Bay Area Scientists in Schools Presentation Plan

Lesson Name: Light can heat too!
Presenter(s): Russell Muren
Grade Level: 3rd
Standards Connection(s): Energy comes from the sun in the form of light

Abstract: The Sun is the biggest source of energy for our planet. The light that hits our planet can be used in a lot of ways including heating! Students will explore absorption and reflection through the construction of a solar water heater. Students will then get to test their own design and see how something they created improves the heating characteristics of light!

Vocabulary/Definitions: *3 – 6 important (new) words*

Energy – The thing that makes everything we do go (this is a broad definition initially to lead into a discussion about how energy can be stored in so many forms)
Heat – a form of energy that we measure with temperature
Absorb – when an object converts light to heat
Reflect – when light bounces off an object instead of being absorbed
Solar Power – energy that comes from the sun
Renewable energy – energy that will never run out

Materials:

What you'll bring with you

- One mason jar for every 4 students
- Aluminum foil
- One pre-made cardboard reflector stand for every 4 students
- Ice
- Construction paper

What students should have ready (pencils, paper, scissors)

- Scissors
- Tape

Classroom Set-up: *Student grouping, Power/Water, A/V, Light/Dark, set-up/clean-up time needed*

It would be ideal to have desks grouped into groups of 4 but not necessary
One table will be needed to be the supply table

Classroom Visit

1. Personal Introduction: **__5___Minutes**

My name is Russell, and I an engineer at Cal Berkeley. I am also a thermoscientist! Explain that thermoscientist is a big word for a person who studies Energy and Heat. At Berkeley I am studying how we can use energy and heat to create new forms of Renewable Energy. Today we are going to build a simple machine that will use energy and heat to make Renewable Energy!

Topic Introduction: **__10__Minutes**

Big Idea(s), vocabulary, assessing prior knowledge. What questions will you ask to learn from students?

Before we start learning about Energy, we are going to setup an experiment! Tell the students that you are going to ask them to make a prediction. You are going to put two ice cubes on top of two different surfaces. One is going to be on top of black paper and the other is going to be on top of tinfoil. Then you are going to shine a bright light at both of them. Ask the class which ice cube they think will melt faster. Make a table on the board and have the kids raise there hands to vote for which they think will melt faster. Then turn on the light and tell the kids that while the experiment is running you are going to talk to them about Energy.

Tell the class that energy is everywhere and is the thing that makes everything go and write the word on the board. The biggest source of energy is the sun! The sun provides our planet with light but it can also give us heat. (write on board and ask if anybody knows what the definition of heat is) Ask the class what color shirt gets the hottest when it is really sunny outside. (answer black) Right!, that is because black absorbs the most light. (write the word absorb up on the board). Absorb means to take light and turn it into heat. (write the definition on the board). What other colors absorb a lot of light? (write a list on the board of all the colors they list that are good absorbers) Ask the class if you get as hot in a white shirt?(answer no) That's because white reflects light instead of absorbing it. (write the world reflect up on the board). Reflect means to bounce off and not absorb (write on board). What other colors are good reflectors? (write a list of the board right next to good absorbers. To get the most energy from the sun you have to use both reflecting and absorbing materials. Today we are going to build a device that heats up water using just the sun.

2. Learning Experience(s): **__30__Minutes**

Show the kids the melting ice cubes and ask them which one melted faster. Then write up on the board in the same table which cube melted the quickest. Explain the connection between what they just witnessed and what they just learned about absorption and reflection.

Tell the class that they are going to be designing a water heater based on what they just learned. Split up the class into groups of 4. Tell the groups 2 people from each group are going to be the reflection experts and the other 2 are going to be the absorption experts.

The reflection experts are going to be responsible for designing the reflector for the heater. This part of the heater needs to take sunlight and bounce it onto the absorber. Show them the pre-made cardboard reflector stands and tell them how they wont do any reflecting without a good reflector material. Show them the example reflector. To get the best reflection they will have to pick a reflector material. Show them the different reflector materials that they can choose from. Show them that they are going to have to cut the reflector materials to fit onto the reflector stand. Then show them where they are going to attach the reflector materials to the cardboard reflector stands.

The absorption experts are going to be responsible for the designing of the absorber for the heater. The absorber needs to convert as much of the light to heat as it possibly can. Show the students one of the mason jars and tell them that this would not be a very good absorber because clear glass doesn't absorb much light. Show the students the example of an absorber that you have brought. To get the best absorption they will have to pick an absorbing material for the inside of the mason jar. Show them the materials and tell them that they are going to have to pick the material and figure out how to best put it in the jar to absorb the most light. Be sure to tell them that its ok if there absorbing material gets wet.

