Sending Messages with Light and Sound

Waves: Light and Sound

Teacher's Guide

BOCES 4 Science

Teacher's Guide

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Written by teachers and administrators from public school districts within the borders of the NYS Midwest Joint Management Team in conjunction with the BOCES 4 Science Educators

Principal Writer 2016-17: Nancy Shellenberger

12/17

Foreword

BOCES 4 Science is a collaboration between four New York State BOCES (Board of Cooperative Educational Services). This collaborative of science educators came together to respond to the need for instructional resources based on the New York State pK-12 Science Learning Standards (NYSSLS). The research behind the Next Generation Science Standards (NGSS) and the NRC publication, A Framework for K-12 Science Education is the basis for the NYSSLS.

We believe that the future health and well-being of our world depends on scientifically literate people making informed decisions. The development of literacy in science begins at the earliest grades. Elementary children must have concrete experiences upon which to hook their understanding and new vocabulary – this is especially true in the discipline of science. We embrace the notion that students should experience phenomena and solve real problems to learn about the world. We strive to present lessons and materials that will make high quality science instruction available for all students through cost-effective resources for teachers.

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About this Unit

Overview

The unit Waves: Light and Sound is designed for ***first*** grade. The main topics covered in this unit include the relationship between vibration and sound, the relationship between light and seeing, how light interacts with different materials, and how light and sound are used to communicate over distances. Learning in this unit builds towards an engineering design project. In this project students apply what they have studied to design and build a device that uses light and/or sound to communicate. This challenge speaks to a theme that runs throughout the New York Science Learning Standards. This is the theme of how people depend on technology and how scientists and engineers work together to improve technology.

Scheduling

This unit is scheduled to be in the classroom for twelve to sixteen weeks. There are approximately 32 science instructional sessions in this unit, based on 30-40 minutes each. Adjust your schedule accordingly. Please return the unit promptly or to request an extension, call your contact person at BOCES 4 Science. *Guidance on scheduling is provided on the BOCES 4 Science website under Grade 1 Waves. Included is guidance on teaching the unit in fewer weeks.

Materials to Obtain Locally

Some lessons require materials that are NOT supplied in the kit. These materials can be easily obtained by the teacher or the students. Materials that will need to be provided are indicated with an asterisk in the lesson materials list and are also listed below:

- Chart paper
- CD player and a CD of heavy percussion music or Ipad
- Clear Tape
- Crayons or markers
- Hole puncher
- Musical Instruments (guitar, violin, drum - optional)
- Paper ream boxes
- Paper towel rolls
- Projector or an Interactive Whiteboard
- Red food coloring
- Regular flashlight (non-LED)
- Scissors
- Shoe and cereal boxes
- Tape measures and/or rulers
- Toilet paper rolls
- Two books of identical size

Three Dimensions

Each of the BOCES 4 Science lessons includes at least one element from each of the three dimensions identified in the NYSSLS. The lesson page identifies the specific elements targeted; the NYSSLS topic page is included on page 8 of the Teacher's Guide.

Science and Engineering Practices (SEP) – These are the major practices that scientists employ as they investigate and build models of their understanding of the world. They also include key practices used by engineers as they design and build systems.

Disciplinary Core Ideas (DCI) – Selected to represent four major domains: the physical sciences; the life sciences; the earth and space sciences: and engineering technology, and the applications of sciences.

Crosscutting Concepts (CCC) – These big ideas have application across all domains of science and provide one way of linking across the domains of the DCI's. In addition, they link to ideas that are parts of other elementary subjects.

NYSSLS Shifts in Instruction

It is the intention of BOCES 4 Science that this unit provides lessons that demonstrate the following shifts in instruction:

- **Explaining Phenomena or Designing Solutions to Problems:** The unit focuses on supporting students to make sense of a phenomenon or design solutions to a problem.
- **Three Dimensions:** The unit helps students develop and use multiple grade-appropriate elements of the SEPs, CCCs, and DCIs which are deliberately selected to make sense of phenomena or design a solution to a problem.
- **Integrating the Three Dimensions for Instruction and Assessment:** The unit will elicit student artifacts that show direct, observable evidence of three dimensional learning.
- **Relevance and Authenticity:** By taking advantage of student questions and experiences in the context of their homes, neighborhood and community, the lessons in this unit will motivate student sense-making or problem-solving.
- **Student Ideas:** This unit provides opportunities for students to express clarify, justify, interpret or represent their ideas and to respond to peer and teacher feedback.
- **Building on Students' Prior Knowledge:** Since student understanding grows over time, this unit identifies and builds on students' prior learning in three dimensions in such a way as it is explicit to both students and teachers.

