Bay Area Scientists in Schools Presentation Plan

Lesson Name: OpenScope – Build Your Own Microscope!
Presenter(s): Malav Desai, Pamela Jreij, Harrison Liu
Grade Level 3rd Grade

Standards Connection(s) 3rd Grade Physical Science – Light has a source and travels in a direction. (4) Vision: We see objects when light travelling from an object enters our eye.

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.

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)	PS4.B: Electromagnetic Radiation ▪ An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2)	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.

Mathematics:

MP.2 Reason abstractly and quantitatively.
MP.5 Use appropriate tools strategically.
MP.4 Model with mathematics.

FOSS Connections:

Grade 3 Module: Matter and Energy
Investigation 2: Light

Teaser:

Meet graduate students from UC Berkeley and learn about how we study biology and use engineering to design solutions to problems. Students will learn how a microscope works and build one ourselves!

Objective: As a result of your lesson, what will students learn? What will they be able to do?

Students will learn how lenses bend light to form images as well as the parts of a microscope. Students will also have a chance to put together their own simple microscope

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

Lens, image, objective, eyepiece

Materials:

What will you bring with you?

OpenScopes and various other demonstration materials

What should students have ready (pencils, paper, scissors)?

Rulers, paper, pencils

Clear desk space – at least 2 feet for each Openscope

Classroom Set-up:

- Students should be in groups of 2-3.
- The classroom should not be overly bright.
- We will also need ~15 minutes of set-up/clean-up time each.

<u>Differentiated Instruction:</u>

English Learners: Repeat directions, if necessary, and physically model how to build microscope. Write vocabulary, e.g. lens, microscope, 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 create other images with their microscopes.

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OpenScope Lesson Plan

Subjects: Light, lenses, optics, image formation, microscopy
Learning Objective: By the end of the lesson students should understand how lenses bend light to form an image, how the image will be affected as the lens is moved, the names of the image forming lenses of a microscope (objective and eyepiece), and the basics of how a microscope magnifies a sample.
Team Members: Malav Desai, Pamela Jreij, Harrison Liu
Lesson Plan Quick Summary: A demonstration of a teaching microscope will be given and the students told that by the end of the class they will have constructed their own microscope. Students will first learn that light bends when moving from one material to another via a demonstration using a glass of water. Next, students will work together in pairs or groups of threes using a provided OpenScope to create an image of a famous scientist on a piece of wax paper. The students will be asked to move the lens back and forth to demonstrate how lenses work. A second lens will be provided to magnify the image further. It will then be revealed that they have created a compound microscope and more detailed explanations given.

Required Materials:
Desk space (~2 feet required for the OpenScope)
Paper
Pencils
Ruler

Provided Materials:
Pen-in-water light bending demonstration
OpenScopes (enough for 2-3 students per scope)

Detailed Lesson Plan

<u>Introduction</u>

- We are graduate students from UC Berkeley and UCSF
- We study biology and use microscopes a lot
- Today we're going to show you how they work and let you build your own!

<u>Microscope Demo</u>

- We use microscopes to look at *really small things*
- Pass around a bunch of prepared slides (all of the same sample) – tell kids to look at it
- Now place our own slide onto a teaching microscope – we can now see a lot more detail!
- Summary: microscopes let us look at very small things – this is important in biology where we look at worms, flies, cells, all of which are very small!

