Teaching_Tips

3. http://www.ucp.org/ucp_generaldoc.cfm/1/9/6573/6573-6573/404

B/VI

1. http://www.afb.org/Section.asp?SectionID=36&TopicID=163

2. http://www.tsbvi.edu/Outreach/seehear/summer02/tips.htm

AT

1. http://www.cast.org

2. http://www.washington.edu/doit

3. http://www.nectac.org/topics/atech/udl.asp

4. http://www.jan.wvu.edu/media/udatfact.doc

5. http://www.k8accesscenter.org/index.php

6. http://www.familyvillage.wisc.edu/education/at.html

7. http://www.ed.gov/policy/gen/guid/assistivetech.html

SWAC

1. http://sunearthday.nasa.gov/swac/

2. http://son.nasa.gov/tass/tools.htm

LD

1. http://www.ku-crl.org/

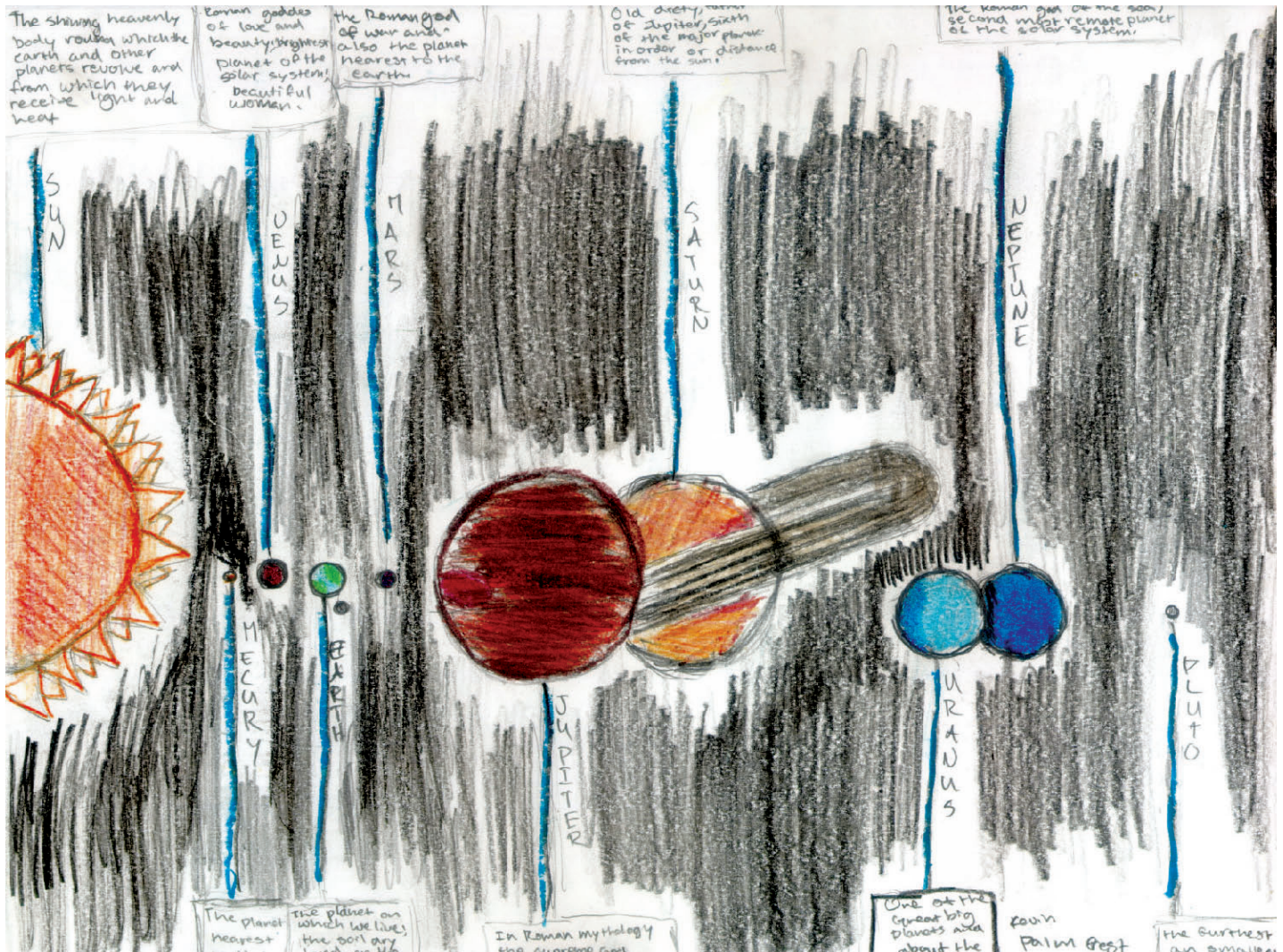2. Deshler & Lenz, Scruggs & Mastropieri, etc

ADD

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Informal

1. Janice Majewski (coordinator). *Smithsonian Guidelines for Accessible Exhibition Design*, Washington, DC: Smithsonian Institution, 1996. Describes the Smithsonian Institution's philosophy and practice of accessible design. Available online at *http://www.si.edu/opa/accessibility/exdesign/*.

2. Kennedy, Jeff. *User-Friendly: Hands-On Exhibits That Work*, ASTC, December 1990, ISBN 0944040225. This book looks at the human factors that affect hands-on exhibits. Illustrations provide data on human dimensions for visitors of all ages and sizes, including wheelchair users. The manual covers such topics as creating legible, accessible labels; designing user-friendly viewers and eyepieces; selecting exhibit controls and making them easy to use; and planning audio exhibits and noise control.

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Your journey awaits.