Tried & True

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Time-Tested Activities for Middle School

Edited by Inez Fugate Liftig

NSTA press
National Science Teachers Association

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Preface

by Inez Fugate Liftig

Every rock band has its signature songs, every restaurant has its specialties, and every magician has a famous trick. So it is with science teachers. We each have our own special activities and demonstrations, and we improve upon them every year. We may not remember where we originally found the lessons—perhaps from a former teacher, a mentor, a textbook, or a workshop—but they have become an integral part of our classroom instruction.

Every year, some of our incoming students know they will do certain labs or see particular demonstrations in our classrooms. Word is passed down from sibling to sibling, and some students start asking for these activities on the very first day of school. Older students who come back to visit us often recall these activities and vividly describe their favorites.

It is these kinds of activities that *Science Scope* hoped to capture when the editors introduced the "Tried and True" column in February 2003. We did not solicit or recruit a specific writer, as we do for other columns, because we wanted submissions from as many of our readers as possible. We wanted as full a representation of the nature and variety of classic science activities as we could get. So our call for papers has remained more or less the same over the intervening years:

> *Do you have an activity that has withstood the test of time, one that deserves a place in any collection of lab classics? Perhaps you have been doing it so long that you have forgotten where you originally found it, or you have changed it so much that it hardly resembles the original. Tell us what makes the activity worth keeping. Is it the never-fail excitement it generates with students? Is it the clarity with which it teaches a concept? Is it the ease with which it develops valued lab or process skills? What special ingredients or twists do you add to make the classic version even better?*

Many of these activities originated before computers and calculators were used in classrooms, but they are timeless and most can easily be refitted to incorporate today's technology—including probes, gauges, sensors, computers, and other interactive media devices.

Every teacher has his or her own special reason for using a Tried and True activity, but the multipurpose, flexible nature of these classics is part of what makes them so enduring and so endearing. What serves as a springboard introductory activity for one teacher can be a unit capstone for another; what is a formative assessment in one class can be part of a summative assessment in another. For example, if the "Egg-in-the-Bottle Demonstration" is done at the start of a unit on heat and air pressure, as the author suggests, it will reveal students' prior knowledge of the topic and any preconceptions they might have. However, the same activity would work equally well as a summative assessment at the end of an air pressure unit to let the teacher know whether the students had understood the concepts taught. In the same way, assigning the writing task described in "Peanut Butter and Jelly Science" before reviewing procedure writing will let the teacher know how much practice students need with the process. That same exercise, on the other hand, could be turned into an excellent essay question at the end of a review unit on direction writing.

Organization of This Book

The volume in your hands contains a varied and useful collection of "Tried and True" columns from the past seven years. They are organized by instructional strategies and the core science disciplines—life science, Earth and space science, physics, and chemistry.

Activities that can be used as stand-alone lessons to develop particular science skills appear first in the book, under the heading "Developing Inquiry Skills." However, applicable content can be easily incorporated into any of these lessons to teach science skills in tandem with other topics of study. Similarly, many of the content-specific lessons listed in core areas of science can be turned into stand-alone science skills activities.

Some of the activities in this collection fit more than one science content area. "Soil Is More Than Just Dirt," for example, is listed as a life science activity, but it could easily be crafted into an Earth science activity as well. Similarly, "Evaporating Is Cool," which falls under chemistry here, would make an excellent weather or water cycle–related Earth science activity.

You can also use the lesson formats of these activities as templates for designing or restructuring your own investigations and demonstrations. "Tried and True" activities can be enhanced with the use of higher-level critical-thinking questions or extended into more open-ended inquiry investigations. With additions, many of these activities can easily become 5E inquiry lessons, and those which are more teacher-centered can be made more student-centered by giving fewer directions and less information to students.

Veteran teachers will find new activities within this collection, or new twists to activities they are already doing, but this collection will be especially useful to new teachers who are just developing their own signature lessons. Will students start to know you as the teacher who shuffles cards? Or perhaps as the one who asks her students to write advertisements for cell organelle jobs? Only time will tell.

Safety Note

These activities do contain safety precautions. However, before attempting any activity with students, work through it step-by-step on your own so you know what to expect. Then add whatever supplemental safety instructions or warnings you feel are necessary.