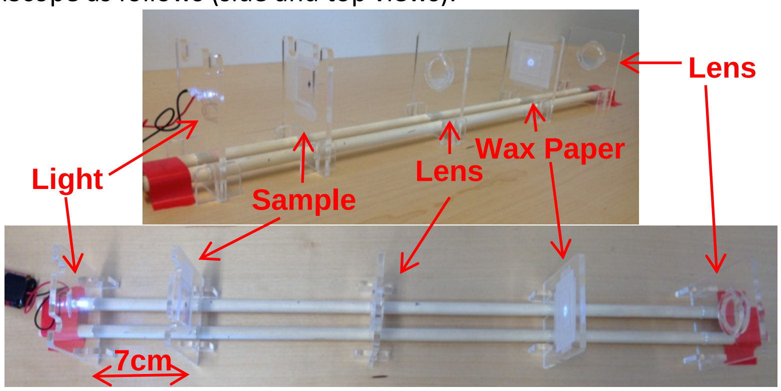
<u>Light Bending Demo</u>

- So microscopes make small things bigger, but how do they work?
- They work by bending light in such a way that things look bigger than they really are!
- Tell kids to look at a beaker with a pen inside, fill slowly with water, did anything change?
- The pen should look like it got cut off – this is because anytime light moves from one material to another it will *bend* cause the pen to look like it got cut off

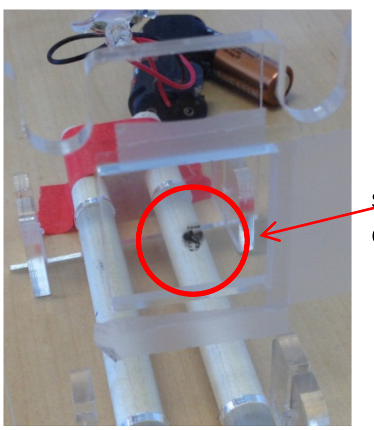
- Lenses are made of glass, so light will bend when it moves from air to glass. Lenses are shaped in such a way that they will form an *image* when light travels from air to glass.
- But what do we mean by an image?

OpenScope Demo – Image Formation

- Students should work in groups of 2-3 and sit next to an OpenScope
- Set up the OpenScope as follows (side and top views):

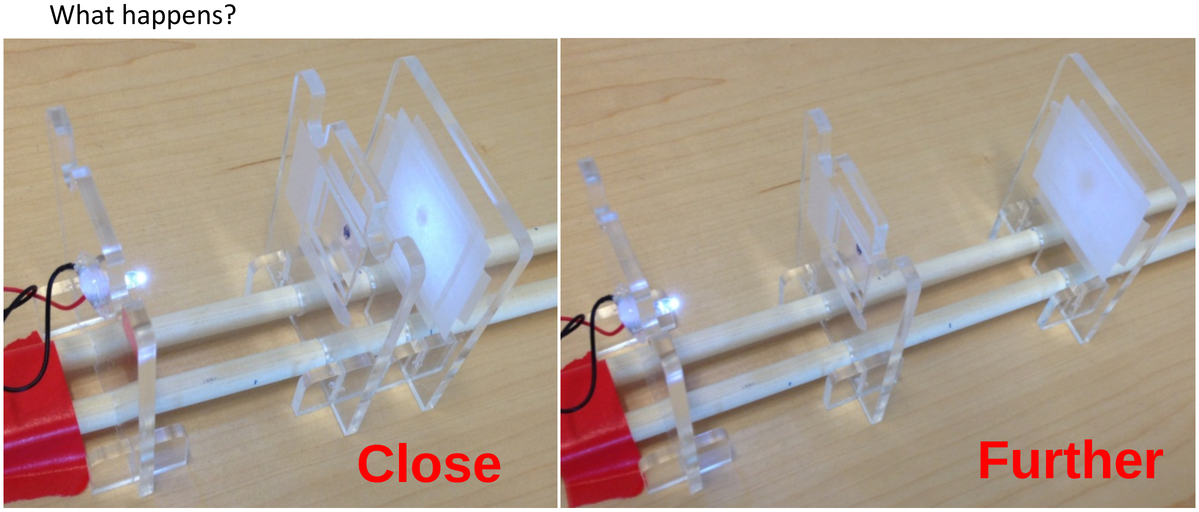


  - The light source is a LED run on two AA batteries
  - The "sample" is a picture of a famous scientist printed on a transparency
  - The two lenses in the system are identical ~75mm focal length plastic lenses
  - A wax paper holder is used so images can be viewed
  - The system slides on a pair of dowels taped to the table for stability.