Assessment:

Providing opportunities for assessment of learning and feedback to students is an important step in the educational process. This unit includes embedded formative assessments and a final summative assessment of learning. The teacher is encouraged to use a variety of informal or anecdotal assessment strategies as well.

Additional Features of this Unit

This Grade 1 Waves: Light and Sound unit also includes a Student Science Journal. A digital version of the Student Science Journal is available online at the BOCES 4 Science website. (A web address and password are located on a colored insert in the Teacher's Guide.)

Additional resources for the teacher, such as the specific assessments, additional resources and activities as well as direct links to videos or websites mentioned in the teacher's guide can also be found on the BOCES 4 Science website.

Features that Support 3-D Learning

Look for these features in the Teacher's Guide:

NYS pK – 12 Science Learning Standards within each lesson provide the teacher with specific information about the Performance Expectation and the 3-Dimensions that are targeted by the instruction in this lesson.

Performance Expectations:

K-2-ETS1-2 – Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Science and Engineering Practices

Developing and Using Models

Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization or storyboard) that represent concrete events or design solutions.

- Develop a simple model based on evidence to represent a proposed object or tool.

Disciplinary Core Ideas

ETS1.B Developing Possible Solutions

- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

Crosscutting Concepts

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s).

ELA/Math/Social Studies Connections:

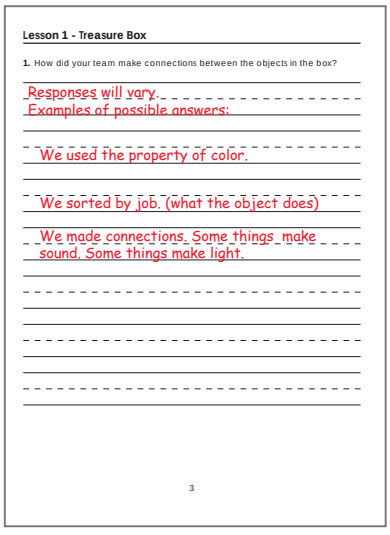
ELA: 1SL1, 1W2

Math:

Social Studies:

Throughout the Teacher's Guide, the 3-Dimensional Domains are color coded within the text so that teachers know to emphasize or explicitly point out to students this connection to either the **Science and Engineering Practices (SEPs)** and the **Crosscutting Concepts (CCCs)**. In addition, small boxes on the right hand side of the Procedure serve as a visual reminder as well.

In addition, a small picture of the page(s) of the Student Science Journal (with answers) that students are using for each lesson has been included on the appropriate pages in the Teacher's Guide (see box to the right). This keeps the teacher from needing to go back and forth between various documents



Lesson 1 - Treasure Box

1. How did your team make connections between the objects in the box?

Responses will vary.
Examples of possible answers:

We used the property of color.

We sorted by job. (what the object does)

We made connections. Some things make sound. Some things make light.

3

SEP: Science and Engineering Practice(s):

Constructing Explanations:

Make observations (firsthand or from media) to construct an evidence based account for natural phenomena.

New York State P-12 Science Learning Standards

Waves: Light and Sound

Students who demonstrate understanding can:

1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. [Clarification Statement: Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.]

1-PS4-2. Make observations (firsthand or from media) to construct an evidence-based account that objects can be seen only when illuminated. [Clarification Statement: Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.]

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. [Clarification Statement: Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).] [Assessment Boundary: Assessment does not include the speed 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.* [Clarification Statement: Examples of devices could include a light source to send signals, paper cup and string "telephones," and a pattern of drum beats.] [Assessment Boundary: Assessment does not include technological details for how communication devices work.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education:*

Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question. (1-PS4-1),(1-PS4-3)

Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.

- Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena (1-PS42)

Disciplinary Core Ideas

PS4.A: Wave Properties

- Sound can make matter vibrate, and vibrating matter can make sound. (1-PS4-1)

PS4.B: Electromagnetic Radiation

- Objects can be seen if light is available to illuminate them or if they give off their own light. (1-PS4-2)
- Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.) (1PS4-3)

Crosscutting Concepts

Cause and Effect

- Simple tests can be designed to gather evidence to support or refute student ideas about causes. (1-PS4-1), (1-PS4-2), (1-PS4-3)

New York State P-12 Science Learning Standards

- Use tools and materials provided to design a device that solves a specific problem. (1-PS4-4)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Scientists look for patterns and order when making observations about the world. (2-LS4-1)

PS4.C: Information Technologies and Instrumentation

- People also use a variety of devices to communicate (send and receive information) over long distances. (1PS4-4)

Connections to Nature of Science

Influence of Engineering, Technology, and Science, on Society and the Natural World

- People depend on various technologies in their lives; human life would be very different without technology. (1-PS4-4)

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-levels: **K.ETS1.A** (1-PS4-4)**; 2.PS1.A** (1-PS4-3); **2.ETS1.B** (1-PS4-4); **4.PS4.C** (1-PS4-4); **4.PS4.B** (1-PS4-2); **4.ETS1.A** (1-PS4-4)

Common Core State Standards Connections:

ELA/Literacy –

W.1.2 Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure. (1-PS4-2)

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-PS41), (1-PS4-2), (1-PS4-3), (1-PS4-4)

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-PS4-1), (1-PS4-2), (1PS4-3)

SL.1.1 Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups. (1-PS4-1), (1-PS4-2), (1PS4-3)

Mathematics –

MP.5 Use appropriate tools strategically. (1-PS4-4)

1.MD.A.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object. (1-PS4-4)

1.MD.A.2 Express the length of an object as a whole number of length units, by layering multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. (1-PS4-4)

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas unless it is preceded by (NYSED).

Lesson 12

Lenses

Vocabulary:
lenses
opaque
tint
translucent
transparent

Focus Question:
What is the effect of different lenses on our sight?

Lesson Synopsis

Learning Target:
I can observe how different kinds of lenses change how I see.

Lesson Description:
This lesson is designed to introduce students to the ideas expressed in DCI PS4.B "some materials allow light to pass through them. Other materials allow some light through and others block the light."In this lesson, students will engage in an **investigation by making observations of a proposed object or tool to see If it solves a problem**. Students will do this by testing a variety of different lenses which they will insert a plastic mask. Students will do this to determine the effect of each lens on their ability to see. Through this investigation, students will learn that some materials are transparent and let nearly all light through. Some materials are translucent and let only some light through. And some materials are opaque and do not let any light through.

Safety:
Students should not share masks.
Students should not put disks in their mouths.

Management

Materials

For the whole class:
Red food coloring*

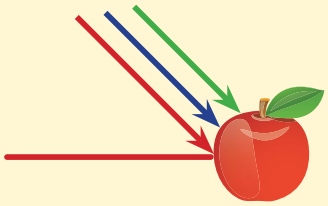
For each student:
Black disks/lenses
Mask
Translucent disks/ lenses
Transparent disks/lenses
Red, blue and green tinted lenses
"Lenses" pages 21-22 in the Student Science Journal

* provided by the teacher or the student

Preparation:
Get masks and lenses out. Consider putting each type of lenses on a Styrofoam tray (available in the kit). This is especially helpful with the clear lenses since they are hard to see

Teacher Background:
Light can pass through materials which are clear such as glass, water, clear plastic. These materials all share the property of being transparent. Light can also partially pass through such materials as wax paper, vellum, and tissue paper. These materials all share the property of being translucent. Light cannot pass through materials that are opaque. Most of the objects around us are opaque. To see an opaque object like an apple, light is reflected off

the apple. With most opaque objects not all the light received is reflected; some of the light is absorbed by the object. The light around us, sometimes referred to as white light, is made up of red, orange, yellow, green, blue, and violet light. Opaque objects only reflect back the light that is their coloring. So when we look at a red apple, the apple reflects back red light and absorbs all the other bands of color. This discussion of how we see in color is not for first graders. Similarly, the tinted lenses which students will use in this lesson, have a dye in them that absorbs certain colors. If you look through the red lens at white paper you will a red or pink color. Although the white paper has reflected all of the colors of the spectrum, the red lens absorbs all colors except the red, which is transmitted to your eye.



