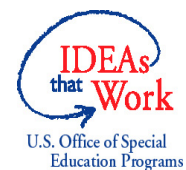




Middle School Science: Access for Students with Autism Spectrum Disorder



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Beginning in the 2007-08 school year, all students will be required to demonstrate mastery of science standards, including students with disabilities (U.S. Department of Education, 2005). Given this requirement and the current era of teacher accountability, it is important that all science teachers be prepared to work with students with disabilities. Furthermore, it is important for teachers to ensure that students with disabilities, including students with autism spectrum disorder (ASD), have access to the general science education curriculum. Unfortunately, teacher education programs often do not spend time preparing science teachers to work with students with disabilities (Cawley, Hayden, Cade, & Baker-Kroczyński, 2002). This is often compounded when science teachers reach the classroom and are often not included in the planning process for students with disabilities (Haskell, 2000).

Consequently, it is important to provide science teachers with information about students' specific disabilities and the strategies that will help these students achieve in the science classroom. Students with ASD make up one set of students that requires support in the general education science classroom. This document focuses on the specific needs of students with ASD and on strategies that can help these students access the middle school general education science curriculum.

Middle School Science Instruction and Students with Disabilities

Science is often viewed as one of the more promising content areas in which to include students with disabilities in the general education curriculum (Cawley et al., 2002). This is true for several reasons. First, science classes frequently provide opportunities for students to interact and collaborate with each other and with teachers. Second, typical science tasks can easily be broken down into small, manageable segments that are helpful for students with disabilities and necessary for inclusive activities (Cawley et al., 2002; Brownell & Thomas, 1998). Third, a small body of literature indicates that students with disabilities benefit from hands-on science instruction in the general education classroom. The research in this area continues (Dalton, Morocco, Tinvan, & Mead, 1997).

Despite the fact that science appears to be an appropriate place to mainstream students with disabilities, it appears that mainstreaming is not occurring, or if it is, that it has not translated to measurable gains in achievement. Achievement gaps exist between students with disabilities and their non-disabled peers in the science classroom. This is particularly true once students enter middle school (Anderman, 1998), where science instruction becomes intensified, district-wide tests become a requirement, and for the first time many students receive instruction from certified science teachers. To decrease the achievement gap between students with disabilities and their non-disabled peers in a middle school science classroom, there must be a

close relationship between curriculum and specially designed instruction (Cawley, Foley, & Miller, 2003). Students need to be taught grade-level science content using appropriate instructional strategies, accommodations, and modifications that allow them to access the curriculum.

Grade-level standards should be the starting point for the instruction of any middle school student. While each state's standards may differ in content and format, the National Science Foundation has established a set of science standards appropriate for students in middle school. These standards encompass numerous topics that must be taught to students in the middle grades. It is important for teachers to ensure that all students, including those with autism spectrum disorder, have access to these science standards. The national science standards for middle school grades (grades 5-8) can be found in the box below.

Middle School Science Standards

- Unifying Concepts and Processes
 - Systems, order, and organization
 - Evidence, models, and explanation
 - Change, constancy, and measurement
 - Evolution and equilibrium
 - Form and function
- Science as Inquiry
 - Abilities necessary to do scientific inquiry
 - Understandings about scientific inquiry
- Physical Science
 - Properties and changes of properties in matter
 - Motions and forces
 - Transfer of energy
- Life Science
 - Structure and function in living systems
 - Reproduction and heredity
 - Regulation and behavior
 - Populations and ecosystems
 - Diversity and adaptations of organisms
- Earth and Space Science
 - Structure of the earth system
 - Earth's history
 - Earth in the solar system
 - Science and technology
 - Abilities of technological design
 - Understandings about science and technology
- Science in Personal and Social Perspectives
 - Personal health
 - Populations, resources, and environments
 - Natural hazards
 - Risks and benefits
 - Science and technology in society
- History and Nature of Science
 - Science as a human endeavor
 - Nature of science
 - History of science

<http://www.nap.edu/readingroom/books/nses/html/>

Characteristics of Students with Autism Spectrum Disorder

Autism was first included as a separate and distinct category of disability under the Individuals with Disabilities Education Act (IDEA) in 1997. Until that time, autism was categorized as "other health impaired" (Coffey & Obringer, 2004). This was because individuals with autism exhibit a wide range of characteristics, which can also be indicative of other disabilities (Bellini, 2004). Recently, autism has been viewed as a continuum, referred to as autism spectrum disorder (ASD) (Coffey & Obringer, 2004).

