MIT Museum Workshop
Lights, Camera, Action: Physics & Photography
Pre- and Post-Visit Activities
Recommended for High School

Introduction

The purpose of these activities is to help your students get the most out of the MIT Museum workshop Lights, Camera, Action: Physics and Photography. In the workshop, students will engage with photographs taken by Berenice Abbott during her collaboration with MIT's Physical Sciences Study Committee (PSSC) in the 1950s. Part of a massive revamping of high school science textbooks following the launch of the Sputnik satellite, Abbott's photographs illustrate a range of physics, chemistry, and biology principles. Many of her photographs can still be found in textbooks across the country.

After studying an Abbott photograph showing the effects of a magnetic field, students will create their own versions of the photograph, using magnets and iron filings as Abbott did. Students will then explore wave motion with a ripple tank, and create their own Abbott-style kinematic experiments using different types of balls and a strobe light.

Through the pre-lesson, students will become more familiar with the relationship between scientific principles and art, while the potential post-lessons will encourage students to build on their knowledge of Berenice Abbot's work and their experiences with expressing physics concepts through images. Feel free to follow these lesson plans as strictly or as loosely as best suits your students and the role of the workshop in your curriculum.

Pre-Visit Lesson: Illustrating Science

<u>Purpose and Aim</u>

The purpose of this lesson is to introduce students to the challenges and strengths of using drawings to express scientific principles. Through taking turns selecting a scientific principle to convey to their partners through a drawing, students will:

- experience the challenges in expressing an abstract principle in a concrete way
- explore the role of visual images as a medium for communication
- discuss what an image requires to effectively convey a specific idea

While this activity focuses on physics concepts, it would work just as well for any scientific concepts.

<u>Materials and Space</u>

Materials:

- at least two versions of the Illustrating Science worksheets
- discussion questions
- whiteboard/smartboard/large chart paper/overhead projector
- picture from a science textbook

Space: Students can remain at their desks for this activity.

Procedure and Motivation

1. Introduce the activity by challenging students to interpret a drawing of a simple scientific content. You will draw the concept on a whiteboard or overhead projector and then guide them through the interpretation. Some possible concepts that could be drawn are:

- a solvent dissolves in a solution
- increased temperatures cause molecules to move faster
- the earth's tilt causes seasons

Once you finish drawing, ask the class what science concept your drawing illustrates. Guide students in looking for visual clues by asking guiding questions and hinting at helpful places to look. Once the students figure out the concept, have a short discussion about the clues in the drawing that helped students figure out what it was meant to convey.

2. Divide students in pairs, and hand out the worksheets. Each partner should have a different worksheet, to prevent students from picking the same concept as their partners, and so students can't look at the list on their sheets for help in figuring out their partner's drawings. There are four different versions of the worksheet, labeled A through D. The concepts on worksheets C and D are slightly more difficult than the concepts on A and B, so those worksheets would be good for advanced classes or students you feel could use more of a challenge.

3. The students begin the activity with each student drawing a concept for the other to figure out. Students should have a limited amount of time to draw; a minute or two should be ample time. Some students may be inclined to draw more of a diagram than an illustration. For the purpose of this activity, a diagram would be fine; the only restriction is that students can't use any text in their drawings.

4. When students are finished drawing, they should fold over the top of their worksheets so their partners can't see the list of concepts they had to choose from. They should then exchange papers and try to determine the concept in each other's drawings. Once the students are finished, they should go over the discussion questions together.

5. A few students should share their experiences with the activity as well as their responses to the discussion questions with the class. As a group, make a list of characteristics that enable a picture to effectively convey a scientific concept.

6. Show the students a picture from a science textbook that you feel does not do an effective job in expressing a scientific principle. Ideally this picture is from the class' textbook, and is not an obviously terrible picture. Discuss with the students what concept they think the picture is trying to express, and have the students check off which characteristics from their list the picture contains. You may have the class collectively draw a new version of the picture, or have the students do it individually for homework.

***Optional**: if you would like to introduce students more directly to Berenice Abbott's work, the class may watch this video about an Abbott exhibition at the University of Virginia: http://www.virginia.edu/artmuseum/exhibition/making-science-visible. They can also read this article on Abbott and her scientific photographs: http://online.wsj.com/article/SB10000872396390443989204577603251965520644.html.

