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Motivating Youth with Disabilities to Learn in the Science Classroom: A Guide for Educators

By Peg Lamb, Bill Hodges, Mary Brown, and Dave Foy

Introduction

Historically, students with disabilities have experienced difficulties in fully accessing and participating in middle school and high school science programs and courses. Moreover, teachers have held lower expectations for students with disabilities than for students without disabilities in science programs (Cunningham & Noble, 1998). This situation continues to disenfranchise students with disabilities because they exit high school unprepared for college courses that can lead to a career in the sciences (Vogel, 1993). In addition, few students with disabilities exit high school inspired to attend college and pursue careers within the sciences.

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This brief focuses on strategies for motivating students with diverse learning styles—including students with disabilities—in science courses and programs. Information in this brief is drawn from the Bridges Project supported by a grant from the National Science Foundation Program for Persons with Disabilities. As part of the project, a team of science teachers from Holt High School in Michigan, in partnership with faculty at Lansing Community College, researched differences in expectations and the types of supports available for students with disabilities within the two institutions.

Alternatives and Solutions

Students with disabilities vary widely in their learning styles and abilities. Teachers must be able to present materials in ways accessible to all students and then hold all students responsible for the same level of mastery. Quality education integrates many techniques to engage, educate, and assess students without lowering standards (Wilson, Shulman, & Richert, 1987).

Presenting information in several ways prevents boredom, gives students confidence and success, and strengthens individual areas of weakness for students with and without disabilities. In a science classroom, many opportunities exist to diversify instruction.

Case Studies

The use of case studies can be effective in motivating all students. A case study is a multidimensional problem presented for the class to analyze. In order to solve the problem, students must gather information, learn investigation and analysis tools and techniques, and apply them to the case. Learning through case studies provides students with a reason for performing laboratory activities and participating in class discussions (Caseau & Norman, 1997).

For example, a unit on water could focus on a fish kill in a river. Students would brainstorm about what could have killed the fish, how toxic substances could have entered the river, and how the river could be tested for pollutants. This would motivate students to learn about the water cycle (how water moves from one area to another) and water pollution. The case-study format encourages students to ask for information as well as use skills and techniques needed to find evidence. Such an activity empowers students to lead the investigation and develop ownership in the process by directing their own learning.

Students request information to help solve the problem and then retain that knowledge. Students who ask questions listen for answers. Such case studies conceal the science content inside the story line. This gives students who do not have a preexisting interest in science the motivation to persist.

Hands-On, Lab-Based Education

In science, students can learn much through experimentation. The process starts with asking questions that lead to experiments, actively conducting experiments, analyzing the results, and drawing conclusions. Furthermore, students need to work in collaborative groups and consult one another to verify and assess interpretation of results. Through hands-on activities and social interactions in a lab group, students are exposed to multiple ways of discovering and learning. If the laboratory activity is well designed and includes questions that guide students to analyze their results, students learn a great deal.

For example, the concept of the law of conservation of mass could be taught in many ways. Students could read about it in a textbook and have the information interpreted in a lecture. In a more interactive approach, students would conduct an experiment to verify the law. The problem with this method is that students who paid attention to the lecture should know what will happen in the experiment. Instead, prior to instruction, the teacher might give each lab group an Alka-Seltzer® tablet, an empty soda bottle, and some water. The students could be instructed to find the mass of all three items, then to find the mass again after the tablet was placed in the sealed bottle. If they performed the experiment correctly, they would discover that the mass did not change. This approach allows the students to teach themselves the law. Since the outcome has yet to be discovered, students will be more focused.

Using laboratory investigations aids the motivation and retention of material for students with disabilities. However, this alone is insufficient. Students with disabilities often lack confidence or the conceptual understanding to acknowledge or recognize when they do not understand a lesson. Therefore, teachers must rely on many techniques to present information and multiple methods to communicate, especially when students fail to ask questions. The following are some strategies for engaging all students, including those with disabilities.

Analogies

Knowledge of popular culture is useful in making personal connections with students and is often a key to unlocking their understanding of scientific concepts (Hesse, 1966; Thiele & Treagust, 1995). The concept of protein channels and active transport in cell membranes is difficult for many students to comprehend. Laboratory experiments do not reveal the microscopic process, and images and animations do little to help students grasp the concept. An analogous macroscopic (large-scale) process can help students visualize a microscopic (small-scale) process. Most students are familiar with the cartoon Scooby Doo™ and are aware that in almost every episode, a character grabs an object, such as a book or candlestick, and an entire section of wall flips to reveal a hidden room. This "flipping" action is very similar to the action of active transport proteins within the cell membrane. A comparison of protein channels to "flippy" doors often seen in the Scooby Doo™ cartoon, helps students visualize the process by using a frame of reference from popular culture.

