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LIGHT PLAY

A Guide from the Creativity Lab

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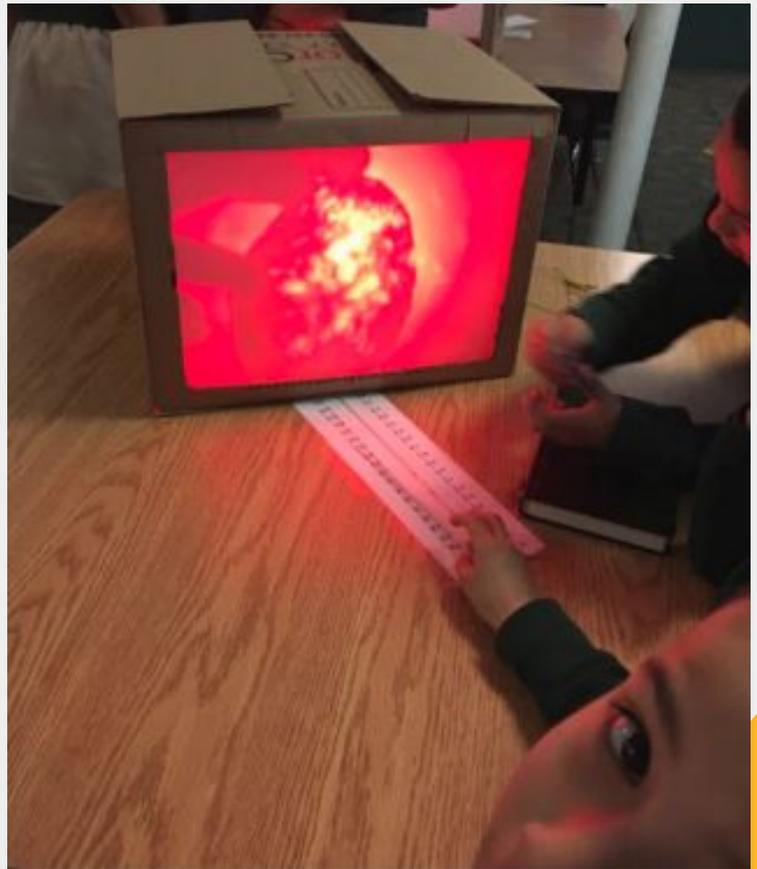
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Based on

An activity from The Tinkering Studio

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About This Project

As part of our Light & Sound Expedition, students explore properties of light by creating moving scenes with objects in light boxes, which we built with [instructions](#) from the Tinkering Studio. This guide focuses on the inquiry model used in classes, rather than a strict step-by-step process.

Students discover that materials interact with light differently: some materials allow light to pass, others block light entirely; some things reflect or refract, while others focus light beams. Students play with changing the size of shadows and make observations about reflections, refraction, symmetry, and motion.

Shadow Puppet plays, an extension of Light Play, are a perfect project for interdisciplinary learning. As students demonstrate mastery of properties of light, they can also explore their own culture, or act out a scene from a book or a moment in history, integrating with language arts or social studies.

Our Story

With the light boxes, students in our first grade classes explored the questions: How do different materials interact with light? How can we use light to communicate with other people?

To build the LED lights, we gathered parents and volunteers for an afterschool build session. Our design differed from the Tinkering Studio's slightly – we used cardboard boxes with a screen in the front, so boxes can be folded and stored flat.

So far, our first graders have been the only ones to explore light, sound, and storytelling through Light Play. But, now that they're built, we intend to incorporate light box play in to units for middle and high school science classes as well. Later in this guide, there are some ideas of how to use the boxes with older students.

Materials & Tools

Reflective Objects: mylar, Christmas tree bulbs, mirrors, disco balls, sequined fabric

Translucent Shapes: party cups, plastic champagne flute, water bottles, bubble wrap, shower curtains, plastic takeout container, plastic tubes and rods

Shadow Objects: strawberry baskets, cheese grater, springs, mesh, feathers, cut paper, small toys, printed transparencies with patterns

Colorful Filters: acrylic scraps, dichroic films, iridescent cellophane

Lenses: prisms, flat lenses, old glasses, magnifying glass, plastic half-pint containers with water

For light box, motor and screen, see: LCL.how/LightMaterials

Collect recyclables for other materials.