Children with ASD have characteristics that range in severity and symptoms, but the characteristics tend to lie in several main areas (Wagner, 2002). It is important to remember the wide range of characteristics of students with ASD and to recognize the strengths that these students bring to the science classroom:

- **Cognition.** Cognition tends to be varied across the

autism spectrum. Many students with ASD exhibit cognitive skills in the low average or below average ranges. Others, however, have cognition in the average to above average ranges. Often students with ASD exhibit an uneven skill profile and will show a large difference in scores between their verbal and performance ability on standardized testing (Wagner, 2002). **In the science classroom**, students with average to above average cognition have the capacity to understand middle school science content. Learning the content, in fact, may be a strength for these students and can be used as a place to begin focusing science instruction. Students with ASD who have lower cognitive skills may lack background knowledge in science, making it difficult to learn new concepts that build upon prior knowledge. These students may also have difficulty understanding science content, and difficulty with abstract reasoning, which is necessary for making some connections in science and for inquiry learning. These students may also have difficulty participating in traditional assessments.

- **Social Functioning.** Students with ASD may exhibit impairment in social functioning, including the ability to (1) understand and read nonverbal cues from others, (2) respond to eye contact and social smiles, (3) show interest in and/or share with others, (4) seek comfort when hurt and/or comfort others, (5) interact with others and make friends, and (6) use appropriate social

responses (Wagner, 2002). **In the science classroom** impairment in social functioning may lead to a difficulty working in groups or with lab partners, both of which are often found in the general education classroom. The structures found in a science classroom, however, may lend themselves to opportunities for social skills instruction and support for students with ASD (see sidebar to the left).

- **Communication.** Students with ASD may have difficulty with both expressive (speaking) and

Opportunities for Social Skills Instruction in the Science Classroom

Direct Skill Instruction

Directly teaching social skills to students with ASD requires (a) identifying skills necessary to perform a task, (b) sequentially teaching each step for every skill, and (c) providing practice in multiple settings (Simpson, Myles, Sasso, & Kamps, 1997). Teachers use verbal and physical prompts and can enlist socially competent peers to assist.

The middle school classroom provides opportunities for direct skill instruction in laboratory and group work settings, where students can directly learn and apply social skills while working with partners. For example, a student with ASD can be directly taught appropriate social skills for sharing equipment and taking turns in a group. This skill can then be generalized to group work as well as lab partner work.

Peer Mediated Social Interaction

In peer mediated strategies, socially competent peers are taught to initiate social interactions with students with ASD and are then paired with those students for social activities in natural settings (Simpson et al., 1997). Students with ASD may be paired with one or more peers. There is evidence that these relationships lead to increased and longer lasting interactions between students with ASD and socially competent peers (Sasso, Garrison-Harrel, & Rogers, 1994).

Because of the high level of group and partner work required in the middle school science classroom, there are many opportunities for peers to be trained and to serve as models and instructors for students with ASD.

receptive (understanding) language. They may have difficulties using language appropriately, including grammar, tense, and parts of speech. Other communication difficulties often include an inability to imitate the language of others in an appropriate context, difficulty with abstract reasoning, and literal interpretation of language (Wagner, 2002). **In the science classroom** communication skills are necessary for speaking, reading, and vocabulary. Some students with ASD have limited speaking abilities or are nonverbal, which can influence the ways in which such students work in groups and participate in whole-class activities. Some students have difficulty with receptive written language and therefore have difficulty gaining information from written sources, such as textbooks, which are often used to present and reinforce material in a science classroom. Vocabulary is also very important for science learning, and students with ASD may have difficulty retrieving unfamiliar verbal labels for vocabulary words, particularly with little or no previous background knowledge. Students with ASD are often able to memorize vocabulary in isolation, but can have difficulty with application. It is important to distinguish, therefore, whether a student has full comprehension of vocabulary or whether he or she is using verbatim repetition of words or facts.