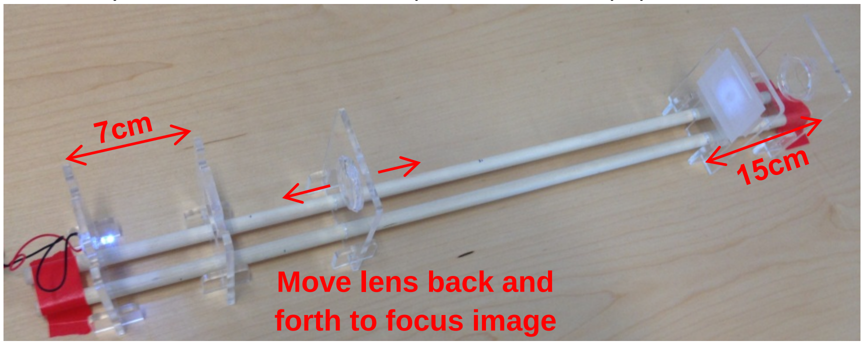
- Tell students to look at the small picture of a famous scientist, who is it? Measure the size of the picture and write it down.

- Now turn on the LED, move the wax paper screen near the picture and move it further away. What happens?

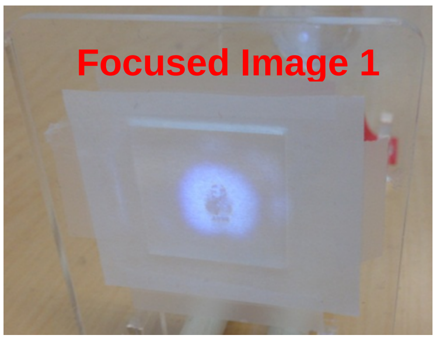


- The image of the scientist should get larger/blurrier as you move it further away
- Explain that light is diverging outwards – will cause picture to become blurry
- If there's a way we can stop the light from "spreading out" we can reform the picture of the scientist – we can do this with a lens!

- Rearrange the OpenScope as below (wax paper should be 15cm from the end of the **dowel**). Place the first lens anywhere between the sample and the wax paper.

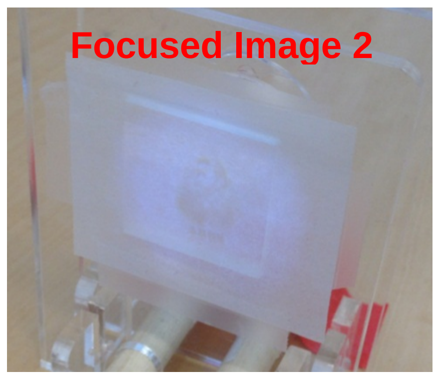


- **Keeping the picture and the wax paper screen fixed**, move the lens back and forth until an image of the scientist appears on the screen.



- Explain that the lens is taking the light that is "spreading out" and bending it back together!
- Ask students to measure and record the size of the image, is it bigger or smaller than before?
  - The image should be larger!

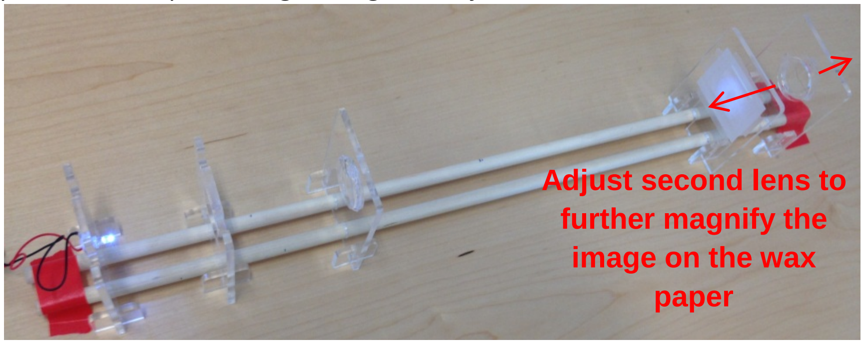
- Now move the **lens only**, 1cm closer to the sample. **Holding everything else fixed**, move the wax paper screen until the image is in focus again (Note: this is more difficult in a brightly lit classroom, the pictures taken are during daylight and are harder to see than if the lights are partially off).

