Adapting Laboratory Curricula for Visually-Impaired Students

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Abstract: At West Virginia University (WVU) we have adapted our General Biology lab exercises to accommodate several blind students. Upon reflection, we found that most standard lab exercises have a strong visual orientation, and some processes (e.g. mitosis) that are mainly explained through diagrams are difficult to understand from a verbal description alone. To address this problem we developed tactile models and developed Braille-labeled "manipulables" that allow blind students to make their own observations with the help of "seeing-eye student" assistants. We describe the models we have created and the way we have accommodated visually impaired students at WVU.

How we assisted visually impaired students in our General Biology labs

Introduction

Over the past two years, we have had 3 lab sections that enrolled blind students. To our knowledge, this is the first time that this has occurred in West Virginia University's (WVU) General Biology program for non-majors. At the time, we had some experience with students who had other disabilities (such as learning disorders or hearing impairment), but they generally required only minor accommodations (such as extra time on tests, copies of lab lecture notes, or a sign-language interpreter) in order to succeed—no modification to the curriculum was necessary. When considering the needs of a visually-impaired student, however, the highly visual nature of biology laboratory exercises becomes quite evident. Whether the exercise focuses on microscopy, dissection, titration, or other lab techniques, most of our measuring tools, observation methods, and experiments rely on vision. What follows is a summary of our findings and strategies in working with a small number of visually-impaired students. For a more detailed discussion of accommodating visual and other disabilities, we recommend a web site developed by Edward Keller (Keller, 2006).

Logistical Concerns: How to provide one-on-one assistance

In our experience, visually impaired students need individualized assistance in the lab to truly benefit from and fully participate in laboratory exercises. This poses a logistical challenge, since a single instructor cannot simultaneously teach 24 students and provide the needed time and assistance to a visually impaired student, and relying on the goodwill (and level of understanding) of undergraduate volunteers is neither reliable nor fair to other students enrolled in the course. As a solution, we hired an undergraduate as a personal "sighted assistant" for each visually impaired student, using funding provided by the Dean of our college. This assistant (usually a senior with solid biology background) served as both scribe and interpreter for the visually impaired student during laboratory exercises.

The "assistant" accompanied the blind student to the lab each week, gave descriptions of any diagrams used in the lab, described the experiment and results, read values from any measuring devices, and acted as reader and scribe for post-lab questions. Before each lab session, this assistant read the lab, met with the TA or lab staff as needed for guidance, and constructed models or alternative activities that used other senses such as touch, smell, or hearing.

A positive outcome of this "undergraduate assistant" method was that the visually impaired student and his assistant developed a good working relationship. As a result, the assistant not only was scribe and reader during the lab, but also helped with some portions of the lecture course. She served as reader and scribe during exams, assisted with online activities and homework for the lecture course, and also over time evolved into an informal biology tutor. We were fortunate that the student assistant we hired was creative, independent, and ambitious, and she created most of the tactile models listed in Table 1. Most importantly, this arrangement seemed to benefit the visually-impaired student, as he chose to enroll in a second semester of non-majors biology lecture and lab.

Logistical Concerns: Safe Navigation

As with all other students, visually impaired students must be kept safe in the lab, which may require some additional modifications to layout or habits. When students travel with guide dogs, special care must be taken to remove broken glass or other hazards from the floor. In our experience, guide dogs are well-behaved and will lie down quietly, so it helps to seat the student along one side of the classroom. The only problem we observed was that other students needed to be reminded not to pet or distract the dog, since this was a new classroom experience for many of them. For visually-impaired students who navigate with a cane, we needed to be more careful with placement of objects in hallways or service corridors. We found that these students often used sounds or seemingly fixed objects (like large aquaria) for navigation—and small displacements of these objects sometimes caused them to become disoriented. We also needed to be especially mindful of where we stored carts and other lab equipment, so as not to obstruct walkways.

Modifications to Lab Exercises

In practice, we found that most of our lab exercises relied heavily on visual observation. Whenever possible, we modified existing activities (Table 1) so that the visually impaired student could participate directly in the same lab, answer the same questions, and (ideally) experience the same learning outcomes as his or her classmates. As an example, we modified a natural selection lab that relied on visual recognition of variation (e.g. dark or light coloration of organisms) to instead depend on differences in texture between the simulated “organisms” (e.g., smooth paper vs. sandpaper).

In other exercises that required observation or measurement of chemical reactions or living organisms, the assistant announced what was happening: “Another bubble has formed,” or “it changed color,” or “the worm’s heart beat 20 times.” At the end of the data-collection period, the sighted-assistant would then describe the data, read any numbers, and ask the student to describe any trends. Graphing was problematic, as it is primarily a visual representation—so we generally dispensed with graphing for a verbal description of trends. We had some success with having the student “graph” using yarn and a plastic (or rope) grid, but this generally only worked with visually impaired students who had been sighted at some point—those who were blind from birth found this activity confusing and unhelpful. The rest of the lab exercise, however, could be used with very little modification.

In some cases, however, we had to develop completely different activities for lab exercises that were heavily “visually oriented” and descriptive (e.g. microscopy). As an example, the visually impaired student studied tactile models of the cell and organelles constructed (by the sighted assistant or lab staff) from pipe-cleaners, paper, or thin sheets of foam. One major shortcoming of this approach is that our models were generally two-dimensional representations of three-dimensional objects. While this representation seems sensible to a sighted person accustomed to viewing two-dimensional “slices” through a microscope, it is less meaningful to a visually-impaired student who is unfamiliar with microscopic images. The success of this approach depended heavily on a good verbal description and guidance from the sighted assistant to get the information across.