- **Behaviors.** Some students with ASD may exhibit special skills, interests, and talents in certain areas (e.g., a student may have a narrowly defined interest such as photocopy machines or may have special skills, such as the ability to mentally solve complex math problems), although this is rare. Students with ASD may also exhibit behaviors such as the repetitive use of objects, compulsions or rituals, hand and finger mannerisms, self-injury, and unusual preoccupations. Some students also show little interest in engaging in new activities (Wagner, 2002). Students with ASD may exhibit rigidity in their behaviors, which can appear to be defiance or non-compliance when in reality the student may be following his or her own set of rules and may feel that they cannot be broken. **In the science classroom** student interests and special skills can be motivating and lead to opportunities for independent study projects. These skills and talents can allow students with ASD to develop expertise that can be shared with their classmates. Some behaviors exhibited by students with ASD may hinder work in lab groups and may make it difficult to engage students in new classroom activities. These behaviors can also be distracting to other students in the classroom, and can hinder the development of social relationships.

Providing Middle School Students with ASD Access to the General Education Science Curriculum

Several research-based strategies have been identified as effective in helping provide access to the general education curriculum for students with disabilities. The following table, **“Strategies for Students with ASD in the Science Classroom,”** presents some of these research-based strategies, their applications to the science classroom, and ways in which each strategy helps to provide access to the middle school science

curriculum for students with ASD. The table is intended to be a guide for teachers or other practitioners who are including students with ASD in a science classroom. It is important to remember that implementing strategies takes time and may differ depending on each student's need. It is also important for teachers to become familiar with each of the strategies before implementing them in the classroom. To that end, included in the table are links where teachers can gain more information about each strategy. Teachers may also want to seek out professional development opportunities that will provide them with information and additional strategies for teaching students with ASD in the middle school science classroom.

Strategies for Students with ASD in the Science Classroom

Strategy	Description of Strategy	Implementation in the Science Classroom	How it Provides Access to Students with ASD
Graphic Organizers	<p>Graphic organizers are visual and graphic displays used to organize information and key conceptual relationships.¹ Graphic organizers can be completed as a teacher-directed activity or independently by students.</p> <p>For more information: http://www.k8accesscenter.org/training_resources/udl/GraphicOrganizersHTML.asp</p>	<p>Graphic organizers can convert information containing words in a meaningful way for students. They can be used to display textbook information, illustrate key science concepts, and organize steps in processes such as laboratory experiments.</p> <p>For example, for a textbook chapter on the differences between meiosis and mitosis, a graphic organizer can be used to summarize the information and display the steps in each cell process.</p>	<p>Cognition – Graphic organizers can help students with ASD understand difficult content by displaying it in a meaningful way. They can provide easy access to necessary background information.</p> <p>Communication – Graphic organizers can allow students to access information from science textbooks, even if they have difficulty reading the text.</p>
Peer Tutoring	<p>In peer tutoring, student partnerships link higher-achieving students with lower-achieving students or those of comparable achievement for structured study sessions. Peer tutoring increases students' motivation to achieve classroom goals.²</p> <p>For more information: http://www.k8accesscenter.org/training_resources/documents/PeerTutoringFinal.doc</p>	<p>Peer tutors can be used to help students gain information from text, to review or study key science concepts, and to assist with appropriate behavior and implementation during lab experiments.</p> <p>For example, during a laboratory experiment, a trained peer tutor can interact with and help a student with ASD use appropriate social skills. That peer tutor can also assist the student with ASD in performing necessary tasks and gaining information from the experience.</p>	<p>Cognition – Peer tutors can help re-teach and explain concepts to students.</p> <p>Social Functioning – Specific peer tutoring strategies can be used to have socially competent peers teach and support appropriate skills and behaviors for students with ASD.³</p> <p>Behaviors – Peer tutoring can provide positive reinforcement and feedback to students with ASD to increase social behaviors and decrease unwanted behaviors.</p>

