Sensors

Let It Shine

Grade Levels: Kindergarten – 2nd

Academic Content Areas: Science, Technology, Engineering, & Mathematics

Topics: Physical Science; Science & Technology; Scientific Inquiry; Scientific Ways of Knowing; Geometry & Spatial Sense; Patterns, Functions & Algebra; Data Analysis & Probability

Recommended area of co-teaching for an AFRL Engineer or Scientist

Main Problem/Essential Question

Do all materials let the same amount of light shine through?

Summary

This investigation is to introduce/solidify students' working knowledge of sorting and classification. Through this process students will investigate light transmittance through everyday objects. The students will perform a simple flashlight test to classify objects into three predetermined groups; that of transparent, translucent, and opaque. Students will create class graphs to represent the discoveries. An in depth post discussion will help solidify sorting and light classification concepts as well as address other targeted standards.

This classification scenario will introduce students to some basic concepts of matter and light. Students will explore that not all objects are the same. Students will explore that varying degrees of light can pass through their objects.

Understanding how light passes through different materials is necessary when designing glasses, sunglasses, sport glasses, windows, car/ airplane windshields, and helmet visors.

Big Ideas / Focus

Classification is the process of organizing materials based on a determined property. In this lab students will classify a kit of materials based on varying physical properties. Students will use their data to create class graphs.

Students will discover that when light strikes an object, some may or may not pass through the object. Whether or not light passes through an object depends on the type of material the object is composed of. Translucent materials all light to pass through but distort the light rays so a clear image cannot be seen through the material. Transparent materials allow light to

pass through and objects to be clearly seen through them. Opaque materials do not allow light to pass through and therefore you cannot see through them.

Teacher Note: Background information and Appendix C contain additional information on transmittance.

Light rays will travel from a source in straight lines. When light rays encounter objects or materials in their path, one or more of three things may happen: some light could be reflected, some light could be absorbed, or some light could pass through.

Prerequisite Knowledge

Students need to know how to operate a flashlight.

Students should have a basic understanding that light travels in a straight line. This can be demonstrated by studying shadows, through using multiple pieces of string with one end attached to a specific part of a student's body and the other end attached to the corresponding part on their shadow; students can see that they block the light and the light that they do not block travels past them, in a straight line, to the flat surface where their shadow is. This is why the student's body is a near perfect outline and not some unrecognizable blob.

Standards Connections

Content Area: Science

Physical Sciences Standard

Students demonstrate an understanding of the composition of physical systems and the concepts and principles that describe and predict physical interactions and events in the natural world. This includes demonstrating an understanding of the structure and properties of matter, the properties of materials and objects, chemical reactions and the conservation of matter. In addition, it includes understanding the nature, transfer and conservation of energy; motion and the forces affecting motion; and the nature of waves and interactions of matter and energy. Students demonstrate an understanding of the historical perspectives, scientific approaches and emerging scientific issues associated with the physical sciences.

Grade K: Benchmark A: Discover that many objects are made of parts that have different characteristics. Describe these characteristics and recognize ways an object may change.	2. Examine and describe objects according to the materials that make up an object (e.g., wood, metal, plastic and cloth). 3. Describe and sort objects by one or more properties.
Grade 1: Benchmark A: Discover that many objects are made of parts that have different characteristics. Describe these characteristics and recognize ways an object may change.	1. Classify objects according to the materials they are made of and their physical properties.

Science and Technology Standard

Students recognize that science and technology are interconnected and that using technology involves assessment of the benefits, risks and costs. Students should build scientific and technological knowledge, as well as the skill required to design and construct devices. In addition, they should develop the processes to solve problems and understand that problems may be solved in several ways.

Grade K: Benchmark B: Explain that to construct something requires planning,	3. Explore that each kind of tool has an intended use, which can be helpful or harmful (e.g., scissors can be

communication, problem solving and tools.	used to cut paper but they can also hurt you).

