Lesson Plan for ED 5680 – Great Lakes Maritime Transportation Teacher Institute
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Lesson: Lighthouses and Lenses

Target grade & subject: Middle/High School Earth Science (grades 6, 7, 8)

Lesson overview:
The lesson will cover the function and importance of lighthouses. The main focus (pun intended) will be on the use of Fresnel lenses to concentrate the beam of the light. The lesson will serve as an extension of the unit on optics and lenses, will connect to social studies topics, and will involve writing across the curriculum, a major school improvement goal in my district.

Sources consulted:

How to increase the range of your LED Flashlight
http://www.andrewdavidson.com/articles/led/


Original Lens Distribution,
http://www.terrypepper.com/lights/lists/distribution.htm

Seeing the Light – The Incredible Fresnel Lens,
http://www.terrypepper.com/lights/closeups/illumination/fresnel/fresnel.htm

Wikipedia; Lighthouse,
http://en.wikipedia.org/wiki/Lighthouse

The Great Lakes Shipwreck Museum, Whitefish Point, MI.

The Valley Camp Museum Ship, Sault Ste. Marie, MI.

The Inland Seas Maritime Museum, Vermillion, OH.

Point Iroquois Light Station Museum, Hiawatha National Forest, MI.

Learning Objectives:
At the end of this lesson, students will be able to:

1. Explain the functions and importance of lighthouses.
2. Compare & contrast ordinary & Fresnel lenses
Michigan Content Expectations addressed:
E1.2k – Analyze how science and society interact from a historical, political, economic or social perspective.

S.IP.00.14 - Manipulate simple tools (for example: hand lens, pencils, balances, non-standard objects for measurement) that aid observation and data collection.

7 – G4.2.1 - List and describe the advantages and disadvantages of different technologies used to move people, products, and ideas throughout the world.

P4.8A – Draw ray diagrams to indicate how light reflects off objects or refracts into transparent media.

Materials needed:
- PowerPoint presentation on Great Lakes Lighthouses and Lighthouse Lenses
- Whiteboard, light colored wall, or projection screen
- LED flashlights
- Magnifying glasses
- Credit card size pocket magnifiers (Fresnel lenses) – these can be found in some pharmacies, craft stores, and from online sources such as Edmund Scientific, etc.
- Meter sticks
- Worksheet for activity (provided)
- Computers with internet access

New vocabulary:
Fresnel lens - A thin optical lens consisting of concentric rings of segmental lenses and having a short focal length. (http://www.thefreedictionary.com/Fresnel+lens)
Focal length - The distance between the optical center of a lens or mirror to its focal point. (http://www.thefreedictionary.com/focal+length)

Focus questions:
What is a lighthouse?
Where would you expect to find them?
What purpose do they serve?
How do they work?

Classroom activities:
After discussing the focus questions (included in the PowerPoint), show and discuss the rest of the PowerPoint presentation.
For the activity, have students work in pairs. Each pair should have an LED flashlight, a meter stick, an ordinary hand lens, and a pocket-size Fresnel magnifier. Each individual student should have a copy of the attached worksheet.

Following the instructions on the worksheet, have students measure the focal lengths of the two lenses, while projecting an image of the LED flashlight pattern on the wall – see http://www.andrewdavidson.com/articles/led/ - the focal lengths will vary depending on what lenses you have available. Have them focus on a wall across the room. The easiest way to measure the focal length is to lay the meter stick on a table, place the lens at the end, and move the flashlight back & forth along the meter stick until the image on the wall comes into focus.

Have them compare the size and sharpness of the images. The shorter focal length will produce a larger image. A longer focal length would allow the projected beam to be to be seen at a greater distance. The image from the hand lens will probably be sharper than from the Fresnel lens – this is an inherent limitation of Fresnel lenses.

The online research portion of the assignment should be done by each student independently. This could be assigned as homework, or could be done in the computer lab during class time. If desired, students could give presentations.

**Assessment:**
Assessment will be based on accurate completion of the attached worksheet, which includes a lab and online research component.

Lab activity ANSWERS:
1. A roughly circular pattern. Light should radiate away from flashlight in a cone shape.
2. Focal length will vary, depending on what you have. Light should form a cone from light to lens, then another longer cone from lens to wall.
3. Focal length will vary, depending on what you have. Light should form a cone from light to lens, then another longer cone from lens to wall.
4. The shorter focal length will produce a larger image.
5. The hand lens should produce the sharper image.
6. The focused light is more concentrated, and will be visible form farther away.

**Bonus Question:** Because of the curvature of the Earth, raising the light will allow it to be seen from farther away.
Lighthouses and Lenses Activity

Materials needed: LED flashlight, hand lens, Fresnel magnifier, meter stick.

1. From across the room, shine the flashlight on the wall. Describe the pattern of light that you see. Draw a sketch showing the path of the light rays from the flashlight to the wall. Label the flashlight and the wall.

2. Lay the meter stick on the table, with the zero end toward the wall. Hold the hand lens at the zero end, and move the flashlight along the meter stick until the LEDs come into focus on the wall. Measure the distance from the light to the lens in centimeters and record it here: __________. This is the focal length of the lens. Sketch the path of the light rays as they are focused by the lens and form a beam. Label the light, lens, and wall.

3. Repeat the process from number 2, using the Fresnel lens instead of the hand lens. Focal length: __________. Sketch and label below.
4. Compare the sizes of the images formed by the different lenses. Which is larger? Write a sentence relating the image size to the focal length.

5. Compare the sharpness of the two images. Which is sharper or more clear? Which type of lens would be most suitable for use in a camera or projector?

6. Which would be more clearly visible from a distance – the unfocused light from number 1, or the focused light from number 2 or 3? Why?

Bonus Question: Lighthouses are usually tall, so the light can be seen from farther away. Why does raising the light make it visible from a greater distance?
Lighthouses and Lenses Online Research

On the computer, go to http://lighthouse.boatnerd.com/ . Choose one of the lighthouses listed there from one of the Great Lakes – Superior, Michigan, Huron, Erie, or Ontario.

Answer the following questions using complete sentences and your own words. Be sure to answer the questions completely. If the information is unavailable, say so in your answer.

1. What is the name of your lighthouse, and where is it located? Which of the Great Lakes is it on?

2. When was it built? Is it still in use? If not, when was it discontinued?

3. Was this lighthouse ever equipped with a Fresnel lens? If the article doesn't say, try looking here: http://www.terrypepper.com/lights/lists/distribution.htm
   If it is still active, what kind of light is in use today?

4. Is this lighthouse open to the public?

5. Print out a picture of your lighthouse and attach it to this paper. Label it with the name and location of the lighthouse, and the name of the photographer.