A Hands-On Activity on Optical Resolution and Engineering Design

Description

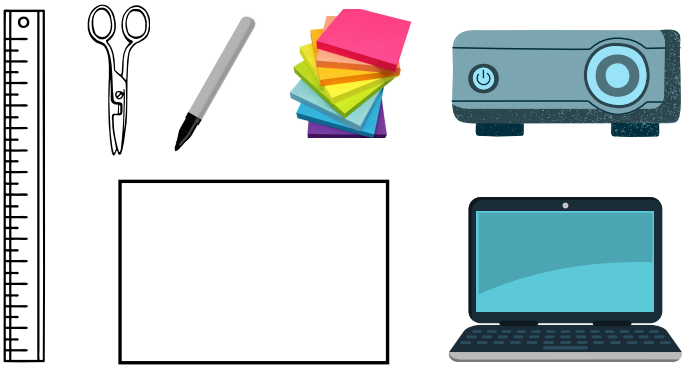
This activity is designed to challenge students to think creatively and critically about engineering design through the example of resolution in digital cameras, and in turn empower students to be smarter consumers.

While the target audience is middle school, part 1 can be done by children in grades 1-5, and more challenging extensions can scale to the level of the students.

Keywords: resolution, optics, trade-offs, engineering design, digital cameras, middle school, hands-on

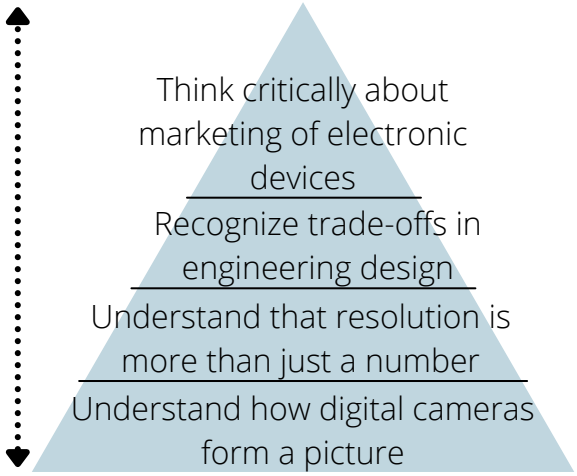
Materials

Ruler, scissors, sharpie, colored square sticky notes, white posterboard, projector, computer



Learning Objectives

Synthesis and Abstraction

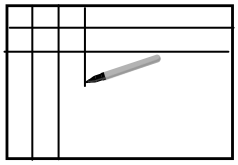


Foundational Knowledge

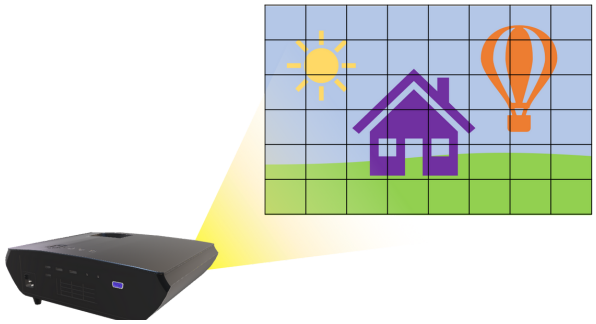
Age group: 6th-8th grade
Time Required: 45-60 mins

Preparation

1. Draw 3"x3" sqares on posterboard. You may wish to cut the board in half to save time & resources.



2. Use QR code provided to load PowerPoint with images that use standard Post-It colors
3. Hang posterboard on wall and project one of the images



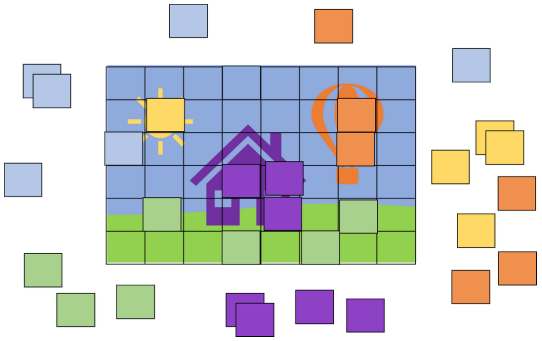
Pre-Activity Discussion

A "pixel" is a "picture element". When you look at a picture on your phone, you are actually seeing lots of little dots of color.

What is your understanding of the "resolution" of a picture? A store sells two cameras. One has 1MP (1 million pixels) for $50, and another has 2MP (2 million pixels) for $100. Which is better?

Activity Part I

Students place sticky notes over squares on the board, trying to match the color of the projected image. Some squares will have multiple colors; the student must choose only one note per square. Choosing the dominant color, or a mix (eg, a half blue, half yellow square becomes green) are both valid! Now turn off the projector and discuss how the image has changed.



Why doesn't this look exactly like the original picture? What would make the pixelated (post-it) picture look better?

Activity Part II

A. (More advanced students) Try your idea! If possible, have two setups, so students can do this in teams, trying different possibilities. Allow movement of the projector (or a zoom function), provide scissors to cut the sticky notes, and additional posterboard with tape.

B. (Younger Students) Provide teams of students pre-made setups:

1) Projector in place, with 4x the amount of gridded posterboard and sticky notes
2) Projector zoomed in to 1/4 the original size, and sticky notes cut into quarters.

Discuss what happened, and how these things relate to real cameras. The table below outlines some possible solutions, though students may very well invent others! Information in column 3 will need to be provided to students to facilitate the final discussion question.

POSSIBLE IDEAS	CAMERA ANALOGUE	COST TO MAKE
Make the post-its smaller	higher spatial resolution	smaller pixels are hard to make and don't work as well
Move projector or "zoom in"	higher numerical aperture	lenses and optical parts are very expensive
add more squares	higher number of pixels	cheap and very easy to make

If you increase the number of post-its without making the image bigger, there is nowhere to put the extra post-its and the spatial resolution is the same. You must also increase the size of the image by using optics (eg, zoom in the picture by moving the projector). You can achieve the same effect by keeping the projector in place and same number of pixels, but making the pixels smaller (eg, cutting the post-its down to a smaller size).

Answer to pre-activity question: we don't know which camera really has better resolution, because all we know is the number of pixels, and nothing about the lenses, optics, or pixel size. Why do you think camera manufacturers market them this way?

This activity was developed by Mel White (mjw336@cornell.edu) for an outreach program at the IthacaSciencenter (www.sciencenter.org) in 2019.