Scientific Inquiry Standard

Students develop scientific habits of mind as they use the processes of scientific inquiry to ask valid questions and to gather and analyze information. They understand how to develop hypotheses and make predictions. They are able to reflect on scientific practices as they develop plans of action to create and evaluate a variety of conclusions. Students are also able to demonstrate the ability to communicate their findings to others.

Grade K: Benchmark B: Design and conduct a simple investigation to explore a question.	3. Use appropriate safety procedures when completing scientific investigations. 4. Use the five senses to make observations about the natural world. 7. Use appropriate tools and simple equipment/ instruments to safely gather scientific data. 10. Make new observations when people give different descriptions for the same thing.
Grade K: Benchmark C: Gather and communicate information from careful observations and simple investigation through a variety of methods.	9. Make pictographs and use them to describe observations and draw conclusions.
Grade 1: Benchmark B: Design and conduct a simple investigation to explore a question.	3. Use appropriate safety procedures when completing scientific investigations. 6. Use appropriate tools and simple equipment/ instruments to safely gather scientific data (e.g., magnifiers, timers and simple balances and other appropriate tools).
Grade 1: Benchmark C: Gather and communicate information from careful observations and simple investigation through a variety of methods.	4. Work in a small group to complete an investigation and then share the findings with others. 5. Create individual conclusions about group findings. 8. Use oral, written, pictorial representations to communicate work. 9. Describe things as accurately as possible and compare with the observations of others.
Grade 2: Benchmark B: Design and conduct a simple investigation to explore a question.	4. Use appropriate safety procedures when completing scientific investigations. 7. Use appropriate tools and simple equipment/instruments to safely gather scientific data (e.g., magnifiers, non-breakable thermometers, timers, rulers, balances and calculators and other appropriate tools).

Grade 2: Benchmark C: Gather and communicate information from careful observations and simple investigation through a variety of methods.	5. Use evidence to develop explanations of scientific investigations. (What do you think? How do you know?) 10. Share explanations with others to provide opportunities to ask questions, examine evidence and suggest alternative explanations.

Scientific Ways of Knowing Standard
Students realize that the current body of scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world. This includes demonstrating an understanding that scientific knowledge grows and advances as new evidence is discovered to support or modify existing theories, as well as to encourage the development of new theories. Students are able to reflect on ethical scientific practices and demonstrate an understanding of how the current body of scientific knowledge reflects the historical and cultural contributions of women and men who provide us with a more reliable and comprehensive understanding of the natural world.

Grade 1: Benchmark A: Recognize that there are different ways to carry out scientific investigations. Realize that investigations can be repeated under the same conditions with similar results and may have different explanations.	2. Demonstrate good explanations based on evidence from investigations and observations.
Grade 2: Benchmark C: Recognize that diverse groups of people contribute to our understanding of the natural world.	4. Demonstrate that in science it is helpful to work with a team and share findings with others.

Content Area: Mathematics

Geometry and Spatial Sense Standard:
Students identify, classify, compare and analyze characteristics, properties and relationships of one-, two-, and three-dimensional geometric figures and objects. Students use spatial reasoning, properties of geometric objects, and transformations to analyze mathematical situations and solve problems.

Kindergarten: Benchmark C: sort and compare 2D figures and 3D objects according to their characteristics and properties	1. Identify and sort 2D shapes and 3D objects from the environment using the child's own vocabulary.

Patterns Functions and Algebra Standard:
Students use patterns, relations and functions to model, represent and analyze problem situations that involve variable quantities. Students analyze, model and solve problems using various representations such as tables, graphs and equations.

Kindergarten: Benchmark A: sort, classify, and order objects by size, number, and other properties, and describe the attributes used.	1. Sort, classify, and order objects by size, number, and other properties.
Grade one: Benchmark A: sort, classify, and order objects by size, number, and other properties, and describe the attributes used.	1. Sort, classify, and order objects by two or more attributes such as color and shape, and explain how objects were sorted

Data Analysis and Probability Standard*:*
Students pose questions and collect, organize, represent, interpret and analyze data to answer those questions. Students develop and evaluate inferences, predictions and arguments that are based on data.