Cartoons, movies, music, television, amusement parks, and local events provide common knowledge that can be used by teachers to promote student understanding of difficult information. Furthermore, knowing a student personally allows the teacher to choose analogies that are specific to the individual. For example, a student was having difficulty understanding that the eye was a passive receiver of light. She was convinced that "seeing" involved the eye reaching out to objects (a common misconception). Since the student played softball, comparing the eye to a catcher's mitt and explaining that the mitt receives the ball like the eye receives light provided an analogy for the student as to how the eye works (Hesse, 1966; Thiele & Treagust, 1995).

Storytelling

Students often need a context in which to place an idea. Connections made between existing schemas in the brain facilitate new learning. The mention of a place or a person often brings to mind memories and stories associated with it. If connections in the brain are made with a story, students will learn more readily. Storytelling may focus on a student's or a teacher's experiences. For instance, the teacher can relate a personal experience with a surgical procedure, such as a radial keratometry operation to correct near-sightedness. The story of watching the knife descending on the eye and feeling the pressure of the knife on the eyeball engages students and compels them to understand how the lens and cornea help create an image on the retina. Such a story can lead to an experiment with lenses and allows students to see practical uses for the information. Such stories engage students and connect the newly taught information with interesting and meaningful narratives (Wilson, 2002).

Role-Playing

Having students act out roles is engaging to both the actors and the audience. Allowing students the freedom to take on roles can generate interest in a topic. For example, students can be assigned the role of "expert" and be expected to convince classmates that their view is right. This role-play can take the form of a debate, a lawsuit, a presentation, or a committee meeting. Such role-playing promotes deeper understanding than simple memorization, and the dramatizations can lead to greater understanding for the entire class.

In attempting a more meaningful final exam, a scenario can be created whereby the entire class becomes a committee convincing a third world nation that money should be spent trying to prevent diseases. Each student can be assigned to play the role of an expert in a specific area. The students must organize information they have learned and present it to the committee.

With creativity encouraged within the grading rubric, students may see many different types of presentations with information conveyed in forms very unlike the original instruction. This allows many students to grasp the material in new ways. In addition, the teacher gains a much better perspective on the level of understanding students have attained.

Models and Modeling

Science teachers try to explain phenomena that cannot be seen. Electrons, X-rays, the processes of cell membranes, and the interior of the earth have all been investigated without direct viewing. Through many ingenious inventions and thought processes, scientists have described these objects and events (Nersessian, 1999). One challenge of science teaching is to make sense of such elusive phenomena. Models are advantageous as they can give students a visual representation of occurrences at both the macroscopic and microscopic levels.

Physical models can be derived from several sources. They can be commercially purchased, teacher-developed, or better yet, student-created. Models that show processes are better than inactive ones. For example, Crystal Scientific sells a ground water simulator with which dyes can be injected into water wells. As the dye moves through the ground water, the students see the flow of a contaminant in an aquifer, a process which in nature is not easily observable. Chemistry teachers create molecular models simply by using toothpicks and styrofoam balls to visually illustrate molecular configurations. Students can model cell processes by constructing a giant cell with construction-grade plastic and inflating it with a window fan. They can even role-play the movement of molecules in and out of the cell.

In addition, the teacher can model scientific thinking and behavior. Teachers have many opportunities for modeling writing, developing hypotheses, experimenting, analyzing, problem solving, synthesizing, and drawing logical conclusions. Performing an experiment will generate student questions; when a student asks an unanticipated question, a teacher can model how to find the answer. Student questions serve as opportunities to develop hypotheses, discuss resources for solutions, and perhaps carry out an actual experiment to draw conclusions. In sum, both models and modeling are effective strategies for the classroom, particularly for students with disabilities.

Science for All

All students are capable of learning science, and expectations for all students should be the same. This belief intensifies the challenges of science teaching. Hands-on learning with theme-based instruction will reach a majority of students. However, a science teacher must also approach concepts in multiple ways, through analogy, storytelling, role-playing, models, and modeling. These additional strategies will allow students with different learning styles, abilities, and strengths to be successful. By providing multiple ways of learning, teachers facilitate the success of all students.

Resources

Inclusive Science Education Web Site
http://www4.ncsu.edu/~ecparson/ISEFdisabilities.htm

Inclusion in Science Education for Students with Disabilities
http://www.as.wvu.edu/~scidis/

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