Making Music Videos with a Homemade Projector

OVERVIEW

ESSENTIAL QUESTION

How can you reproduce the effects seen in the music video for Zedd, Maren Morris, and Grey's song "The Middle" using a homemade projector?

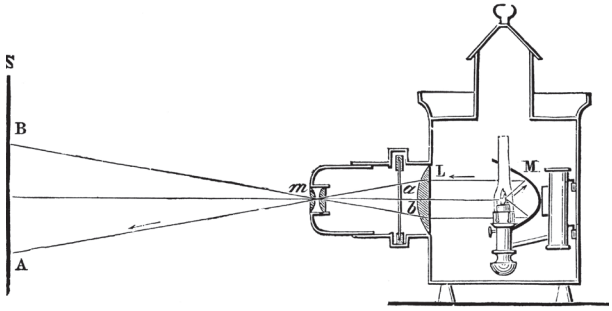

Illustration: Elroy M. Avery

OVERVIEW

Grey, Maren Morris, and Zedd's "The Middle" proves that a music video doesn't need millions of dollars, celebrity appearances, or extravagant special effects to be engaging. The elements of director Dave Meyers' video are simple: a room, good lighting, and the lyrics to the song projected on the walls and furniture. At the most intense moments of the video, drinking glasses, fruit, and flower vases shake and fall to the floor. It's a simple and beautiful concept—and one that can be reproduced in the classroom.

The main "special effect" of the music video is the projection of light, the science of which has been known for millennia. Around 300 B.C., Chinese philosopher Mozi wrote about the phenomenon today known as camera obscura, wherein a scene on one side of a screen can be projected as a reverse image through a small pinhole onto a canvas. Just around 100 years later, the Chinese were constructing bronze "magic mirrors," which reflected various patterns when light was shined upon them in a dark room. With the development of concave mirrors and lenses came the ability to make projection devices much smaller, while still producing a large image. In the late 1600s, Dutch scientist Christiaan Huygens invented the fire-lit "Magic Lantern," a small box that allowed images on glass slides to be projected on a canvas. Despite Huygen's belief that the invention was frivolous, Magic Lanterns captured people's interest, and quickly they became mass produced for entertainment and educational usage. With the invention of the light bulb, projectors no longer needed firelight to operated, paving the way for the slide and overhead projectors in the 1900s, and the digital multimedia projectors of today.

While the technology for projecting light is constantly improving, the basic elements remain simple: all that is needed is a light source, a lens, an image to project, and a dark container to hold the mechanism. In this lesson, student groups use their smartphones and household materials to build their own projectors, and create their own short videos in the vein of "The Middle."

Materials required for this lesson:

- Smartphone
- Small Box (Shoebox-sized)
- Pencils
- Magnifying Glass
- Cardboard
- Electrical Tape
- Scissors or a box cutter
- Hot glue gun
- Video editing software (optional for extension activity)

OBJECTIVES

Upon completion of this lesson, students will:

1. KNOW (KNOWLEDGE):

- The basic mechanisms of projectors
- The prototype-test-refine process
- Physical properties of light
- Different types of lenses and their effects on light

2. MASTERY OBJECTIVE:

- Students will be able to better understand the science behind light waves by building and refining their own projectors.

ACTIVITIES

MOTIVATIONAL ACTIVITY

1. Play some or all of the music video for Zed, Maren Morris, and Grey's song "The Middle." (*Note: This links to the official video on YouTube. It may begin with an advertisement, we suggest loading the video before class.*) Ask students:

- Did you find this video exciting or boring? Why? What did you like about it, or not like about it?
- Do you think this video was expensive to create, compared to other music videos or commercials you have seen? Why?
- Did you see actors in the video? How many different locations did the producers need to film to create the video?
- What special effects do you think might have been used in this video?
- What do you think the main special effect used might have been?
- Do you think you could make a video similar to this one? How?

PROCEDURE:

1. Ask students:

    - How do you think the lyrics were made to appear in the video? What device could accomplish this visual effect?

    - Do you think the process of projecting words or images onto something is a new technology, or an old technology?

    - Before electricity was discovered, do you think it was possible to project an image on a wall? How?

2. Show students **Image 1, Illustration of a Magic Lantern**. Tell students that this illustration was created in 1671, by scientist and scholar Athanasius Kircher. Ask students:

    - What do you think is portrayed in this picture?

    - What might be the purpose of this illustration? (*If necessary, point out the alphabetic markers throughout the illustration as an indication that it is a kind of blueprint.*)

3. Tell students they will now discuss each of the individual elements in the illustration, from left to right. Ask students:

    - What is the skeleton image on the wall. How is it being made?

    - In the middle of the illustration, just inside the large box, there appears to be a board with circular images on it. What might that board be? What are the images on the board? What is the purpose of this board?

    - What is the tube-like object directly to the right of the board? What might its purpose be?

    - What is the object producing fire to the right of the tube? Why is fire needed to make this mechanism work?

    - What is the hole and chimney in the top of the box needed for?

    - According to this picture, what are the main elements required to make a projector? (*By the end of the discussion, student should have listed the following four elements: a light source, an image to project, a lens, and a box to contain the whole mechanism.*)

4. Split students into groups, and hand out a set of materials to each group, including a box, a magnifying glass, scissors and black electrical tape. Ask students:

    - With the materials you have in your groups, can you make a projector? Are any of the four elements we need missing? (*Students should note that the collection of materials does not have a way to make light, or an image to project.*)

    - Is there anything we can use that would both provide light and an image? Hint: many people carry such a device in their pocket every day!