Kindergarten: Benchmark A: Pose questions and gather data about everyday situations and familiar objects	1. Gather and sort data in response to questions posed by teacher and students.

Preparation for Activity

Copy pre-test for students.

Prepare the kits from listed materials. (a flashlight, a piece of black construction paper, a piece of cardboard, a piece of foil, a hand towel, a dark colored plastic bowl, "almost" clear plastic lids, cellophane/ transparency in various colors, tissue paper, muslin, waxed paper, a paper plate, a mirror, a metal pie pan, a piece of wood (wooden spoon), a ceramic tile, and a clear transparency.)

Provide students with a white background either a sheet of thick white paper or a tri-fold science display board to be used for transparency testing. This white background needs to be larger than any light that is to pass through any provided object.

Prepare a basic chart in power point that can be projected onto an electronic white board for interactive data collection about the items in each kit (allow students to fill in the categories). *Teacher Note: if this resource is not available chart paper can be used to record student observations instead.*

Cut out the flashlight pictures (see Appendix A) for the students to use on the pictograph. Have tape or glue ready for them to use on the pictures.

Prepare a chart paper pictograph for the whole class for post discussion. Draw in a baseline and vertical lines to help guide the students as to where they should place their sticky flashlight symbols. Tape three cups (clear, frosted, and white) below the baseline as identifiers for the students and appropriately label them Transparent, Translucent, and Opaque. Each student will have one "flashlight" to vote with.

Critical Vocabulary

Hypothesis - a scientific guess or prediction

Light - the energy producing a brightness that makes seeing possible

Observation - things you notice in the world around you using your five senses

Opaque - materials that do not allow light to pass through; the light is reflected and/or absorbed

Translucent - materials that allow light to pass through and may or may not allow objects to be seen clearly through them

Transparent - materials that allow light to pass through without distortion and allow objects to be clearly seen through them

Transmittance- the fraction of light that passes through the sample

Timeframe

Time Allotment	*Activities*
10 minutes	Pre-Test
10 minutes	Review with students how to sort and classify. Discuss observations and using their senses (not taste) to observe.

15 minutes	Students make observations about each item in the kit and sort them into student-generated categories.
20 minutes	Discuss how items were grouped. Show students how to shine a flashlight through a material. Explain activity.
30 minutes	Test several materials to see how much, if any, light passes through them.
15 minutes	Post-Activity discussion.
10 minutes	Post-Test

Materials & Equipment

Excel/Power point, electronic white board and projector (alternative: chart paper)

Tape (to attach flashlight symbols to chart paper)
Clear plastic cup
Frosted plastic cup
Solid white plastic cup

Group Kits:
Flashlight
Thick white paper or tri-fold science display board (for the background)
Black construction paper
Cardboard
Foil
Hand towel
Dark colored plastic bowl
"Almost" clear plastic lid
Cellophane / transparencies of different colors
Tissue paper
Muslin
Waxed paper
Paper plate
Mirror
Metal pie pan
Piece of wood (ex. wooden spoon or block)
Ceramic tile
Transparency (ex. quarter sheet of a clear transparency)

Safety & Disposal

Students should use care when working with objects that may have sharp edges (metal pie pan, foil, etc.).

Students need to be cautioned not to shine the flashlight in each other's eyes.

Students will be able to make better observations if the classroom is darkened. Remind students about safety precautions in this setting.

Pre-Activity Discussion

Introduce the term observation to the students as you notice in the world around you. What do you see? What do you hear? What do you feel? What do you smell?

Introduce the term properties to the students as *ways to describe a material based on your observations* (hard, soft, smooth, rough, color, weight, etc).

Show the students the materials in the kit that they will be using. Introduce all of the materials in the box, by desired name.

Model how to describe the properties of one or two objects.

Demonstrate how to sort objects by characteristic (e.g. “I am going to put these two together because they are both heavy. This one is not very heavy, so I am going to put it in a different group.”)

