Western Engineering

Outreach

Smartphone Projector

Grades K-2

Meet Today's ENG HERO!

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Dr. Knopf completed his B.E., M.Sc., and Ph.D. in Saskatchewan. Dr. Knopf's expertise is in the general field of product design and advanced manufacturing. Some of his areas of research include engineering design and 3D shape reconstruction. He is also a technical reviewer for numerous academic journals and conferences.
To learn more about Dr. Knopf visit:
https://www.eng.uwo.ca/mechanical/faculty/knopf_g/index.html

Learning Goal:

- Students investigate how to bend light waves to increase the size of an image.
- Curriculum Connections: Grade 1 - Energy in Our Lives; Grade 2 - Movement

Materials Needed:

- A small cardboard box
- A magnifying glass or camera lens
- Scissors
- Tape
- Smartphone
- Materials to decorate the box (optional)





Engineering and Science Connections:

What is light?
Light is a wave. There are many types of waves. For example, there are radio waves, microwaves, visible light, or x-rays. The light that we can see is called visible light. We can see it because the light travels at a certain frequency. Frequency is the number of waves that pass a certain point within a given amount of time.

Visible light travels at a frequency that we can see. However, there are lots of other waves that travel at different frequencies that we can't see. An example of that is x-rays. If you have ever broken your arm and had to go to the doctor, you might have gotten an x-ray. X-rays are another type of wave and are used to create an image of a broken bone (and many other applications) but we cannot see the waves as they travel like we can visible light.

Why do we only see certain colours?
We will see different colours depending on the frequency of the light wave. Though all visible light is within a certain range of frequencies, each colour has a slightly different frequency. Those slightly different frequencies is why we are able to see different colours. Those colours are ROYGBIV, which is an acronym for red, orange, yellow, green, blue, indigo, and violet. When you see something that is a certain colour, like a red shirt for example, the shirt is absorbing all of the colours of the light except for the red colour. The red colour is bouncing back to your eye and causing you to see red.

Did you know that you see white light because all the colours are bouncing back and you see black light because all the colours are being absorbed?

Normally light travels in a straight path, unless it goes through a material, like a lens. When light travels through a lens with a curved edge, the light changes direction. Magnifying glasses are lenses that have curved edges and they will be used in the activity today.

The Magnifying Glass: A Detective Tool
Have you ever used a magnifying glass? What happens when you use one?
A magnifying glass makes small things look larger. This is really helpful if you are a detective because it makes small clues look bigger!

When you are looking at an object through a magnifying glass, the lens makes the object look larger than it is. The shape of the lens in a magnifying glass is called a convex lens. Convex means curved outward. A convex lens will bend (change the direction of) the light rays so that they are closer together. This creates a virtual image. The virtual image is farther away from your eyes than the object is, so the object you are looking at looks bigger.

SMARTPHONE PROJECTOR

Magnifying glasses have helped people in a wide variety of activities. Some of these activities are everyday things like reading, but others have helped advance science, like using a microscope to study very small things like insects or bacteria.

A magnifying glass is actually like a simple microscope. Microscopes are used to enlarge images of tiny things like bacteria or viruses, but the same idea can also be used to enlarge images of items that are very far away like stars. A real-life example of this is the Hubble space telescope. This past April (2020) was the 30th anniversary of the Hubble space telescope being in space! Astronauts work on the telescope and make repairs to it while it's in space so the telescope can continuously operate to look at and take pictures of extremely far away things like planets and stars.

How does this relate to today's activity?
Today, you will be using the magnifying glass to make an image on a smartphone bigger. This is the same thing a projector does. How does a magnifying glass help you do that? The answer is in the shape of the lens. The lens is convex, making its sides bend outwards. This allows it to catch, bend, and focus all the light from the smartphone inside the box and project it onto the wall.

As you go through the activity, you will notice that in Step 9 you turn the smartphone upside down. You might be wondering why that is. The human eye has a lens similar to the magnifying glass that you will use in the projector. What your eye sees comes through your eye's lens upside down, but your brain learns to flip the image right side up. Pretty cool, huh? The magnifying glass flips the image just like your eye flips the light from the world, but since the projector doesn't have a brain to flip the image right side up for you, you have to set the smartphone in the box upside down.

Video Recommendations:

Light I The Dr. Binocs Show https://www.youtube.com/watch?v=d7yTlp4gBTI
Bill Nye the Science Guy on Light Bending & Bouncing https://www.youtube.com/watch?v=fD1544bM_c4

Activity:

1. Select your cardboard box. It needs to be tall enough that you can trace the magnifying glass on the side of the box and large enough that inside you can place your magnifying glass and smartphone with some space between them.
2. Choose the end that you want the projection to come from and trace the magnifying glass on that end of the box.

3. Cut out a hole in the box that was slight smaller than the magnifying glass circle you traced. You don't want the hole to be larger than the magnifying glass because later you will need the lens to fully cover the entire hole. You may need adult assistance with this step because cutting the cardboard can be tricky.

4. Make a stand for the smartphone out of cardboard. The phone is going to be placed inside the box, with the screen pointing at the magnifying glass hole. You will likely have to adjust the placement of the smartphone later, so don't attach the stand to the box yet.

5. Test out your stand to make sure that your smartphone will stay up by itself.
6. Place the magnifying glass inside the box lined up against the hole you cut out.
7. Fasten the magnifying glass in place using tape. If possible, tape on the handle of the magnifying glass. You don't want the tape covering any part of the lens because it will distort the projection later on.

8. Decorate your box!
9. Place the smartphone on the stand and ensure it is pointing at the magnifying glass. Remember to place the smartphone upside down so that the projected image will be right side up.

10. Point the box (the end with the hole) at a white wall.
11. Move the smartphone towards or away from the magnifying glass until the projection is focused and clear. This may take some adjusting to get it right.
12. Once your projection is focused and you can see the image from the smartphone clearly up on the wall, turn off the lights and start your movie!

What Did You Learn?

- What is light?
- How does a magnifying glass work?
- What kind of lens is a magnifying glass?

Future Learning

- Experiment with how far away you can place the projector. Did you have to change how close or far away the phone was from the magnifying glass?
- Create your own magnifying glass using a clear jar and water. Then, act like a detective and investigate or go on a nature walk and use your magnifying glass to explore.

Share your creations!

We would love to see what you made. Email as at discover@uwo.ca or tag us on social media.

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Thanks for discovering with us!