19 How the Brain Visually Perceives the World

by Rogene M. Eichler West

These classic activities explore how our eyes and brain receive and process visual information. Each activity requires approximately five minutes. For a richer experience with these activities, consult a neuroanatomy guide with labeled images of the named visual and brain regions, and see if you can determine the pathways along which visual information is being processed.

Acknowledgments

The project incorporating these activities, the Science of Art program at the Museum of Glass in Tacoma, Washington, is generously supported through funding from the Washington State Arts Commission's Art in Education Program.

Activity Worksheet 1

See like a bee

Materials

- Ultraviolet/black light
- Flowers
- Miscellaneous objects

Background Information

Perceiving the world around us begins with vision, and vision would not be possible without light. This is because our eyes, with all their biological complexity and beauty, are really just sophisticated photon detectors. Photons are very small particles that are emitted by light sources such as the Sun or a lightbulb. Photons travel away from their source at the speed of light (3.0×10^8 m/sec) but at different wavelengths, depending on the amount of energy they contain. Certain wavelengths activate the receptors in our eyes. Only a small range of the entire spectrum, or range of wavelengths, is visible to humans. We perceive the longer wavelengths in the visible spectrum as red and the shorter wavelengths in the visible spectrum as violet. Some animals, such as bees, can see farther into the ultraviolet range than humans. What would the world look like if we could see like a bee?

Safety Note

UVA light sources are safest (do not use UVB or UVC), but even UVA black lights should be used judiciously. Never stare into the light or expose skin to the light. UV-protective eyewear should be worn during prolonged or repeated exposure. Follow all usual precautions with electrical devices.

Procedures

1. Examine the objects at the table under normal light and then under ultraviolet light.
2. Describe how their appearances change under the ultraviolet light.

Activity Worksheet 2

Disappearing dot

Materials

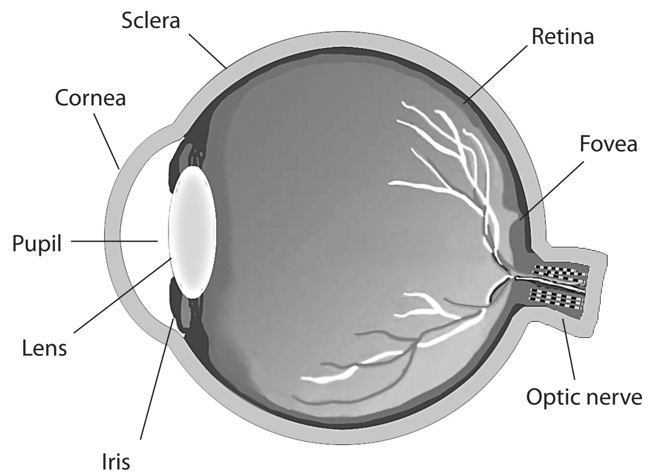
- Copies of Figures 1 and 2

Background Information

Can you name all the parts of your eye? The white part is called the *sclera*. The colored part is called the *iris*. The iris constricts and dilates to control the amount of light (number of photons) entering the eye through the *pupil*. The *cornea* and *lens* focus this light onto the *retina*, which is located on the back wall of the eye. The retina is composed of two different kinds of light-sensitive receptor cells: *rods* and *cones*. Their concentration is highest in an area of the retina called the *fovea*. In contrast, there is another location, called the *blind spot*, or optic disk, where there are not any receptors. This is to make room for nerve fibers and blood vessels to exit the eye via the *optic nerve*, sending signals onward to the brain (see Figure 1). How is visual acuity influenced by this arrangement?

