Inquiry-Based Science Instruction for Students With Disabilities

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Kathy Cabe Trundle, Ohio State University

Veronica is an outstanding science teacher, and I have enjoyed watching her for years. Each time I visit her class, I see the modifications she is using to help students learn and participate in science. As she is dedicated to having all students participate fully in class, she is always looking for new approaches that will make science even more accessible. During my last visit, she was having the students observe different single-celled eukaryotic organisms. As the students walked into the classroom, on their tables were traditional microscopes and laptops connected to digital microscopes and a variety of containers of water with different organisms. Beside each microscope were written directions and directions with pictures. Large pieces of paper and colored pencils were also laid out for students who wanted to draw their organism, and clay was available for those wanting to create a three-dimensional image.

As the students came into class, they quickly took their seats at their assigned tables. Veronica assigned each student to a team in order to maximize each student's learning opportunity. Once the students were settled, she explained that the activity would focus on just finding the organisms. Veronica challenged each group to find at least three different organisms. When they found an organism, they could draw it, create it out of clay, or take a digital picture

with their microscope and post the picture on their laptop computer. Veronica kept the directions short, which let the students get started quickly.

As I watched the class, I found it difficult to identify the students with disabilities. All of the students were looking through the microscopes and finding organisms. Some of the students were using the regular microscopes, while other students had enlarged images on the computer screens. As students found organisms, they captured them digitally, drew them, or created clay sculptures. I was amazed at how detailed and intricate the drawings and sculptures made by the students with disabilities were. Veronica moved from group to group throughout the period, reinforcing the progress of students and demonstrating (as needed) how to use different techniques. It was an action-packed class that was over before I knew it.

As we work with increasing numbers of students with disabilities in our classrooms, Individual Education Plans, 504 Plans, and Intervention Plans are becoming more and more familiar terms in our professional vocabulary and more frequent realities to be considered as we plan our instruction. In science, these plans strive to include a wide range of students in our daily classroom activities. Including students with visual (low vision and blindness), hearing (limited hearing and deafness), mobility, emotional, and cognitive impairments in our development of classroom lessons ultimately makes the science class more inclusive. Moreover, it ensures that *all* students learn about science and become scientifically literate, which is a stated goal in the National Science Education Standards (NRC 1996).

Students with disabilities often are struggling readers who cannot successfully access and use print information. As a result, they usually experience difficulties with traditional science instruction, which typically relies on textbooks and other printed materials for instruction and assessment. Unfortunately, these difficulties can translate into a lack of performance in science class, as well as a lost opportunity to wonder about the natural world. Moving away from a reliance on reading to inquiry instruction affords students with disabilities an opportunity to access and think about the phenomena they encounter each day.

Summary of the Research

Traditional Instruction

When science instruction and assessments rely on reading and writing, students with disabilities are not as successful as their peers. This trend is evident

in studies of classrooms and large-scale assessments. Donahoe and Zigmond (1988), for example, found that when science instruction and assessment were conventional, most of the students with disabilities were likely to earn a grade of D or below. In a science evaluation program for the state of New York, 69% to 75% of students without disabilities passed the test, while fewer than 50% of students with disabilities performed successfully (Cawley and Parmar 2001). A closer look at large-scale assessments reveals another problematic trend: Students with disabilities are likely to score even lower in science and mathematics than they do in reading, vocabulary, and writing (Harnisch and Wilkinson 1989). The lack of comparable scores can be attributed to students having to learn another language—that of science. Overall, traditional instruction can limit the success of students with disabilities in science class and in their academic careers.

Inquiry-Based Instruction

The integration of inquiry into the science classroom provides an alternative approach for students with disabilities to learn scientific knowledge and skills. Moreover, this integration can contribute to building an inclusive classroom in which all children are valued, respected, and given the opportunity to fully participate in the class. In the classroom, inquiry-based instruction gives students with disabilities the opportunity to access information about science and to construct an understanding of the natural world. Research results indicate that inquiry-based science instruction benefits students' achievement, including students with learning disabilities (Mastropieri and Scruggs 1992; Scruggs, Mastropieri, and Boon 1998). For example, students who were taught using inquiry methods performed significantly better than those who were taught via a lecture method, and the inquiry method was significantly more effective for average- and low-ability students (Odubunmi and Balogun 1991). On performance-based assessments, students with learning disabilities who had been taught with inquiry-based instruction outperformed their typically developing peers (Bay et al. 1992).

Several studies report the benefits of inquiry-based science instruction for students who have a range of disabilities. Students with learning disabilities, mild mental retardation, autism (Mastropieri et al. 2001), visual impairments (Erwin, Ayala, and Perkins 2001), or hearing impairments or deafness (Borron 1978) were all able to successfully participate in an inquiry experience and explain their results. Moreover, as they engage in inquiry experiences, students with a wide range of disabilities are likely to become proficient in using science process skills, develop skills to work independently, and become motivated to

learn science (Barman and Stockton 2002). An active environment for the students can result in better learning of concepts in science as well as students having more confidence in their own capabilities to participate in science (Dalton et al. 1997; Palincsar et al. 2001). Overall, a science-as-inquiry environment allows the greatest number of students to experience and learn about science.