Evaluation

This activity provides many opportunities for informal evaluation. Observing the students as they figure out each others' drawings is a good way to gauge their ability levels regarding image literacy and using drawing to express ideas. Observation can also help you figure out who has trouble with the scientific concepts listed, as well as who might find more visual activities difficult. The group discussion and class list of what makes an effective scientific image is another way to assess the class as a whole. A more formal way to evaluate students would be to assign drawing a revised version of the chosen textbook picture for homework, or to have students write a short essay explaining the problems with the textbook picture and describing what would make the picture a more effective way to express the scientific concept. Students may also find a picture from a textbook on their own to redraw and analyze.

Curriculum Standards for Grades 9-12

Subject Area	**Standard**	**Connection**
Physical Sciences and Chemistry Massachusetts Science and Technology/Engineering Curriculum Framework, October 2006, pg 74-75	Motion and Forces 1.5, 1.6, 1.8 Conservation of Energy and Momentum 2.1, 2.2, 2.3 Waves 4.1, 4.2, 4.4, 4.6 Electromagnetism 5.3, 5.4, 5.5, 5.6	The lists of scientific concepts for students to draw include concepts that express these principles.
Visual Arts Massachusetts Arts Curriculum Framework October 1999, pg 80, 83	Observation, Abstraction, Invention, and Expression 3.8, 3.9, 3.10 Critical Response 5.8	Students draw concrete representations of abstract scientific ideas. Students reflect on their own drawings and a textbook picture to determine their efficacy in expressing scientific ideas.
English Language Arts and Literacy Massachusetts Curriculum Framework for English Language Arts and Literacy, March 2011, pp 63, 78	Speaking and Listening Standards 1, 2, 4, 6 Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 2	Students participate in small group and class discussions, collaborate on a list defining characteristics of successful images, and articulate how to improve an image to better communicate its principle. Students may write why the textbook image is ineffective and describe how they would make it better.

Post-Workshop Activities

Here are a few ideas for post-workshop activities that can be done during class time or as homework. Feel free to modify any of these activities as best fits your needs and the needs of your students.

1. Share Berenice Abbott's manifesto (with the class. Ask the class what the word "manifesto" means--Merriam-Webster defines it as "a written statement declaring publicly the intentions, motives, or views of its issuer" (http://www.merriam-webster.com/dictionary/manifesto). Discuss the idea of a manifesto--what was Abbott's goal in writing it, and who was her audience? Students can discuss if Abbott's work does serve as an ambassador to science, as she believed art could (or write about it for homework). Students can also write an essay exploring how an art form other than photography could bridge the gap between science and the general public; they could research an example of an artist/scientist that strives to accomplish this, or use their imaginations. Students could also pick a different area or something they're passionate about--such as sports--and explain how it could make science more accessible. Students could also make a poster/visual presentation of their ideas or write an Op/Ed and present them to the class.

2. Access a copy of Berenice Abbott's *Documenting Science* (Published by Steidl: 2012) available at http://www.barnesandnoble.com/w/documenting-science-berenice-abbott/1108078578). The book, which collects Abbott's scientific photographs and provides background on Abbott and her work, is a fantastic resource for students to further explore Abbott and the connection between science and art. One way to use the book in the classroom would be for students to pick (or be assigned) one photograph from the book and explain which scientific principle the photograph illustrates, and how the photograph does so. Students could also select (or be assigned) a photograph and then take their own photograph that expresses the scientific principle in Abbott's photograph. Students may also find Abbott's take on the concept the students drew in the pre-lesson and compare Abbott's photographs with their drawings. Students should not make this comparison during the pre-lesson, however, in case they get the impression that Abbott's photographs are the "right answer."

3. Have the students take their own photographs in the style of Berenice Abbott. Students may take pictures that express specific scientific principles--physics or otherwise--or they may strive to find an example of a science idea in everyday life. Students may present their photographs and display them in the classroom, like an exhibition in a museum. Alternatively, students may also work in groups to create their own mini-textbook, using text and Abbot-style photographs to explain a scientific concept; students may present their textbooks to the class, and they may stay in the room as a resource for the rest of the year. Again, these do not have to be physics-themed.