Figure 1

Inside the eye

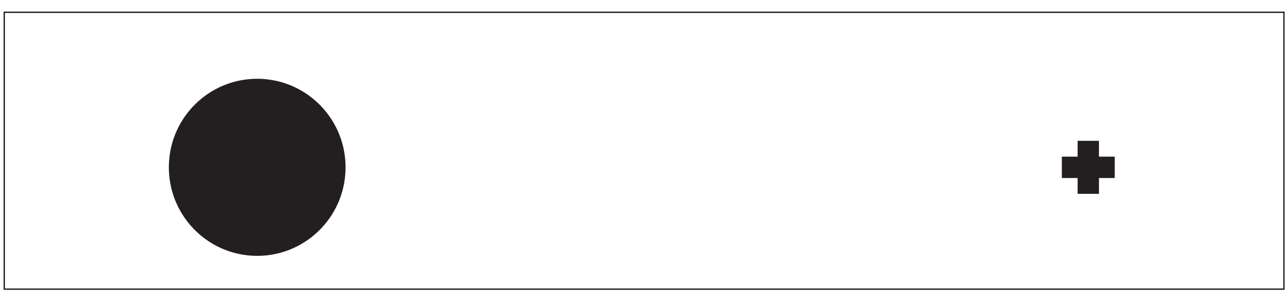


Procedures

1. While holding Figure 2 at arm's length, close your right eye while focusing your left eye on the +. Slowly move the paper toward you while keeping your eye focused on the +.
2. At a certain distance—specifically, when the light from the image falls onto the portion of the retina without receptors—the dot will "disappear." Keep moving the paper toward you until the dot reappears.
3. Repeat this exercise with the opposite eye.

Figure 2

In your blind spot



Activity Worksheet 3

Color correction

Materials

- Copies of Figure 3

Background Information

Rods are more sensitive to light than cones. In fact, rods are so sensitive that they will respond to a single photon! The retina contains more than 10 times as many rods as there are cones. However, rods don't respond with information about color; they send a black-and-white picture of the world to the brain. Cones transmit color information. There are three kinds of cones, each primarily sensitive to light of a particular wavelength (red, green, and blue). The light-sensitive chemicals inside rods and cones, called *photopigments*, are a form of vitamin A. There are a number of optical illusions caused by activating only some of the cones. These illusions are known as *afterimages*.

Procedures

1. Stare at the image in Figure 3 for 15–30 seconds. Then shift your gaze to a sheet of white paper.
2. What colors do you see in the white area and how are these colors related to the colors in the image? (Hint: When you stare at a particular color for too long, the cones associated with those colors become fatigued. Then, when you look away, the information sent from the combination of cones is no longer in balance and you see the complementary colors, which represent activity of the nonfatigued cones.)

Figure 3

Complementary colors

Activity Worksheet 4

Gone in the blink of an eye

Materials

- Copies of Figure 4 (for reference)

Background Information

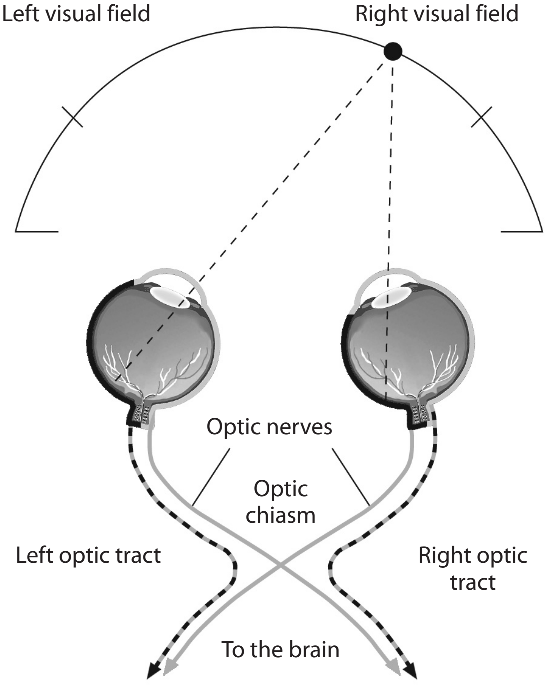
The retina contains five types of neurons that form a network to combine and process the signals produced by the rods and cones before relaying information to the brain. The optic nerve is composed of one of these neuron types, the ganglion cells. Via the optic nerve, each eye sends a two-dimensional imprint of the world to the brain. In an area of the brain called the *optic chiasm* (see Figure 4), the signals from both eyes are split such that information about the left half of the visual field is sent to the right side of the brain and information about the right half of the visual field is sent to the left side of the brain. It is the brain, and not the eyes, that reconstructs our perception of the world as three-dimensional.

Procedures

1. Focus on an object 6 to 10 m away. Close one eye and hold up your arm to line your finger up with the object.
2. Without moving your finger or your head, change which eye is open. (You will find that the farther away the object, the greater the distance your tracking finger will appear to move when you change eyes.)
3. Propose a theory as to how the brain uses these differences to estimate depth.

