Bay Area Scientists in Schools Presentation Plan

Lesson Name: Is Seeing Believing?
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Grade Level 4th
Standards Connection(s): PS: Light has a source and travels in a direction. Light is reflected from mirrors and other surfaces. Vision: We see objects when light traveling from an object enters our eye. LS: Structures of living things help them grow, survive and reproduce.

Next Generation Science Standards:

4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena. (4-PS4-2) Use a model to test interactions concerning the functioning of a natural system. (4-LS1-2) Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Construct an argument with evidence, data, and/or a model. (4-LS1-1)	PS4.B: Electromagnetic Radiation An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2) LS1.A: Structure and Function Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1) LS1.D: Information Processing Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)	Cause and Effect Cause and effect relationships are routinely identified. (4-PS4-2) Systems and System Models A system can be described in terms of its components and their interactions. (4-LS1-1), (LS1-2)

Common Core Standards:

ELA/Literacy:

RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

SL.4.5 Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.

Mathematics:

MP.2 Reason abstractly and quantitatively.

MP.5 Use appropriate tools strategically.

MP.4 Model with mathematics.

FOSS Connections:

Grade 4 Module: Matter and Energy

Investigation 2: Light

Teaser: Vision is our most important sense. Even though we have very keen vision, sometimes our brain can lead us astray and cause us to perceive things that aren't really there. In this lesson, we will first focus on the parts of our bodies that we use to see by tracing light from the retina to the visual areas of the brain. Then, in three interactive stations, we will show that the brain is actually causing changes in what we see.

Vocabulary/Definitions: 3 – 6 important (new) words

- Neuroscience- The study of the brain and how it understands things
- Retina- a layer at the back of the eyeball containing cells that are sensitive to light
- Optic nerve- nerves that carry the images from the retina to the brain, where the brain makes sense of what is happening
- Photoreceptors (Rods & Cones)- The rods are most sensitive to light and dark changes, shape and movement and contain only one type of light-sensitive pigment. Rods are not good for color vision. The cones are not as sensitive to light as the rods. However, cones are most sensitive to one of three different colors (green, red or blue). Cones only work in bright light.
- Interference and Adaptation- Interference is when you're prevented from doing something. Adaptation is when you make changes in order to do something better.
- Opponent colors- The ideas that the colors red, yellow, green, and blue are special in that any other color can be described as a mix of them, and that they exist in opposite pairs.

Materials:

What will you bring with you?

Mirrors; Visual illusions; Kitchen timers; Stroop worksheets

What should students have ready?

Pens/pencils, paper, scissors

Classroom Set-up:

Power for laptops
Have the students split into 3 groups

Classroom Visit

1. **Personal Introduction:**
   We are neuroscience graduate students from UC Berkeley. That means we study the brain.

   Topic Introduction: **10 Minutes**

   Ask what they think is their most important sense. Ask how they navigate their world or get around from day to day. Ask how or with what body parts they see. Trace the visual pathway from eye to brain. Mention that information from the eye travels along the optic nerve to the brain. Introduce the idea of the brain changing the physical world to figure out what the images mean. Emphasize that it helps you make sense of what you see in the world, but sometimes it can make mistakes.

   Today we're going to talk about one of our senses. Can anyone name the five senses? [briefly (everyone can say aloud)--hearing, smelling, touching, tasting, seeing.] The senses help us make sense of what's going on the world and let us know what's good for us and what's bad for us. Which one do we use the most? [Vision.] What body parts do we use to see? [Eyes.] That's right. Our eyes gather information from the outside world, but they don't help us figure out the meaning of what we're seeing. Our eyes are just the first step.

   What body part do you think lets us figure out the meaning of what we see? [The brain.] Let's talk about how information from the eyes gets to the brain. Does anyone have any ideas? What you see travels along the optic nerve, which goes all the way from the back of your eye (the retina) to a part of your brain called the visual cortex. Once it gets there, the brain actually transforms or changes what you see into something useful.