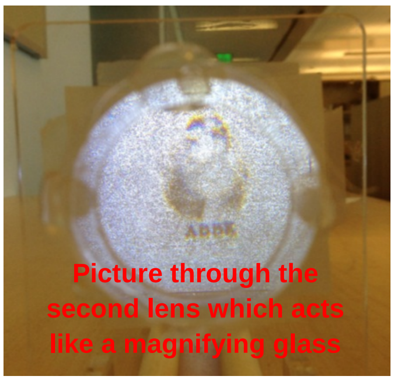


- Measure and record the size of the scientist again, is it bigger or smaller? Where is the wax paper now?
  - The image should have gotten bigger! The wax paper has to be placed further away (now approximately 11cm from the end of the **dowel**).
- Lesson: the closer you move your lens, the larger the image and the further away it forms.

<u>OpenScope Demo – Microscope</u>

- Leaving the previous set-up unchanged, begin to adjust the second lens

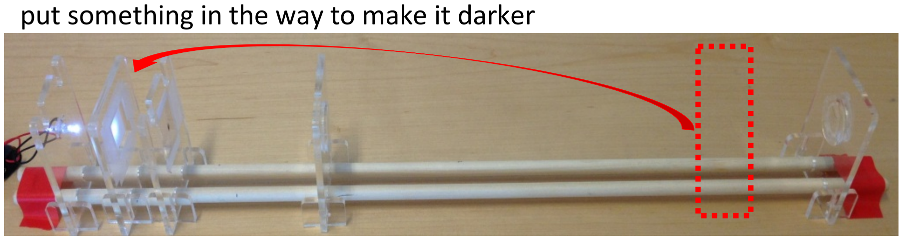




Picture through the second lens which acts like a magnifying glass

- Keeping your eye about 1 inch away from the lens move it back and forth until the image of the scientist on the screen is magnified. Does the scientist look larger or smaller than before?

- Now remove the wax paper and place it in between the sample and the LED.
    - We do this since the LED is very bright and will hurt your eyes in the next step unless we put something in the way to make it darker



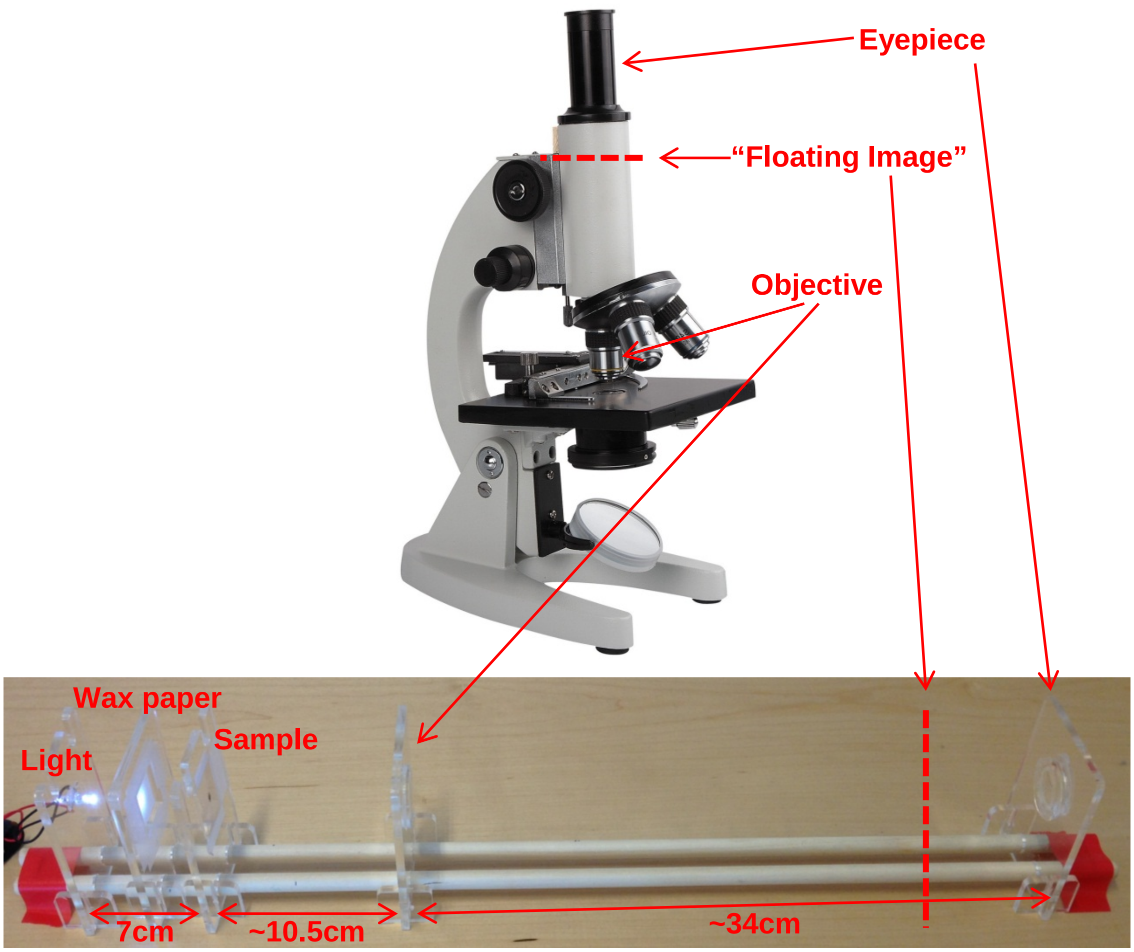
- Now look through the second lens again just like you did before, what do you see?
    - You should still see the scientist!