Standards

Performance Expectations:

1-PS4-2 – Make observations (firsthand or from media) to construct an evidence-based account that objects can been seen only when illuminated.

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

Science and Engineering Practices

Planning and carrying out an investigation.

- Make observations (first hand or from media) and/ or measurement of a proposed object or tool or solution to determine if it solves a problem.

Engage in Argument from Evidence

- Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.

Disciplinary Core Ideas

PS4.B

- Objects can only be seen if light is available to illuminate them or if they give off their own light.
- Some materials allow light to pass through them. Other materials allow only some light through and others block the light and create a dark shadow on any surface beyond them where the light cannot reach.(Boundary: the idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.

Crosscutting Concepts

Cause and effect

- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

ELA/Math/Social Studies Connections:

ELA: 1SL1, 1W4

Vocabulary:

lens - a round piece of material that you look through. Lenses more than one lens

opaque - blocks light. Not able to be seen through

tint - lightly colored

translucent - allowing light to pass through; objects appear blurry.

transparent - allowing light to pass through; objects can be clearly seen.

Misconceptions:
Be aware that some students believe If they can't see then they cannot be seen.

Procedure

Phenomenon:

Pass out the masks. Then pass out the black disks to the student. Show students how to put the black disks in the mask. Once students have put the disks in their masks, tell students that they are going to put on their masks. Ask students to put on their masks. Hold up an object from the classroom – a book, a backpack, a lunch box. Ask students what you holding? If someone, by chance (or by cheating) identifies the object, hold up something else and see if they can identify this. Have students take off their masks.

Sample Questions:

- (Assuming no one saw the object) Why couldn't you see what I was holding? (because of the black lenses)
- What did we learn in lesson 9 about light and sight? (We need light to see.)
- What did we learn in the last lesson about seeing? (to see, the light has to enter our eyes)
- Where is the light source (lesson 10) in this room? (the window and/or the overhead lights)
- What did the black lenses do? (blocked the light from getting to our eyes. Without light we cannot see.)

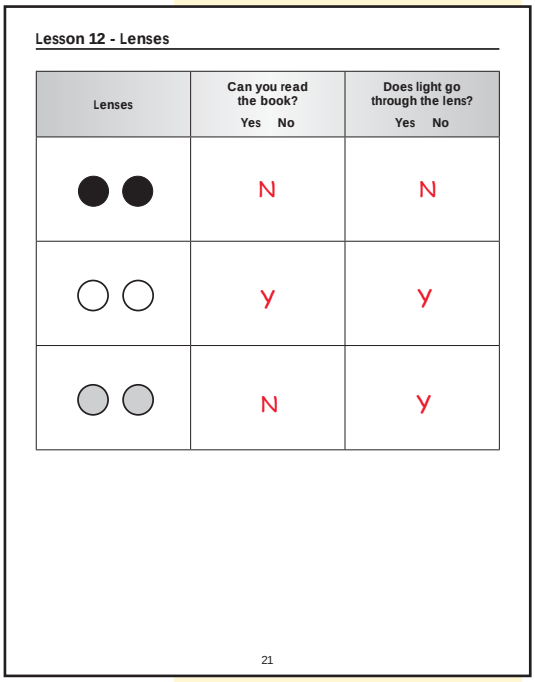
CCC: Crosscutting Concept(s):

Planning and Carrying out Investigations:

Make observations (firsthand or from media) and/or measurement of a proposed object or tool or solution to determine if it solves a problem.