TIME: semester-long expedition

Learning Targets

- I can look closely.
- I can explore complexity.
- I can explore playfully without a preconceived plan.
- I can create works that convey ideas, feelings, and/or personal meaning.
- Detailed standards can be found in the [Light and Sound Expedition guide](#)

Context: Before we make...

Before exploring with light boxes, we discussed how light is used to communicate over long distances, as with Morse code or lighthouses. We also went to the [Bay Area Discovery Museum](#) to explore light and shadows hands on. Teachers may show [videos](#) of light play from the Exploratorium's Tinkering Studio.

This is a great project to bridge STEM and humanities learning targets, and it supports with the Next Generation Science Standards (NGSS). When students are exploring Light Play and later transition to creating shadow puppet plays, they must master light and shadow, and also understand key elements of storytelling, including language, pacing, characters, plot, and dialogue.

Depending on the age of the student and subject area, teachers can customize the parameters and learning targets of the assignment. Students may write an accompanying artist statement, like they would see in a museum. They might give detail about how they created the effects using a science concept (e.g. moving object closer to light source to make it smaller). Physics students could be asked to integrate lenses into their show and share their calculations.

Light Play is also visible in cultural storytelling: in Bali, wayang kulit (shadow puppet) performances tell Hindu epics, and can last all night long. Traditionally, the light is cast by an oil lamp, and puppets are intricately carved by master craftspeople.



[Wayang Kulit](#)



[Jose Svoboda's Set Designs](#)



[Tim Noble & Sue Webster](#)

Material Management

- Scaffold inquiry by introducing different types of materials one at a time (opaque, reflective, translucent, lens).
- Consider separating materials in different areas of the room by property: transparent, translucent, opaque, etc. This will help students learn new scientific vocabulary.
- If you're following the Tinkering Studio's build, some cheaper options include using a single LED flashlight and slow-moving motors (on our materials list). Most hobby motors move very fast, which doesn't work for light play.

Inquiry Model

In the first grade Light & Sound Expedition, we want students to understand that light and sound travel through waves to our eyes and ears. With sound, we can actually feel the vibration of the waves in our bodies. Light waves move too fast to sense in the same way, so we experiment to learn how light works.

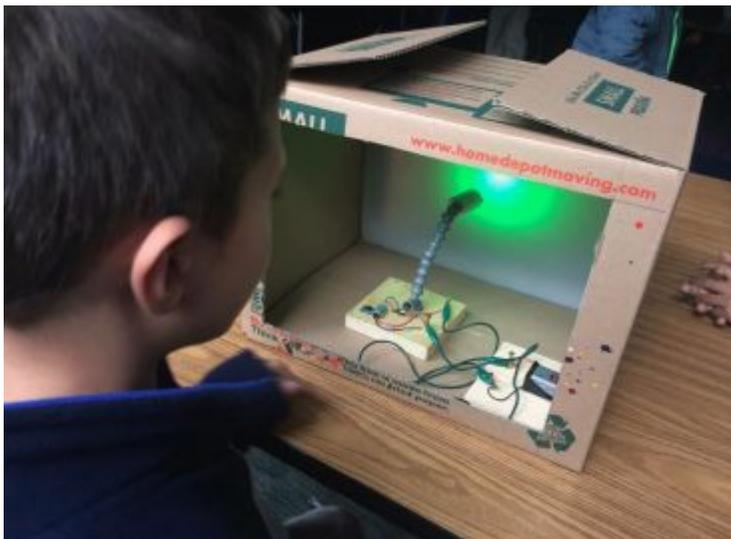
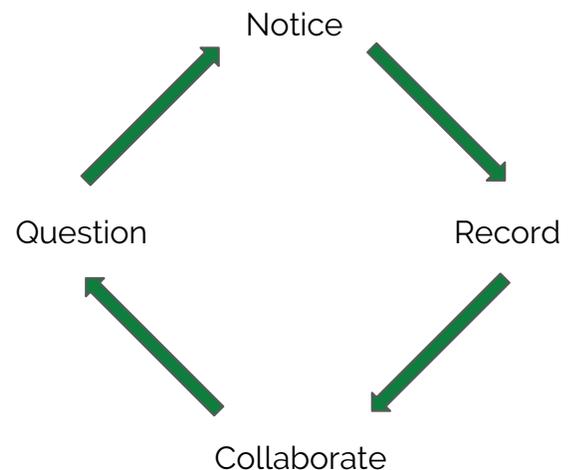
We start with open inquiry: What do we already know about light? How are shadows made?