Picture after removal of wax paper (different camera exposures)

- Natural question is: how does this work? I can only see the scientist when I place my eye near the second lens!
    - Explanation: the image of the scientists always exists where the wax paper used to be. The wax paper blocks the light so we can see the image of the scientist from the outside
    - The second lens magnifies the “invisible” image of the scientist and makes it even larger

<u>Explanation</u>

- What you have just made works the same way a real microscope does
- The first lens is the *objective*
- The second lens is the *eyepiece*
- Your system is the same as the tube of a normal microscope.
- The objective forms an image of your sample that “floats” somewhere inside the tube.
- The eyepiece takes that image and makes it even larger
- And that’s how a microscope works!



Follow-up Possibilities

ELA Activity:

Students answer the following prompt:

"Write a letter to a friend explaining what you learned about microscopes."

Reading Connections:

http://www.amazon.com/dp/0375867538/ I, Galileo. By Bonnie Christensen. Random House/Knopf.

Acclaimed author-illustrator Bonnie Christensen adopts the voice of Galileo and lets him tell his own tale in this outstanding picture book biography. The first person narration gives this book a friendly, personal feel that makes Galileo's remarkable achievements and ideas completely accessible to young readers. And Christensen's artwork glows with the light of the stars he studied. Galileo's contributions were so numerous—the telescope! the microscope!—and his ideas so world-changing—the sun-centric solar system!—that Albert Einstein called him "the father of modern science." But in his own time he was branded a heretic and imprisoned in his home. He was a man who insisted on his right to pursue the truth, no matter what the cost—making his life as interesting and instructive as his ideas.

Mathematics Activity:

Have students measure their images in centimeters and find the area of their microscope images.

Links:

The Exploratorium has optics and light resources:
http://www.exploratorium.edu/snacks/iconlight.html
More information and activities demonstrating microscopes is available here:
http://microscope.fsu.edu/optics/activities/students/
A fun ray tracing tool to experiment with lenses, mirrors, and lots of other stuff:
http://silver.neep.wisc.edu/~shock/tools/ray.html

BASIS Lesson: Optics & Light by Gautham Venugopalan
http://www.crscience.org/lessonplans/3_opticsandlight_venugopalan_10-11.pdf