   How can we show that the brain is doing something to the information that's coming from the eye? Well, sometimes the brain gets tricked. [Show example visual illusion] These are called visual illusions, and you'll see more of them at one of the three stations we have set up. At Courtney's station, you'll see how the brain can be confused if it receives mixed messages. At Elizabeth's station, you'll work with mirrors to show how the brain is actually changing the information it receives from the eyes. We'll split you up into groups, you'll spend about 15 minutes at each station, and then you'll move on to the next.

2. **Learning Experience(s):** **45 Minutes**
   What will you do, what will kids do? Demonstrations, hands-on activities, images, games, discussion, writing, measuring… Describe in order, including instructions to kids.

The students will be split up into four groups (7 or 8 students per group). Each group will move to a station, where they will spend 10 minutes before rotating to the next. The four stations will be:

1. Stroop task:

Materials we bring:
Stroop worksheets
Kitchen timers

Materials provided by classroom:
Writing utensils

Who knows what interference means?
Interference is when you're prevented from doing something. In this activity, we're going to look at what happens when the brain gets mixed or conflicting messages -- when one message interferes with the other, especially when one of those messages is very automatic or something we do all the time.

What's an activity that you do all the time in school and outside school? [Reading].
Right, reading is a very automatic or practiced activity for you by now. Now, let's think about what happens when your brain gets conflicting messages with something that's not as automatic. See how this page has a bunch of color words printed in different colored ink? This is a famous task called the Stroop task. Here is your job: name the color of the ink that these words are printed in, <u>do not</u> read the word. *[Explain and have a volunteer read a few examples of Stroop words; have the students discuss why this is difficult].*

Ok, now we're going to get into pairs and time each other first reading regular words and then reading the Stroop words. You'll record your partner's time on their sheet. Which side do you think you'll be faster at and why? We'll have a contest to see who can go through the colored side fastest.

Follow-up thought questions:

- What might be another thing you could keep track of to measure performance during the Stroop task?
- What do you think would happen to your scores if you read the colored side 10 more times?
- If you have a younger brother or sister who just learned to read, which side of the paper do you think they'd be faster at?

2. Illusions: [adapted from the Whitney Lab and University of Washington Neurobiology and Behavior Outreach:http://faculty.washington.edu/chudler/eyecol.html]

Materials we bring:
Printed out illusions/ computer with illusions

Materials provided by classroom:
None

Who knows what an optical illusion is?

An optical illusion is when you're tricked into seeing something that isn't there. There are many different illusions that can trick our eyes. Scientists have used visual illusions to learn more about our vision. I will now show you some illusions with color.

Look at the black and white picture. Do you see any color there?

Stare at this image for 30 seconds. Why do you think you are seeing colors that aren't there?

I will now tell you how we see color. Have you noticed that as daylight fades or as room lights dim, colors become hard to identify? Do you remember what the retina is? Our color vision depends on special cells in the retina of the eye called photoreceptors. The two color-sensitive cell types are called cones and rods.

Cones only work in bright light and help us see color. Rods take over when it gets dark, but rods don't really help us see colors. In the retina of your eyes, there are three types of color receptors (cones) that are most sensitive to either red, blue or green. When you stare at a particular color for too long, these receptors get "tired" or "fatigued." When you look at a different background, the receptors that are tired do not work as well. Therefore, the information from all of the different color receptors is not in balance. You see the color "afterimages." (Show opponent colors) These pairs are called opponent colors: red with green, and blue with yellow. An afterimage occurs when we "tire out" the cells that correspond to a given color. Tiring out those cells allows their opponent cells to fire relatively more strongly.

Here are some more illusions. Which colors are you seeing in the black and white image? How do you think scientists figured out what our opponent colors are?

Scientists have been able to figure out some details about our vision using the illusions that I just showed you. We will now look at an illusion that we don't understand yet. (Make Benham's disk).