By limiting materials, teachers focus student inquiry on the area of study. For instance, when starting Light Play, students first receive opaque materials so they can focus on shadows. This limitation pushes students to be more creative. We repeat this inquiry cycle with different sets of materials, each of which focuses students on a new concept about light. For example, students can use the light box with materials that are translucent, transparent or reflective; or they can use the box with multiple light sources to see how that affects the shadows.

During the study, we create two distinct spaces on the wall: one a whole class conceptual model of light, where we put student noticings, observations and explanations; and a second for class questions about light.

Student misconceptions are an opportunity for scientific thinking and discussions based on evidence. As students discover that an element of the class model no longer fits, they can remove it from the wall. Just like a real scientific model, the class model is dynamic, and it changes as students learn more about the topic. In order for our students to be scientifically literate we want them to experience the collective creation of scientific model.

What to do with student misconceptions: develop comfort with leaving misconceptions visible in the classroom. Then plan instruction or experiments that support students in discovering evidence that contradicts the misconception. We try never to just tell students the "answer," but rather want students to own the discovery.



Some tips for teaching with Light Play:

- It is helpful to alternate intense bursts of inquiry with calmer discussion at the carpet. This will help keep the class focused and allow students to start fresh.
- Establish norms and act out role-plays with your students around turn taking.
- Teach, and encourage students to use, new vocabulary, like opaque and translucent, after students discover the concept.

Inquiry Example: Opaque Shadows

1) **MODEL:** With whole class together, turn a light box on and invite students to come up to the box with popsicle sticks. **Ask:** "How do we make and change shadows?"

2) **NOTICE:** Send students to tables with boxes and opaque objects. Students explore with creating shadows.

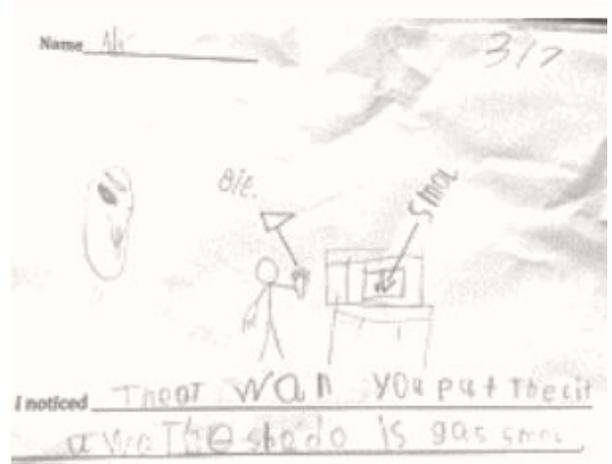
3) **RECORD:** Students record noticings in notebooks or worksheets.

4) **COLLABORATE:** At table groups, students discuss what they noticed, comparing and contrasting findings. Have student write findings on sentence strips for the whole class model.

5) **QUESTION:** What questions do students now have about light?

6) **REPEAT:** On another day, have students explore a new material (reflective, translucent, etc.) to explore how those objects interact with the light source and the screen.

An inquiry cycle like this where students are thinking like scientists, is aligned with NGSS practices. Students are not given the concept; they must figure it out.



Light Play with Older Students

In a middle school science or high school physics class, we plan to implement an activity where we set up four stations around the room, with each having a light box and a particular type of material (opaque, reflective, translucent, refractive, etc).

Students will rotate through the stations and record observations in their notebooks. Some guiding questions are: What do you see? What do you think is happening?

After students look closely, we will create large sentence strips where they can record observations and post them on the wall during rotations.

Extensions of this initial activity could include:

1. Diving into a traditional optics unit
2. Using a thinking routine, like [See. Think. Wonder](#), followed by a student inquiry project, where they further to explore a question they have, such as:
 - a. What happens to image when you have concave/convex lens?
 - b. How can trigonometry help us calculate the size of a shadow?
 - c. What happens to shadows with multiple light sources?

To display what they have learned, students can design a final Light Play box and create a museum-style artist statement describing what materials they chose and why, and which scientific properties of light they are capitalizing on.

Project Extension: Shadow Puppets

Students of all ages can explore light, sound, and storytelling by creating and performing shadow puppet plays. This project is a culminating activity and assessment of student learning in our Light and Sound Expedition.