¹ Kim, Vaughn, Wanzde, & Wei, 2004

² Ryan & Deci, 2000

³ Simpson et al., 1997



Strategy	Description of Strategy	Implementation in the Science Classroom	How it Provides Access to Students with ASD
Adapted Text	<p>Text adaptations can be done with either high or low technology. High-technology adaptations include recorded textbooks or text-to-speech software. Students can listen to the recorded or spoken passages as often as necessary.⁴ Low-technology adaptations include highlighting, color page diffusers, and materials for tracking can be used to help students locate key information.⁵</p> <p>For more information: http://www.k8accesscenter.org/training_resources/computeraided_writing.asp</p>	<p>Recorded science textbooks and text-to-speech devices can be used to provide access to textbook content for students with reading difficulties. Highlighting and other low-technology adaptations can help students locate key vocabulary words and concepts and can also be used to help students follow the steps to complete a procedure.</p> <p>For example, if a student with ASD is working on a classifying activity, the directions for the activity could be recorded so that the student can listen to them as often as necessary.</p>	<p>Cognition – Adapting text can help draw attention to necessary information for students with ASD.</p> <p>Communication – Adapted text can allow students with limited receptive language abilities to access texts and other written reports or instructions.</p>
Computer Assisted Instruction	<p>Computer assisted instruction (CAI) includes the use of digitized textbooks, online or electronic graphic organizers, and web-based or software applications, including websites. CAI can provide immediate feedback to students and individualize instruction, and allow for extensive rehearsal and repetition.⁶</p> <p>For more information: http://www.k8accesscenter.org/training_resources/computeraided_math.asp</p>	<p>Digitized textbooks can be used to communicate science textbook information. Online graphic organizers can organize information and are easy to edit. Software often contains games or other motivational ways to communicate science concepts and information. Also available are virtual experiments and museum visits.</p> <p>For example, a student with ASD might first look at a virtual dissection using interactive software, to gain background information and an idea of what to expect during a lab. The software might also motivate the student to participate in the class activity.</p>	<p>Cognition – CAI can provide differentiated methods of accessing science curriculum, allowing students with ASD to learn concepts through a variety of formats.</p> <p>Communication – CAI provides support for receptive language by providing information in new visual and/or auditory formats. It provides support for expressive language because students with ASD can use programs and software to communicate about curricular material.</p> <p>Social Functioning – CAI may provide a structured and motivating place for students with ASD to work in pairs or groups.</p> <p>Behaviors – CAI can be motivating for students and can provide an avenue for students to express and develop interests.</p>
Mnemonic Strategies	<p>Mnemonic strategies are intended to facilitate the recall of academic content and involve some type of reconstruction of unfamiliar words into more familiar ones.⁷ Research has demonstrated that students with disabilities taught mnemonically outperformed</p>	<p>Mnemonic strategies can be used to teach and reinforce vocabulary in the science classroom. Mnemonics can also be used to teach and reinforce major science concepts.</p> <p>For example, when learning vocabulary related to</p>	<p>Cognition – Mnemonics can help students with ASD learn science concepts. Mnemonic strategies can also help students with ASD develop background knowledge upon which new concepts can be learned.</p> <p>Communication – Mnemonic strategies can help students retrieve unfamiliar labels for science vocabulary words.</p>

⁴ Mastropieri & Scruggs, 1995

⁵ Beck, 2002

⁶ Rieth & Semmel, 1991

⁷ Mastropieri & Scruggs, 1995



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	those taught by alternate methods, such as rehearsal. ⁸ For more information: http://www.k8accesscenter.org/training_resources/Mnemonics.asp	photosynthesis, teachers can provide students with ASD with mnemonics that link key words to terms those students already know and understand.	
Metacognitive Learning Strategies	Metacognitive strategies include goal-setting, self-monitoring, and self-questioning. These strategies help students learn how to become independent learners. They also help to increase students' confidence in their academic abilities (NICHCY 1997). For more information: http://searcher.org/digests/ed433669.html	Metacognitive strategies can help students engage in science curriculum. These strategies can improve students' independence in completing science tasks and labs. ⁹ For example, students with ASD might have a checklist that details each task in a science assignment that should be completed. Students can independently check off each task as they finish it, and determine their next step.	Social Functioning – Metacognitive strategies can help students with ASD become more independent and regulate their own learning in the science classroom. Learning metacognitive strategies can help students with ASD work with peers in small groups as well. Peers can help students learn these strategies. Behaviors – Self-regulation can help students with ASD manage many of the behaviors that might otherwise be disruptive in a science classroom. This can help students reach a greater level of participation in small groups and whole-class activities.

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⁸ Scruggs & Mastropieri, 1992

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