General Guidelines

Several strategies can be used to accommodate students with disabilities. One strategy is "universal design" (Null 1996; Rose and Meyer 2002)—that is, the modification of instruction and materials to ensure that all students can participate to the greatest extent possible. Universal design takes into consideration a wide range of individual characteristics for different people throughout their lifetimes, and it provides learning alternatives for students with differing abilities. Instructional methods that use a universal design include the following:

1. *Establishing an inclusive classroom setting that respects and values all diversity, including special physical and learning needs.* As a philosophy, universal design ensures that all students are valued in the classroom and that accommodations are made to ensure their learning.

2. *Providing physical, visual, and auditory access in the classroom, in laboratories, and during field experiences to ensure that all students have safe physical access to materials and experiences.* In the science classroom, physical accessibility can be accomplished by simple modifications, such as adjusting the height of a laboratory table to allow a student in a wheelchair to sit with peers or modifying laboratory equipment to make handling easier for students with limited manual dexterity.

3. *Using multiple modes for content access, including fieldwork, discussions, lectures, computer work, and inquiry experiences*. Simple modifications include summarizing print information orally prior to the lesson or activity, as well as providing the information to groups of students to discuss before the lesson. With these activities, students have access to the information in different formats.

4. *Creating and providing print materials in a simple format that students may access electronically through a website.* Prior to a science experiment, for example, a teacher can upload the directions for

the laboratory. The student can look at the directions prior to the experiment and prepare for the lesson accordingly.

5. *Encouraging students to interact with each other and their teachers through different formats such as e-mails or online discussion groups.* Online communications can allow students to communicate with one another without the pressure of giving an immediate response. Some students need more time and written comments as they process information. The online environment allows students to read the conversation and to reply in a time frame that is conducive to their processing of information.

6. *Providing feedback both during the learning experiences and after the assignment is complete.* Throughout a science lesson, the teacher should give ongoing feedback to students with disabilities. This ensures that students are provided with adequate directions and reinforcement to complete the activity.

7. *Allowing students to demonstrate their knowledge and understanding in varied ways, such as portfolios, presentations, and demonstrations, as well as on traditional tests and in written papers.* Creating concept maps and drawings and describing a science experience can also reveal students' knowledge and understanding. Concept maps, for example, can be used prior to an activity and afterwards to assess a student's growth in knowledge (Burgstahler 2004).

To accommodate students with disabilities during inquiry experiences, a teacher can do the following:

1. *Provide students with a combination of written, verbal, and pictorial instructions.* Multiple sensory formats (auditory, visual, kinesthetic) maximize access to science information and learning. In a laboratory, for example, the directions can be depicted in pictures as well as written in text.

2. *Create opportunities for students to work with partners rather than alone, and expect active engagement and participation of all students, including those with disabilities*. Allowing all students to work together, and not forming special groups, sends a strong message about including all students in the learning process and creating a learning environment that values all students.

3. *Extend the time allotted for the inquiry process, including additional time for set-up and clean-up.* Providing additional time will ensure that inquiry lessons are not rushed and that students have adequate time to prepare for, participate in, and contemplate the lesson.

4. *Demonstrate and allow students to engage in aspects of inquiry.* Demonstrating various aspects of inquiry can provide an example about how to engage in inquiry. For example, demonstrating the process by which data is collected and recorded can assist students who have not had the experience previously.

5. *Involve students in the accommodation process to help them be self-advocates in their educational experiences.* Self-advocacy should be explicitly taught and students must practice the process so they will be prepared to assume responsibility for their learning and accommodations later in college. In science classes, because they are required to do both written work and laboratory investigations, students must be able to ask for assistance when they encounter new problems.

6. *Approach the development of accommodations with flexible and creative problem solving*. Science is about flexibility and problem solving. If an accommodation doesn't seem to be working, think of a new approach that may be better or consider a different activity. In other words, don't just talk slower and louder!

7. *Provide diverse role models as guest speakers or as illustrations in curriculum materials so that students can believe that science includes men and women from varied backgrounds and with a range of abilities and disabilities.* In science, role models are important and should be included purposefully. That is, a role model should be presented when he or she can enhance the conversation about science. This conversation can focus on the challenges of doing science with disabilities, as well as the unique strengths scientists have when they do science.

Conclusion

Science is the perfect course in which to engage and captivate all students. Inquiry instruction, which is at the center of science teaching, can provide a learning experience for all students at any moment. There are objects to

touch, see, and smell, and there are investigations to conduct. For students with disabilities these opportunities exist naturally in the inquiry class, and making small revisions to instructional and assessment formats can greatly enhance their learning experiences. Ideally, such modifications can be guided by the ideals presented through a universal design approach. These modifications are not difficult to make and often require a small amount of preparation or the use of common equipment in novel ways (e.g., computers with larger text, meter sticks with raised lines). Once these modifications are made, students can participate more fully in the learning experience, thereby having an impact on their overall performance in science class. Moreover, by providing these learning opportunities to students with disabilities, a clear message is sent that all students can and should participate in science and all students will learn science.