3. Mirror drawing: adapting our actions to new sights
[adapted from University of Washington Neurobiology and Behavior Outreach: http://students.washington.edu/nbout/LessonPlans/mirrordrawing.pdf]

Materials we bring:
- 6x6 mirrors
- shape printouts

Materials provided by classroom:
- writing utensils
- stopwatches (optional)

General set-up:

Students are paired in groups of two and take turns drawing and helping. The helper student holds up the mirror and uses a piece of paper or folder to cover the hands and paper of the student drawing at a desk. The student drawing looks in the mirror while tracing between the lines on a shape printout.

Quick introduction:

- Our eyes guide how we move around in the world.
- We do a lot of things without having to think very hard about what we're seeing and doing.
- Give an example; show how people can react quickly without thinking. For instance: "clap when I count to three: one, two, three!" or "quick, draw a circle in the air." Then ask what went into being able to do the action they just did.

Observations (hopefully made by students):

- At first, it is hard to stay within the lines, and your hand wants to draw in the wrong direction.
- After practicing (drawing 2-3 shapes), it gets faster and easier to do

Questions to guide students through ideas:

1. Do you think it will be/is easier or harder to trace something while looking in the mirror vs. just looking at the paper?
2. Why might it be harder to trace while looking in the mirror?
3. What does the mirror do to the image you are tracing? (It reverses it.)
4. What happened as you traced more and more objects? Why did that happen?
5. What do you think would happen if you did everything by looking in a mirror for a long time i.e. a week? What would happen if you stopped using the mirror again?
6. Why might it be important for the brain to be able to adapt like this? (i.e. if you go blind in one eye; learning a new skill like driving (maybe they won't be able to identify with this); when you swim under water; when you learn cursive/how to write.)

Take home messages

- When we change what we see so that it is different from what we touch (i.e. using a mirror) then our brains get confused and we have to think harder about what we do.
- When our brains get confused, we make mistakes.
- The brain can learn and adjust to new things we see.

3. Wrap-up: Sharing Experiences **3 Minutes**

Recap the activities in each station while clarifying main themes. What did the kids do? What did they learn? Connect themes from each station to a general idea of how the brain interprets visual input. Ask for questions.

4. Connections & Close: **2 Minutes**

What else might kids relate to this to from their real-life experience? How can they learn more? Thanks and good-bye! Clean-up.

Next time you use your eyes, think about how your brain is processing the image!

Total 50 – 60 Minutes

Differentiated Instruction:

English Learners: Repeat directions, if necessary, and physically model how to perform activities at each station. Provide students with anatomy vocabulary at the anatomy station. Write vocabulary words on the board and read words aloud. Vocabulary words can also be visually demonstrated using an illustration or action and redefined in very simplistic terms.

Advanced Learners: Have students try mirror drawings with their non-dominant hands.

Follow-up Possibilities

ELA Activity:
Suggest students write a letter explaining "How we learned about vision and how we see..."

Reading Connections:

- The Brain: Our Nervous System by Seymour Simon http://www.seymoursimon.com/index.php/books/detail/the_brain/
- Seeing (Senses and Sensors) by Alvin Silverstein http://www.amazon.com/Seeing-Senses-Sensors-Alvin-Silverstein/dp/0761316639
- The Complete Human Body by Dr. Alice Roberts http://www.amazon.com/Complete-Human-Body-Book-DVD-ROM/dp/075666733X/

Mathematics Activity:
-Have students identify symmetrical portions of the brain on their brain diagrams.
-Students can time themselves (multiple trials) drawing a mirror illustration and then calculate the average time.

Other:
Lots of related follow-up activities can be found in the Exploratorium's Snack Book (http://www.amazon.com/The-Exploratorium-Science-Snackbook-Jossey-Bass/dp/0470481862/) or on the associated website: http://www.exploratorium.edu/snacks/