1. Ask students to open up their Science Journal. Ask students if they think they can read what's on the page once they have put the masks back on. Have them put the masks back on and look at the page to check their prediction.
2. Ask students to remove the black disks from their masks. Have student helpers pick up the black disks while you pass out the clear disks. Ask students to put the clear disks into their masks.
3. Ask students to predict if they will be able to see the page 21 in their book using this type of lens. Ask students to explain their predictions.
4. Have students put on their masks, and look at the printed words in their book? Are they able to clearly see the page? Are they able to see the words ?Ask students to hold their hands in front of their face. Are they able to see their hands?
    a. Why are they able to clearly see these things? Is the light able to pass through the **lens**? (yes) Is the light able to reach their eyes? (yes)

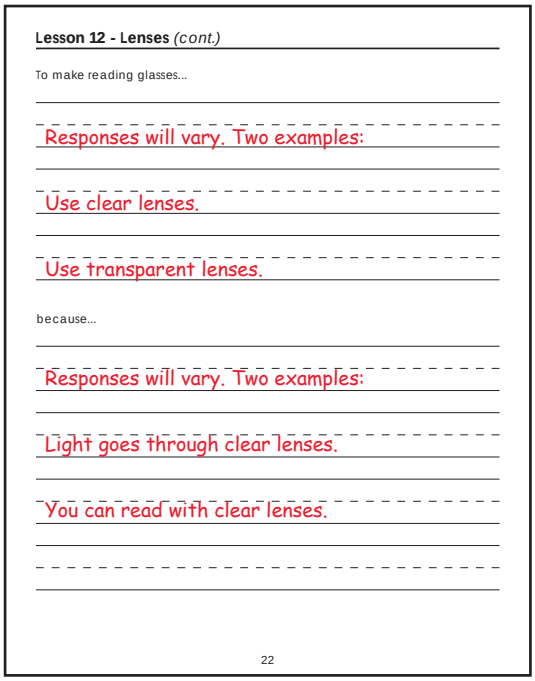
5. Ask students to remove the clear disks/lenses from their masks. Have student helpers pick up the clear disks while you pass out the translucent disks. Ask students to put the translucent disks/lenses into their masks. Ask students if they think that they will be able to read their book or see their hands using this type of lens? Have students explain their answers.
6. Have students put on the masks with the translucent lenses. Can they read their book? Can they see a hand held in front of their face? Does it help to move their hands or the book closer to their eyes or further from their eyes?
    - Ask students to describe what they can see with the cloudy set of lenses.
    - Does light seem to be getting through the lenses? (Yes)
    - Are they able to see clearly? (No)
7. Have students record their findings on the Lenses page in their Science Journals.
8. Introduce the following words. Have students say these words out loud. Point out the **cause and effect relationship** between the type of material, the amount of light that the material lets through and the ability to see.
    - **Opaque** - the black lens was opaque. Opaque materials don't let any light through and we cannot see through them. Many things are opaque such as books, rulers, doors etc.
    - **Transparent** - the clear lens was transparent. Transparent materials let almost all the light through and we can easily see through transparent materials. Most windows are transparent.
    - **Translucent** - the cloudy lens was translucent. Translucent materials let some light through and we can see a little bit through them. Some types of window shades are translucent. They let some light through but not all light.
9. Have students look at their findings recorded on the first page of Lenses in their Science Journals. These findings are their **evidence**. Students should refer to their findings when they make a **claim** about which set of lenses could be used for making a pair of reading glasses. They do this on page 22 of Science Journal.



Lesson 12 - Lenses

Lenses	Can you read the book? Yes No	Does light go through the lens? Yes No
●●	N	N
○○	y	y
◍◍	N	y

21



Lesson 12 - Lenses *(cont.)*

To make reading glasses...

Responses will vary. Two examples:

Use clear lenses.

Use transparent lenses.

because...

Responses will vary. Two examples:

Light goes through clear lenses.

You can read with clear lenses.

22

CCC: Crosscutting Concept(s):

Cause and Effect:

Simple tests can be designed to gather evidence to support or refute student ideas about a claim.

SEP: Science and Engineering Practice(s):

Engage in Argument from Evidence:

Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.