Figure 4

Seeing in 3-D



Activity Worksheet 5

Bright sight

Materials

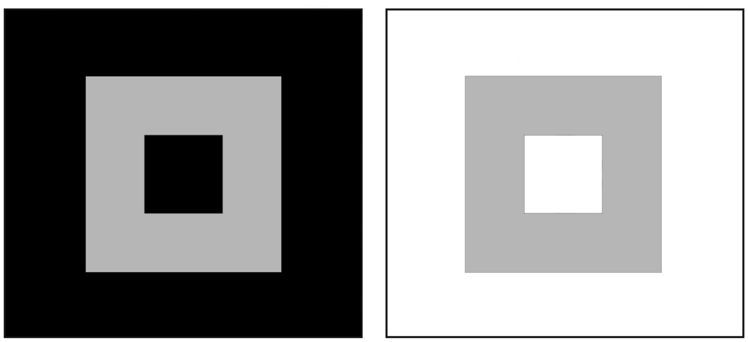
- Copies of Figure 5

Background Information

The optic nerves make connections with other neurons in the *lateral geniculate nucleus* (LGN), the *superior colliculus*, and the *pretectal region*. These structures are all located in the brain stem. The LGN enhances the contrast between signals from adjacent areas of the retina before forwarding the signal on to the visual cortex. As a consequence of this contrast adjustment, we find that the appearance of an object depends not just on the color and intensity of the object, but also on the color and intensity that surrounds it. Contrast allows our brains to compute the edges, or boundaries, that define objects in our visual environment. When these contrasts change over time, we perceive movement.

Figure 5

Shades of gray



Procedures

1. Which gray square in Figure 5 appears the brightest?
2. Cut out the two gray squares and remove their inner squares as well. Place them on a sheet of white paper. Now which square appears the brightest?
3. How do you account for any changes in your perception?

Activity Worksheet 6

Role call for pupils

Materials

- Penlight, low intensity with a focused beam (less than 10 lumens is considered both safe and effective) and a colored cap

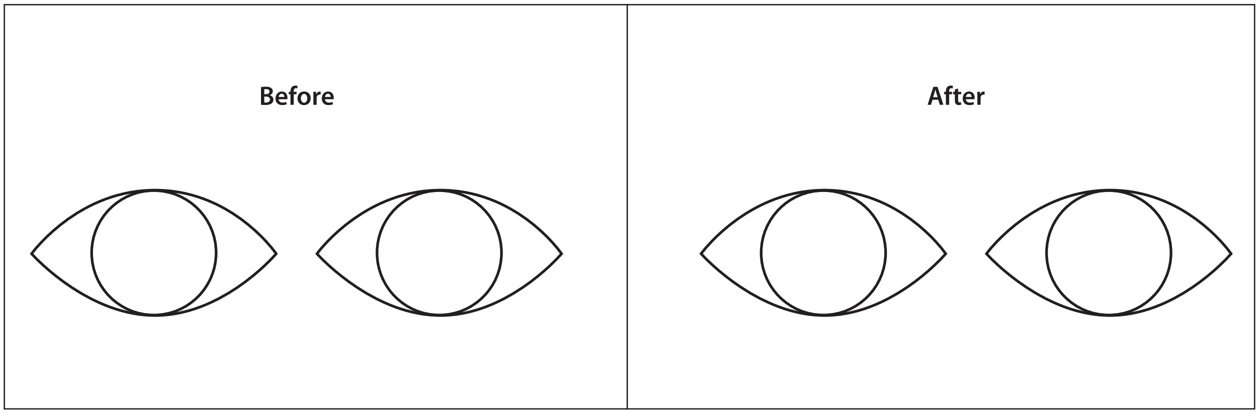
Background Information

The *pretectal* region of the brain controls the pupillary light reflex by sending messages back to the muscles controlling the constrictor muscles of the iris. The reflex is consensual: When one eye is exposed to bright light, the pupils of both eyes will constrict (although not always to the same extent). Physicians often test this reflex in accident victims to determine whether the brain stem has been damaged.

Procedures

1. Turn off the classroom lights and go to an area near a window with a friend. Take note of the relative size of the pupils in both of your friend's eyes in natural light.
2. Shine a small light at your friend's forehead, between the eyes but not directly into either eye, for a few seconds. Then examine both eyes again.
3. What size are the pupils now? Did both eyes change size or just the eye that was illuminated? Sketch the eyes before and after the light.

Figure 6



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