At this point, only our first grade class has created shadow puppet plays. Students spent several months learning about how light and sound can be used for communication. We wanted our expedition to culminate in a making activity where students could demonstrate their learning about light and sound.

Students combined this project with development of literacy skills. They picked a scene from *Elephant & Piggie*, and while one student read aloud, the other students in the group animated the puppets. Students incorporated music into their plays, using different instruments and techniques to infuse their plays with more emotion.

Middle and high school students can also create shadow puppet plays and write artist statements as assessments of learning.

Materials & Tools

MATERIALS

- Paper
- Cardboard
- Popsicle Sticks
- Foam
- Brass Fasteners

TOOLS

- Hot Glue Guns + Sticks
- Glue Sticks
- Scissors
- Cardboard Scissors



Material Management

To introduce the design of puppets, consider making a few models to show students ways of making movement, and how different materials create different shadows. Try the [Parts, Purposes, Complexities](#) thinking routine to push students to look closely and explore the complexity of the puppets.

Ask students to [draw and plan out](#) puppets and props on a worksheet before they start building to cut down on material waste.

How to Introduce New Tools & Tech SAFELY

To avoid burning yourself with hot glue, try these kid-invented tips

- Use low heat guns
- Use popsicle sticks, instead of fingers, to push pieces of fabric together
- Put glue on the big piece instead of the small piece

Project Extension: Shadow Puppets (cont.)

The following is one example of how a class might create Shadow Puppet Plays. Students in this first grade class created plays of scenes from the book *Elephant & Piggie*, which they read in class.

PUPPETS

- 1) **MODEL:** Show models of puppets made by past students or teachers to demonstrate what kind of shadows they made in light boxes.
- 2) **NOTICE:** Student conversation about what they notice.
 - a) Remind students about "transparent, translucent, and opaque" and ask them to use those words in their noticings.
- 3) **DESIGN:** In groups of 3, students [plan puppets](#) and props on worksheet, drawing puppets and deciding on materials. Give students a set of materials to work with. We had foam, cardstock, and multi-colored cellophane.
- 4) **COLLABORATE:** Build puppets (2-3 days). Teachers may want to control materials, and only give students what they've planned to use.
- 5) **TEST:** Turn on light boxes and see how the puppets interact with the light.
- 6) **REVISE:** Make adjustments, like making the puppet smaller so the shadow fits on the screen, figuring out how to get cellophane to maintain shape, etc.

PLAY

- 7) **DESIGN:** Choose instruments and style of sound for each scene of play to match mood and create more emotion in story. We had maracas, ukuleles, drums, glockenspiels, triangles and cymbals.
 - a) Happy sounds are often fast and loud.
 - b) Sad sounds are often slow and quiet.
- 8) **COLLABORATE:** Problem-solve. How can we have the puppet making a shadow, the lines being said, and the music being played all at the same time?
 - a) For example, one student does all the puppet manipulating, while the others sit behind, reciting the lines and playing the instruments.
 - b) Or each character is played by a separate classmate who holds his/her puppet and says the lines while a designated musician plays the sound.
- 9) **PRACTICE!** (3-5 days) Groups practice independently. Each day a different group practiced in front of the class, and received peer feedback about improving the play. (e.g. increase volume, make sure the puppet doesn't turn sideways so the shadow doesn't disappear, etc.)
- 10) **PERFORM:** We invited the kindergarten class to our performance.

Light & Sound Expedition Description

In each of the projects involved in this expedition, students investigate science concepts through making. Each project has its own set of inquiries to launch discovery:

Instruments

- How is sound made?
- Through their senses of touch and hearing, students discover that sound involves vibration.

Light Play

- What is light? How does it work?
- By playing with light and watching it interact with different materials, students explore light.

Shadow Puppets

- How are light and sound used for communication?
- Students design and perform a shadow puppet play using light boxes and instruments.

Reflection & Community Connection

Building the boxes was a great opportunity to engage parents, teachers, and older students in a community making activity. Although the design for the Light Play boxes was complex, we were able to complete them (with enough coaching).

Light boxes are also a great opportunity for students to lead a booth at a Maker Faire or community events. Students can show off their displays and also lead participants through exploration.

Because a play involves performance, this is a great activity to bring school community together. Different classes might serve as the audience for each other. Older students might perform for younger students or students might perform for families at a school celebration. Additionally, this might serve as an entry point for students becoming interested in theater arts.

Other Projects in This Expedition



[Light and Sound Expedition](#)



[Instruments](#)