5. Tell students that using one student's smartphone, they will be making prototype projectors. Based on the Image 1 and the classroom discussion, encourage students to try to design and build their projectors as a group. If necessary, help students cut holes in their boxes for the magnifying glass lens, and glue the lens into their box. (If necessary, teachers can display **Image 2, Projector Schematic**, though it is preferable that students experiment in creating their own projectors without instructions.)

6. Once groups complete their prototype projectors, dim the classroom lights and have students try them. Ask students:

    - How well did your projectors work? Was the image from your smartphone clearly projected? What were some of the issues you encountered?

    - What could you do if your projector isn't bright enough? (*Example: students could turn up the brightness on the smartphone, or try to make the box darker.*)

    - What can be done if the smartphone isn't in alignment with the lens?

    - What can be done if the image is blurry? (*Encourage students to consider the possibility of moving the smartphone around the box*).

    - If the image is projected upside down, what can be done?

7. Give students a chance to refine their prototype projectors. Refinements might include: attempts to build a stand or another means to attach their smartphones within the box; experimenting with positioning the smartphone different distances away from the lens to achieve the sharpest image; or finding ways to make their box darker. Let students experiment and figure out ways to improve their projectors.

8. Again, dim the lights and let students try their updated projectors. Ask student groups to share what they did to refine their projectors, and if it helped. Have each group present their projectors in operation to the class. If one group's projector operated better than the others, analyze as a class what made it more effective.

SUMMARY ACTIVITY

1. After completing and refining their projectors, tell students that they will now discuss what projectors reveal about the properties of light. Ask students:

    - Based on your experiments with the projectors, would you hypothesize that light stays still, or does it move? (*Light is made of waves, that move through space.*)

    - What about the the process of light projection make you believe light moves?

    - Have you ever heard the term, "the speed of light"? What might that refer to? (*Tell students that light waves move approximately 186,000 miles per second.*)

    - Can light change as it moves? How so?

    - With the early projectors, when firelight passed through a glass slide, why does the image on the glass slide appear on the wall? What does that glass slide do to the light that passes through it? (*It blocks some hues of light, at lets others pass through, to complete the image*).

    - What is the purpose of the lens in the projector? How does it change the light waves that move through it?

2. Show **Image 3, Types of Lenses**. Ask students:

    - What is being displayed in this illustration?
    - What do the horizontal arrows represent? What do the vertical rectangles represent?
    - How are flat, convex, and concave lenses constructed differently?
    - How do each of the three lenses affect light as it passes through them?
    - Do you think projectors use a convex or concave lens? Why? (*Projectors use a concave lens to expand the image.*)

EXTENSION ACTIVITY

1. **Make your own video in the style of "The Middle" using the homemade projectors.** (*Note: This activity requires some familiarity with video editing software, such as iMovie or Windows Movie Maker. Additionally, it requires a smartphone program that can create white text on a black background. At least two smartphones per group are required.*)

2. Group students, ideally into sections of four. Ask groups to mutually decide on a poem, song, or other written text they would like projected. It can be written by a poet or musician students agree upon, or it can be an original composition. (*Encourage students to find a poem or song on the shorter side, as they will need to display all the lines with their projectors.*) Ask the groups to assign a **writer**, who will be in charge of writing or finding the text.

3. Ask groups to assign another student as the **typographer**. This student needs to find a way to create white text on a black background on their smartphone. This could be done with most photo editing apps by taking a black picture and editing it to include writing. An app like Note Everything also allows users to type white words on a black background. The typographer's responsibility is to work with the writer to decide how many words from the song or poem should be projected.

4. Next, groups should assign a **projectionist**. This person will place the smartphone with the words in the projector, and hold the projection of the text over a desired canvas (it could be a wall, a desk, or something else in the classroom).

5. Finally, ask groups to assign a **cinematographer**. With their smartphone in hand, this student's responsibility is to take a picture or video (as they prefer) of the projected image.

6. To create the video, the writer should tell the typographer what line of text should be projected. The typographer should then work with the projectionist and cinematographer to decide where there that particular line of text should be projected, and format the text in a way that fits the agreed upon canvas. The cinematographer then captures the projected text on their own smartphone as an image or video.

7. After one word or line is captured in a photo or video, the process begins again, with the typographer moving to the next line of text, the projectionist finding a new spot, and the cinematographer shooting the new scene.

8. Once all the lines are shot as photos or videos, upload the files from the projectionist's smartphone into a computer. Using a program such as iMovie or Windows Movie Maker, edit all the footage together to create the video. Add audio to the video to make it more exciting.

9. Send links to your videos to info@rockandrollforever.org!

COMMON CORE STATE STANDARDS

College and Career Readiness Anchor Standards for Reading (K-12)

Integration of Knowledge and Ideas 7: Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

College and Career Readiness Anchor Standards for Language(K-12)

Language 1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

Vocabulary Acquisition and Use 6: Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

College and Career Readiness Anchor Standards for Speaking and Listening (K-12)

Comprehension & Collaboration 1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

Comprehension & Collaboration 2: Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

Presentation of Knowledge 4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

NEXT GENERATION SCIENCE STANDARDS

1. Waves: Light and Sound

1-PS4-3: Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.

1-PS4-4: Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.