CCC: Crosscutting Concept(s):

Cause and Effect:

Events have causes that generate observable patterns.

10. Have student helpers pick up the translucent lenses. Pass out the tinted lenses. Blue, red and green lenses are available for students to use. Allow time for students to "play" with these different types of lenses. Below are some suggested activities that students can do and the questions related to those activities.

    Sample Questions:

    - Are the **tinted** lenses letting all the light through? (No, only a certain color of light is coming through.)
    - What color is white paper when students are wearing the lenses? (The paper becomes tinted with the color of lens.)
    - What color does water, colored with red food coloring, look like when viewed wearing the blue lenses?(The water may look purple.)
    - What color does water, colored with red coloring, look like when viewed wearing the green lenses. (The water probably looks very dark.)
    - What happens when two red lenses are put in one side and two green lenses are put in the other side. (Flat objects look 3-D or seem to vibrate.)
    - What color lens would students use on a very bright sunny day?(Accept any reasonable answer.)

11. Have students think about the conversation at the end of lesson 10 about sources of light. There we mentioned the difficulty seeing a flashlight outside during the day because the light from the sun is so bright. It outshines the light from the flashlight. When we want to communicate using light during the day, what do we do? We use different colors of light. The stoplight uses green, yellow and red. Brake lights use red. Construction signs, that tell cars to move over, use yellow.

Closing the Lesson

Pass out a treasure box to groups of 3 to 4 students. Have students take out the magnifying glass. Have students take turns laying the magnifying glass on a piece of worksheet or a printed page in the book. Have the students slowly lift up the magnifying glass while looking through it. They should notice that the print gets steadily larger until at a certain point it will then get blurry. Explain to students that reading glasses have lens in them that are like the magnifying glass, they make things larger for people who have a hard time seeing small print.

Have a student in each group take responsibility for seeing that the magnifying glass is returned to the box.

Go back to the Phenomenon that started the lesson, wearing the mask with black lenses. Ask students if there ever is a time when someone would want to wear a mask with opaque lenses? A student may point out that a parent or grandparent wears a black mask to help them sleep at night. People often wear such masks when they are traveling on a train or plane and trying to sleep.

Review with students what they learned in this lesson. There are some materials that light passes through, there are some materials that light does not pass through and there are some materials that some but not all light passes through. How light interacts with a material is a property of that material and affects how we use that material. Students will investigate that idea in the next lesson.

Assessment

Assess by listening to student comments during class discussions, and by evaluating the responses on the pages about Lenses in the Science Journals. Check if students understand the differences between opaque, transparent and translucent materials and their **effect** on how much light gets through. Check to see if students could **support with evidence** which material is best for making glasses.

Connections

Differentiation:

This would be a challenging lesson for students who are visually impaired. Hopefully a teacher's aide can guide them in understanding what other students are experiencing. For students who are visually impaired but not totally blind, their vision may be comparable to what the other students experience when they put on the translucent lenses.

Review with ELLS the pronunciation of the words: transparent, translucent and opaque. Even for native speaker, transparent and translucent sound very similar and can be easily confused.

Extension: After this lesson many students want to learn more about the visually impaired and the strategies that they use to move around and to read. This lesson has also inspired conversation about color blindness.

Cross-Discipline:

Life Science: Although the focus of this lesson is the way light interacts with different material, the lesson does bring attention to how we see. In Life Science for first grade, students study information processing in regard to how animals have body parts that capture and convey different kinds of information,

Art: In art class, students may have learned about the primary colors of red, blue, and yellow and how these can be mixed to form the secondary colors and how if you put all the colors together you get a brown or black color. When students "play" with the colored lens, they will experience this concept of color mixing.

Next Lesson Preparation

In the next lesson, students build on the knowledge acquired in this lesson, to conduct an investigation into transparent, translucent and opaque materials. If you had difficulty getting your room to be dim back in Lesson 9, gather 4 to 5 paper ream boxes to use for Lessons 13 and 14.

If available borrow from the library the book: What's that Shadow, A Photo Riddle Book, by Christopher L. Harbo.