Distribute kits to students at their work areas. Have students examine each object with their lab partner and put the objects in 2 or 3 groups. Allow approximately 15 minutes for them to do this, provide any further scaffolding individual groups may require.

Have several student groups share their sort including the chosen sorting characteristics and examples of which objects went into which group and the characteristic that caused them to be placed in that group. (Example: a group may sort by colors grouping white, lights, and darks. During discussion they may share their bowl and explain that since it is dark green in went into our dark category and our block which is a light wood went into our light category.) Encourage diverse ideas and sorts.

Explain that students are next going to test and re-sort the objects based on how much light they allow through it. Using common classroom objects (water bottles, book bags, etc.), demonstrate how to use the flashlight to test the materials and categorize them.

Teacher instructions

Administer pre test.

Conduct pre activity.

Using groups and kits from the pre activity assign students a role for the upcoming lab.

Discuss how this activity has two parts. First students will sort objects by whether they let light through or not. Secondly, students will sort objects based on whether other objects can be clearly seen through them (regardless of color) or not.

Explain that students will be testing these materials to see how much, if any, light passes through them. Discuss classroom etiquette for having a darkened room.

Discuss terms translucent, transparent, and opaque. Elicit examples for each of these after you have discussed the definitions.

Model how to test materials. The light test can be conducted by placing the head of the flashlight against a flat surface of the object or wrap flexible material over the head of the flashlight and turn the flashlight on. Point the flashlight at a sheet of white construction paper and determine whether the light can be seen or not. It may be helpful to turn the flashlight on and off a few times. (You may want to have a student or adult helper turn off the lights during this demonstration.)

Instruct students to conduct their first sort of light versus no light and create two groups: objects that let light through and objects that do not.

Monitor the room as students are testing materials to ensure that they are testing each material correctly and placing the objects into two categories.

When all groups have finished sorting their materials, turn the lights back on and have student groups share which materials they put in each group. Make a list in an electronic white board excel chart or chart paper of the objects that let none of the light through.

Teacher Note: One of the benefits of using excel is that you can automatically have excel graph the student's data which can be used for classroom summary, math extensions, and instructional differentiation.

(If you have chosen for students to switch roles, do so.)

Have students place opaque materials back into the kit.

Explain that now students are going to conduct their second sort and re-test the materials that let light through them. Demonstrate how students are to hold the materials in their line of sight and look across the room. Then based on their observations the students should create a group for materials that they can clearly see through and group for materials that they cannot clearly see through. (Note: You may need to define "clearly" to your students depending on their age and development, especially regarding color.)

Continue to monitor the room as students test the materials again. For students who are struggling, review the categories with them and help them talk through some of the objects they are testing.

For students who finish early, see options in the Differentiated Instruction Section for lesson variance and continuation.

When all groups have finished sorting their materials, have student groups share which materials they put in each group. Make a list in an electronic white board excel chart or chart paper of objects that they could see through clearly and objects they could not see through clearly.

Refer to the "cup graph" and ask the class the following question: *Which cup do you think will let the most light shine clearly through?* Pass out the flashlight symbols. Have students write their name on their picture. Call the students up one by one to place their symbol above their choice on the class pictograph. After all students have had an opportunity to respond, ask several students to share their reasoning. Have students use examples from the primary activity in their explanations.

Conduct post activity discussion and administer post-test.

Background Information

Translucent materials allow rays of light to pass through; translucent materials may or may not be transparent. Light can either pass through so objects can be clearly seen or it can be scattered or distorted as it passes through. Materials like frosted glass are translucent, but do not allow objects to be seen clearly through them. Transparent materials allow rays of light to pass through and allow objects to be seen clearly through them. Materials like air, clear glass, colored glass, and some colored plastic sheets are transparent. An object is still considered transparent when it affects the color of light passing through, but still allows other objects to be

clearly seen. Opaque materials do not let rays of light pass through. The light is either absorbed or reflected; examples include cardboard, a thick dishtowel, and a baking sheet. *Teacher Note: Background information and Appendix C contain additional information on transmittance.*

Instructional tips

During the activity, students may need:

1. Additional guidance on their respective roles and procedures.
2. To be reminded of how to use the flashlight appropriately.
3. To be reminded that they are to be sorting, not just testing the materials.