Materials

Before the beginning of the semester, our lab manual was translated to Braille by a local vendor known to our Disabilities Services office. Other written materials (e.g. quizzes, study guides, and modified post-lab questions) were either sent out for translation into Braille or were read aloud by the sighted-assistant. In practice, some quiz and post-lab questions needed to be modified slightly to include information or models from the altered lab exercise.

The materials we used were generally inexpensive—the biggest investments required were creative rather than financial. We used paper, sandpaper, dimensional fabric paint, adhesive foam sheets (available in most craft stores), pipe cleaners, yarn, pompons, glitter (for texture), abundant quantities of hot glue, and a low-temperature glue gun. Where necessary, text was added to models using a Braille tape-strip labeler (see vendor below). In general, we focused on texture and shape to emphasize features instead of differences in color.

Vendor for Braille tape-strip labeler: 3M Braille Labeler
Cost: **About** $35.00
Independent Living Aids, Inc.
27 East Mall
Plainview, NY
(800) 537-2118 or fax (516) 752-3135
Retrieved August 27, 2006 from
http://www.independentliving.com/

Table 1. Examples of Modified Lab Exercises

Lab Exercise Topic	Traditional Lab Exercise	Modified Version
Mendelian Genetics	Students count corn kernels and determine phenotypic ratios based on color and texture; write out several Punnett squares.	Students count corn kernels based on texture only, and determine phenotypic ratios; use Braille-labeled tiles to construct Punnett squares.
Enzyme Action	Students view diagrams illustrating enzyme-substrate fit, and then carry out an enzyme catalyzed reaction.	Students use a puzzle (Figure 1) to investigate enzyme-substrate fit, and then carry out an enzyme catalyzed reaction with the help of an assistant.
Diffusion	Students observe diffusion of dye in cold versus hot water.	Students observe diffusion of perfume through a room using scented oil. With help of an assistant, student places a drop of oil inside a balloon to observe diffusion through a membrane.
Natural Selection Simulation: Peppered Moths on a Tree Trunk	Students strew gray and white paper "moths" over photos of tree bark in different shades of gray. Student "birds" harvest the moths with poorest camouflage. The effect on the population is graphed over several generations.	"Moths" and "tree trunks" are made from sandpaper, which is smooth on one side and rough on the other. The simulated "bird" harvests moths based on texture differences. The overall trend in the population is examined over several generations.
Antibiotic Sensitivity	Students place antibiotic disks on a lawn of bacteria. At the next class, the zone of inhibition is measured with a ruler.	The activity is described to the student during the first week. A simulated "Petri dish" made of paper is used for safety: sandpaper disks simulate antibiotic disks, and dimensional fabric paint simulates the bacterial lawn. Zones of inhibition are measured qualitatively by touch.
Allele Frequency and Population Genetics	Students count out two colors of bingo chips representing different "alleles." Students randomly withdraw chips from a bag to carry out "matings" and record genotypes and phenotypes. The activity is repeated with different "allele frequencies."	Half of the bingo chips are replaced with chips covered with sandpaper on one face. These rough and smooth "alleles" are used in the exercise.
Mark/Release/Recapture	A terrarium full of crickets simulates a population. Students capture and mark a subset of these crickets with correction fluid, and then release them into the terrarium. After a short delay for "mingling," a sample is recaptured. Standard equations are used to estimate the population size.	Pom-pons are substituted for crickets, which are marked with a felt-tip marker. The terrarium is shaken to simulate movement of organisms. A sighted assistant helps to recapture and analyze the results.

Mitosis/Meiosis	Students observe cells in mitosis using microscope slides of onion root tips. Students examine a drawing of cells in meiosis, and draw their own diagram with a different number of chromosomes.	Students study a tactile, two-dimensional model of the stages of mitosis and meiosis. A sighted assistant describes the steps and quizzes the student.
Karyotyping	Students cut out simplified diagrams of chromosomes from a fictitious "patient" and paste onto a karyotype template. They then analyze the karyotype for missing chromosomes and report on the likely condition of the patient.	Students analyze a pre-made three-dimensional karyotype created with dimensional fabric paint. Chromosomes are analyzed based on relative length and centromere position. The student analyzes the karyotype and reports on the patient's genetic status.

Literature Cited

Keller, Edward. 2006. Disabilities, Teaching Strategies, and Resources. Retrieved August 27, 2006 from http://www.as.wvu.edu/~scidis/sitemap.html

About the Authors

Jane Caldwell received her B.S in integrated science and biology from Northwestern University, and her Ph.D. in biophysics from the University of Wisconsin at Madison in 1992, where she specialized in protein structure by NMR. Jane has been teaching for just six years, but during that time has taught at a private high school, a single-sex middle school, a community college, a small liberal-arts college, and a large research university. She currently is a Senior Lecturer and Program Coordinator for the non-majors General Biology program at West Virginia University. She teaches introductory non-majors biology and an advanced course on protein structure and function. Her current professional interests include incorporating active learning into the large lecture classroom.

Kristi Teagarden received her B.S. in Biology from Bethany College in 1999. She worked as a Clinical Microbiology Technician at WVU Hospitals from 1999 – 2002, and as a Laboratory Technologist I at Precision Therapeutics Inc. from 2002-2003, where she conducted primary cell culture and chemosensitivity testing on cell lines from oncology patients. She has been the Academic Lab Manager for the Non-Majors General Biology Program at West Virginia University since 2003. She received the Eberly College Outstanding Staff award in 2005. Her current professional interests include developing practical introductory microbiology labs for non-scientists, and maintaining a virtually perfect lab safety inspection record.