Berenice Abbott's "Manifesto"

PHOTOGRAPHY AND SCIENCE

We live in a world made by science. But we--the millions of laymen--do not understand or appreciate the knowledge which thus controls daily life.

To obtain wide popular support for science, to that end we may explore this vast subject even further and bring as yet unexplored areas under control. There needs to be a friendly interpreter between science and the laymen.

I believe that photography can be this spokesman, as no other form of expression can be; for photography, the art of our time, the mechanical, scientific medium which watches the page and character of our era, is attuned to the function. There is an essential unity between photography, science's child, and science, the parent.

Yet so far the task of photographing scientific correctness has not been mastered. The function of the artist is needed here, as well as the function of the recorder. The artist through history has been the spokesman and conserver of human and spiritual energies and ideas. Today science needs its voice. It needs the vivification of the visual image, the warm human quality of imagination added to its austere and stern disciplines. It needs to speak to the people in terms they will understand. They can understand photography preevidently.

To me, this function of photography seems extraordinarily urgent and exciting. Scientific subject matter may well be the most thrilling of today. My hope of moving into this new field comes logically in my own evolution as a photographer.

After I had explored the possibilities of portrait photography in Paris for some years, I set myself the task of documenting New York City. Now after ten years of work at this interpretation, I find this phase of my career rounded out with the publication of my book, Changing New York.

The problem of documenting science, of presenting its realistic subject matter with the same integrity as one portrays the culture morphology of our civilization, and yet of endowing this material so strange and unfamiliar to the public with the poetry of its own vast implications, would seem to me to lead logically from my previous experience.

I am now seeking channels through which this new creative task may be approached.

Berenice Abbott

New York City, April 24, 1939

Name:_________________ Date:_______________

Partner's Name:_______________

Illustrating Science (A)

Select one of the following statements:

1. the arcs of a bouncing ball gradually decrease in size	4. when directly above a sphere, light casts a circular shadow
2. a pendulum moves faster at the bottom of its swing than the top	5. light bends when passing through a prism
3. magnets of opposite poles repel each other, creating a magnetic field	6. a higher frequency wave has a shorter wavelength

Draw it in the space below; **then fold the page over to hide the list**, and show your drawing to your partner so she/he can determine which concept you drew.

Name:_________________ Date:_______________

Partner's Name:_______________

Illustrating Science (B)

Select one of the following statements:

1. in a vacuum, a heavy and light object fall at the same speed	4. a ball casts elliptical shadows for each source of light; shadows overlap where this is common focus
2. a swinging ball makes an elliptical pattern	5. particles in the air shows a light beam from the source of light to the target
3. a magnetic field reaches in all directions	6. waves hitting a barrier reflect

Draw it in the space below; **then fold the page over to hide the list,** and show your drawing to your partner so she/he can determine which concept you drew.

Name:________________ Date:______________

Partner's Name:______________

Illustrating Science (C)

Select one of the following statements:

1. a current running through an electric coil generates a magnetic field	4. in very shallow water, wave propagation becomes slower as the depth of water increases
2.the virtual image of an object is located behind a mirror	5. the center of mass moves in a straight line as an object spins
3. a multi-faceted reflective surface reflects a scene from different perspectives	6. an electric charge tends to be static on insulators and can move on and in conductors

Draw it in the space below; **then fold the page over to hide the list**, and show your drawing to your partner so she/he can determine which concept you drew.

Name:________________ Date:______________

Partner's Name:______________

Illustrating Science (D)

Select one of the following statements:

1. a magnetic field bends an electron beam in a vacuum tube	4. circular waves intersect to create an interference pattern
2. angle of incidence equals angle of reflection	5. spheres of unequal mass demonstrate conservation of momentum in collision
3. an imbalance of charge on a surface creates static electricity	6. a battery creates a current through a wire to power a light bulb

Draw it in the space below; **then fold the page over to hide the list**, and show your drawing to your partner so she/he can determine which concept you drew.

Illustrating Science
Discussion Questions

1. What physics principles did your and your partner's drawings illustrate?

2. Was it more difficult to draw the concept or figure out the concept from the drawing? Why?

3. What strategies did you use to help your partner to determine the concept you were drawing?

4. What strategies did you use to figure out what concept the drawing was expressing?