You may want to collect the materials explored in the pre lesson and have students physically demonstrate each one while reviewing the pre test.

Assignment of Student Roles and Responsibilities

Appendix D has printable student name-tags. An alternative is to have students switch roles for the second materials sort in the lab.

Member	***Role Name***	***Brief Description***
1	Flashlight Technician	This student is responsible for safely using the flashlight to test the scientists chosen material. (Sorting decisions should be made by both partners)
2	Materials Scientist	This student is responsible for choosing and holding the tested material. (Sorting decisions should be made by both partners)

Student Instructions

Students are to complete the pre and post-test, actively participate in the pre activity and the sorting lab. Students should then use their gained knowledge to actively participate in the post discussion and successfully complete the post-test.

During the sorting lab students are to follow verbal cues provided by teacher.

Formative Assessments

Students will be assessed using the written pre/post test, the attached lab inquiry rubric and the post discussion.

Lab Inquiry Rubric

Category	2	1	0
Ability to Sort/ Classify	Student successfully sorts all materials	Student attempts to sort all but materials but either some materials are left unsorted or are sorted incorrectly	Student does not exhibit the ability to sort materials.
Scientific Terms	Student consistently uses accurate terminology (translucent,	Student uses terminologies (translucent, transparent, and	Student does not use terminology (translucent, transparent, and

	transparent, and opaque) to describe materials	opaque) to describe materials, but terms are not always used correctly.	opaque) to describe materials accurately.

Scientific Tools	Student uses flashlight and test materials only for intended use of scientific investigation.	Student uses flashlight and test materials for gathering scientific data but some incorrect use was noted.	Student does not consistently demonstrate appropriate use of materials.
Teamwork	Student actively interacts with partner through inquiry and sorting.	Student engages with partner but tries to complete inquiry and/or sorting independently.	Student does not interact with partner during this lab.
Communication of Scientific Inquiry	Student shares explanations or critical thoughts during the class discussion of materials and lab findings.	Student participates but does not provide any original thoughts in class discussion of materials and lab findings.	Student does not participate in class discussion of materials and lab findings.

Post-Activity Discussion

Have students share explanations of translucent, transparent, and opaque using evidence from their inquiry. Have students identify the common characteristics of those objects. (Examples may include: I could see through them. The light went right through.)

Pre-Test / Post-Test

Appendix B is the pre-test/post-test.

Administer the first page for the pre test and both pages for the post test. Use the pre-test/post-test rubric for grading

Pre- Test/ Post-Test Rubric

Question	***1 point***	***0 points***
1	Student correctly circled the toilet paper roll.	Student incorrectly circled the hand.
2	Student correctly circled the sunglass lens.	Student incorrectly circled the hand towel.
3	Student correctly circled the eggshell.	Student incorrectly circled the book.
4	Student correctly circled the window.	Student incorrectly circled the leaf.
5	Student correctly circled the shell.	Student incorrectly circled the pan.
Teacher Note: Questions 6-9 are only administered for post-test.		
6	Student correctly matched the term translucent with the toilet paper.	Student incorrectly matched the term and picture.

7	Student correctly matched the term transparent with the window.	Student incorrectly matched the term and picture.
8	Student correctly matched the term opaque with the pan.	Student incorrectly matched the term and picture.
9	Student correctly circled the wax paper column.	Student incorrectly circled another column.