Tell them that when you say so that the reflection experts should come up to the front and get there materials. Then when you say so the absorption experts are going to come up and get there materials. Ask if there are any questions.
Let them get their materials.
As they build walk around helping the different groups.
When it looks like most groups have picked and attached there materials tell them that they have just a few more minutes to work.
If it is a sunny day* start going around the class filling the absorbers with ice cubes. When all the absorbers are filled tell the groups to get there heaters and bring them outside. Place the heaters in direct sunlight. Show the class that you are also putting an open mason jar with no reflector or absorber full of ice outside in order to compare how quickly the ice melts. Go back inside and wrap thing up.

3. Wrap-up 1: Sharing Experiences and Building Connections __5__Minutes
Putting the pieces together – how will students share learning, interpret experience, build vocabulary?

Tell the class that they are going to go back and check on the ice in about 30 minutes.
Ask the class what they learned about absorption. Ask what they learned about reflection. Tell them about the large solar plants in southern California that can heat oil up to 700 F!! Tell them about how these plants generate energy for thousands of people using the same ideas of reflection and absorption.

4. Close: **__5___Minutes**

How can kids learn more? Thanks and good-bye! Clean-up.

Ask them what types of things they do with hot water. (wash hands, shower, cook). And explain that hot water usually comes from burning gas which costs a lot of money, but it could come form the sun which would be free. Ask them if they have any questions.

TOTAL 60 – 80 Minutes

Follow-up – After Presentation

Suggest students write a letter explaining "How we learned about ?"

About a half hour after the heaters have been place in the sun go back and check on them. Have the students look at how much ice is left in the heater and compare it to the amount of ice left in the clear jar. Ask Teacher and kids to write a letter about what they learned. Drawings are encouraged.

* If it is a cloudy day tell them that the next sunny day the teacher is going to show them how to use there solar water heaters and they are going to be able to put them into action. On the next sunny day the teacher will help the kids put ice in all the heaters and take the kids outside to setup the solar heats. The heaters do not need to be setup in any particular way as long as the sun is high in the sky. The teachers should then go through the same line of questioning with the students. Is the ice melting faster in the heaters?

Build a Reflective Solar Marshmallow Cooker - In this activity, learners use the Sun's energy to cook marshmallows. Learners construct the solar oven out of simple everyday materials. They experiment to see how the color of the marshmallow (vanilla or chocolate) and height of the straws affect cooking time. Use this activity to introduce learners to solar energy and reflection. Note: this activity requires adult supervision. http://stardate.org/teachers/activities/cooker

Activity Directions: http://stardate.org/sites/default/files/ReflectiveSolarCooker.pdf

Materials

- shoebox
- aluminum foil
- string
- tape
- straws
- manila folder
- marshmallows (white and chocolate, or other color)

Preparation

1. Cut slots of equal length down the short sides of the shoebox opposite each other. Draw a scale, beginning with zero at the top, along each slot. Then cut diagonal slits at the corners of the box for the string.
2. Cut a manila folder in half along the fold. Place one half inside the shoebox, so that the folder bows into a curved, half-pipe shape resting on the bottom of the box. Fasten with tape in this shape to the box.
3. Lay a sheet of aluminum foil, shiny-side up, along the curved folder. Tape it to the box, fitting it to the folder shape.
4. Cut two 20-inch lengths of string. Knot each at one end. Floss the knotted ends into slits A and B. Drape the string inside the box, and insert the other end into slits C and D.

Experiment

1. Place one white marshmallow onto a straw near the end, and a colored marshmallow (or more, if you have several colors) on a second straw.
2. Snip a slit at one end of the second straw and join the slit end to the other straw. Space the two marshmallows an inch or two apart from each other.
3. Lay the straw into the slot so that the marshmallows are near the center of the box. The straws should rest on the string at both ends.
4. Pull on both strings to bring the straw to the first level from the bottom.
5. Direct the box toward the Sun; prop it up. Allow the marshmallows to cook for a specified time.
6. Repeat with another set of marshmallows at a different height for the same length of time.

Analysis

1. Why is the shiny surface curved? Would this work if it were straight?
2. Did the color of the marshmallow make a difference? Why?
3. Did the height of the straws make a difference? Why?

Answers

1. It is curved to focus the sunlight. A straight surface will reflect but not focus light.
2. The darker marshmallows should cook faster, since white reflects rather than absorbs energy. (This is the reason you are cooler when you wear white clothes in the sunlight than when you wear dark colors.)
3. When the straws bring the marshmallows where the Sun's energy is most concentrated, the marshmallows will cook fastest. Imagine that the reflecting surface is part of a circular pipe (depending on the shape of your box, it may not be perfectly circular). The focus is one half of the radius of this pipe.