Technology Connection

The **ADISC** Model of technology created by ITEL:

Integration Model	***Application Description***
Technology that supports students and teachers in **dealing effectively with data**, including data management, manipulation, and display	Electronic white board MS Excel/ Power point
Technology that supports students and teachers in conducting **inquiry**, including the effective use of Internet research methods	Flashlight
Technology that supports students and teachers in **simulating** real world phenomena including the modeling of physical, social, economic, and mathematical relationships	Flashlight
Technology that supports students and teachers in **communicating and collaborating** including the effective use of multimedia tools and online collaboration	Electronic White Board MS Excel/ Power point

Interdisciplinary Connection

Literacy Connections:

The Magic School Bus Gets a Bright Idea: A Book about Color and Light by Joanna Cole. (Scholastic Inc., 1997)

Science Secrets: Light by Jason Cooper (The Rourke Cooperation, 1992)

Light and Dark by Sally Hewitt. (Franklin Watts, 1998)

Home Connection

Students can repeat the same process at home, testing other objects.

Students can test materials using sunlight in place of the flashlight.Differentiated Instruction

Differentiated Instruction

Process Differentiation: Allow students to develop their own way of testing the materials, versus providing them with the process.

Process Differentiation: If students have trouble keeping their sorting piles organized because they keep confusing their piles, provide the groups with two or three pieces of paper and have them label their piles. This label can be crossed off and rewritten for each sort.

Product Differentiation: Conduct the investigation in a large group, allowing each student to test each material, but all working simultaneously.

Product Differentiation: Have students find objects in the room that they predict will be in each category (transparent, translucent, and opaque), and then allow them test these objects to determine if their predictions are correct.

Content Differentiation: Have students put 5-8 objects in order from those that allow the most light through to those that allow the least amount of light through.

Content Differentiation: Kit differentiation would be to allow students to choose additional items to be tested such as the paper they have in their notebooks, their clothing (coats or hats), etc.

Content Differentiation: Ask students to predict which category a material will be in before testing it.

Extension

Consider sharing sections from one or more of the trade books below with your class:

> *The Magic School Bus Gets a Bright Idea: A Book about Color and Light* by Joanna Cole. (Scholastic Inc., 1997)
>
> *Science Secrets: Light* by Jason Cooper (The Rourke Cooperation, 1992)
>
> *Light and Dark* by Sally Hewitt. (Franklin Watts, 1998)

Students are able to virtually test 5 common objects for opacity. Students can adjust the wavelength (color) of the light and read a virtual light meter: http://www.ltscotland.org.uk/5to14/resources/science/light/opacity.asp

Display the following PowerPoint presentation for the entire class and discuss the different objects on each page. http://www.primaryresources.co.uk/science/powerpoint/transparent.ppt

Career Connection

The Laser Protection Lab (RYJ) supported by both Advanced Materials and Manufacturing and Sensors Lab study which materials are opaque and transparent for LASERS. This lab focuses their efforts on eye protection for pilots as well as protection for sensors to keep them from being "blinded" by incoming lasers. A potential fieldtrip or guest speaker may be arranged to help students explore this lab's light concepts application to real world careers and problems.

Teacher Note: This group of technicians, electronics and optical engineers, and physicists use frequency filters to accomplish their goals. Frequency filters block different portions of the electromagnetic spectrum.

Additional Resources

Resource:	***Purpose and Application:***
http://www.ltscotland.org.uk/5to14/resources/science/light/opacity.asp	Virtual opacity test for 5 common objects

http://www.primaryresources.co.uk/science/ zpowerpoint/transparent.ppt	Power point presentation on translucency, transparency, and opacity.

Credits

Tamra Sundermann – Primary author
Sandra Preiss – Contributing author, Editor
Tommy Baudendistel, Ph.D.
Timothy Carey – Contributing author
Sarah Drew – Contributing author
Michael Eismann, Ph.D. – Contributing author
Leesa Folkerth – Contributing author
Kim Puckett – Contributing author
Tina Spaulding – Contributing author

Teacher Reflections

Were students focused and on task throughout the lesson?

If not, what improvements could be made the next time this lesson is used?

Were the students led too much in the lesson or did they need more guidance?

Did the students learn what they were supposed to learn?

How do you know?

How did students demonstrate that they were actively learning?

Did you find it necessary to make any adjustments during the lesson?

What were they?

Did the materials that the students were using affect classroom behavior or management?

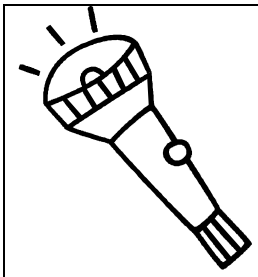
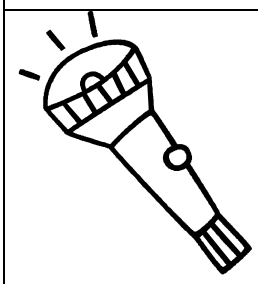
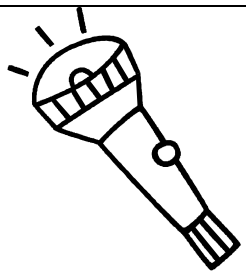
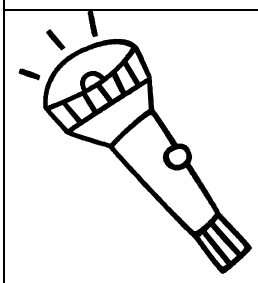
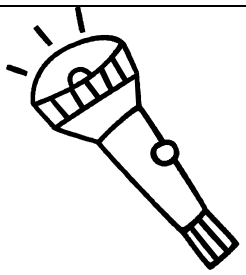
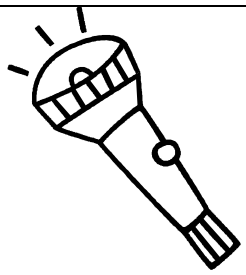
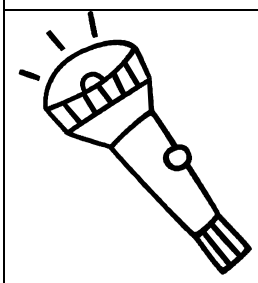
What were some of the problems students encountered when using the flashlights?

Are there better items that can be used next time?

Which ones worked particularly well?

Additional Comments

Appendix A: Pictograph Symbols

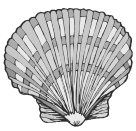
 NAME	 NAME	 NAME
 NAME	 NAME	 NAME
 NAME	 NAME	 NAME
 NAME	 NAME	 NAME

Appendix B: Test

Name _____

Date _____

Directions: Circle the object that lets more light through.

1.	Hand 	Toilet Paper 
2.	Sun Glass Lenses 	Hand Towel 
3.	Book 	Egg Shell 
4.	Window 	Leaf 
5.	Shell 	Pan 

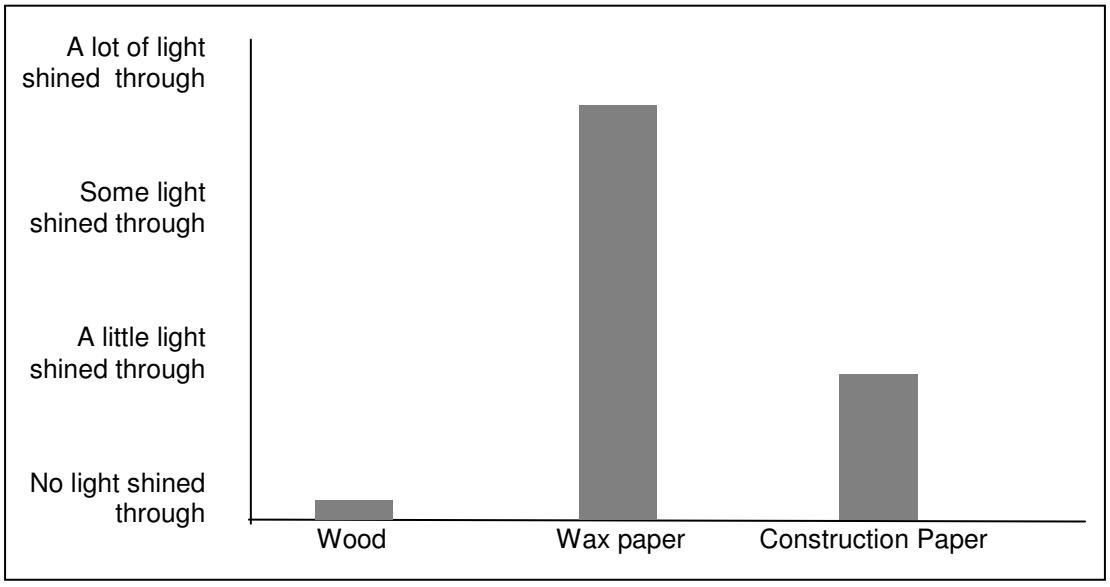
Matching:

6. Translucent

7. Transparent

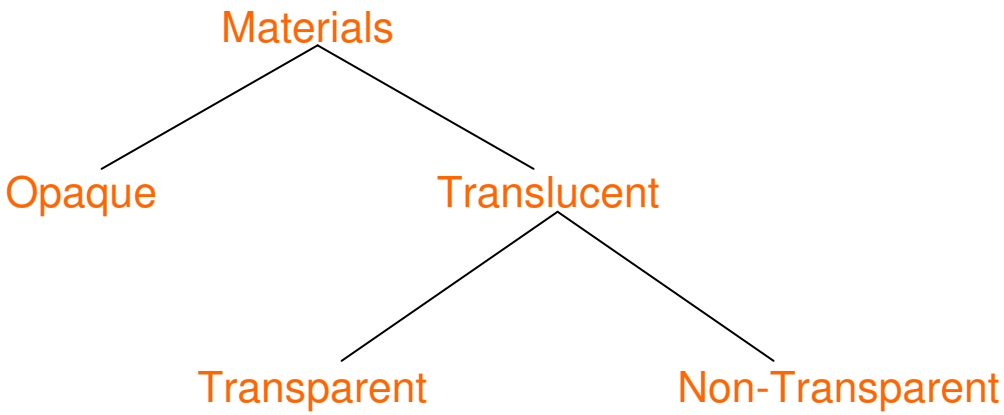
8. Opaque

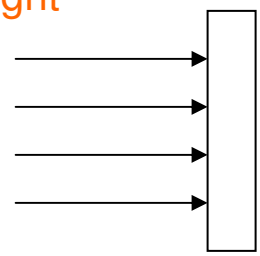
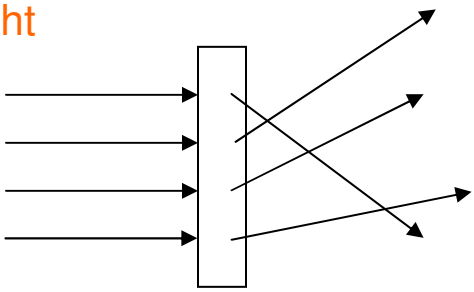
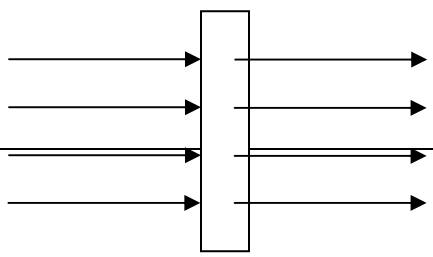
9. Circle which material let a lot of light shine through.



Appendix C: Opacity, translucency, and transparency

Transmittance is the fraction of incident light that passes through the sample.



How Materials Transmit Light	
Opaque	
Translucent (Non-Transparent)	
Transparent	

Appendix D: Name Tags for Student Roles

FLASHLIGHT TECHNICIAN 	**MATERIALS SCIENTIST** 
FLASHLIGHT TECHNICIAN 	**MATERIALS SCIENTIST** 
FLASHLIGHT TECHNICIAN 	**MATERIALS SCIENTIST** 
FLASHLIGHT TECHNICIAN 	**MATERIALS SCIENTIST**