Locating the Sun

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Target Grade: 4th Grade Science

Time Required: 6 days, 45 minute lessons

Standards

Next Generation Science Standards (NGSS):

- MS-PS1-6.: Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
- MS-PS3-3.: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

Lesson Objectives

Students will be able to:

- Use the engineering design process to design a home using solar panel energy.
- Analyze data from collected solar panel energy.
- Reflect on the pros and cons of using solar panel energy.

Central Focus

Working in groups, students will use the engineering design process to create a home using solar panel energy. Students will be able to reflect on the use of solar energy and relate it to their own homes.

Key words: renewable, science, prototype, LED, engineering, design process, solar

Background Information

During the lesson, students will build upon their prior knowledge of solar energy to create a home using solar panels. Some key concepts and terms that could be beneficial to the students prior to the lesson are the following:

- Solar energy: radiant light and heat from the sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis.

- How solar panels work: Solar panels work by absorbing sunlight with photovoltaic cells, generating direct current (DC) energy, and then converting it to usable alternating current (AC) energy with the help of inverter technology.
- Renewable energy: energy that is collected from renewable resources that are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat.

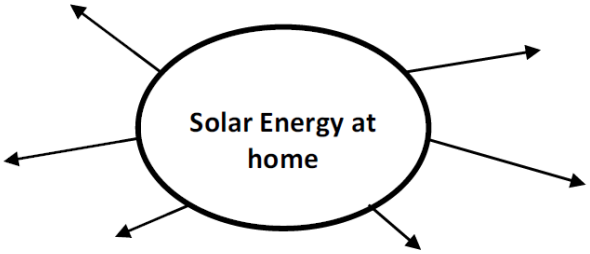
Materials

- Small solar panels with 6V output
- White LEDs
- Cardboard
- Scenario envelopes (one per group)
- Instruction guide (one per group)
- Design work page
- Alligator clips
- Digital multimeter
- Toothpicks

Instruction

Day 1:

- Begin the class by placing students into groups with 3-4 students.
- In each group, provide the students with a large sheet of paper with a concept map already drawn in black marker.
- Ask students to begin writing what they know about solar energy at home at the end of the arrows.



Concept Map

- After a few minutes, ask students to write any questions they have regarding solar energy onto the concept map.
    - Provide time to discuss any questions the students may have regarding solar energy.
- Begin lesson by showing the following video on energy use around the world: https://bit.ly/2LNqe6a.
- Following the video, have a discussion by asking some of the following questions to prompt deeper thinking:
    - How are countries selecting their power sources?
    - What traits do the countries share that have a similar energy source?
    - What types of societies are putting focuses on each type? What does that say about their values as a country?

- As an exit ticket, have students write on sticky note or piece of paper any question they have from the day's lesson. Have students turn in exit ticket.

Day 2:

- Spend the first two minutes of class going over any major question form the previous exit ticket.
- Have student concept maps from previous day on their group's tables along with the scenario envelopes, one per group sealed.
- Inform students that as a class they are going to look at solar energy through a global perspective and interpret the best use of it given their position on the globe.
    - At this point provide each group with the instruction guide and the handouts.
    - Allow groups 5 minutes to read through their instruction guide and assign roles.
- Instruct students to open up their scenario envelopes and begin planning their designs.
    - For each design, the students will need to take into account the best placement of their solar panels as well as roof angles given their location on the globe.
    - In addition, they will need to develop a home that meets their family's needed amount of space and lighting.
    - In their design, they also need to account for the number of solar panels they will need in their house based on the number of lights they plan to install.
    - Remind students of the information located on the back of their design page.
        - Each LED requires 3v of electricity to operate
        - Each solar panel is about 2"x 4"
        - Each panel provides about 6v of electricity
- As an exit ticket, have students write on sticky note or piece of paper any question they have from the day's lesson. Have students turn in exit ticket.

Day 3:

- Hand out the groups' scenario envelopes along with their design pages.
- Have students begin building their designs.
- Students will use cardboard, toothpicks, and LEDs to build and wire their houses.

Day 4:

- Recap the information from the previous day given the constraints and dimensions of solar panels.
- Students will complete the house circuit by attaching the solar panels and then taking them outside for testing.
- Students should take notes on their houses ability to light and power the LEDs they built into their homes.
- Allow enough time outside to provide each group with the opportunity to test their homes.
- Once inside give students time in their group to answer the following questions as an exit ticket:
    - Was your design successful or unsuccessful?

- What made it successful or unsuccessful?
- If you could, how would you change about your design?

Day 5:

- Recap group success from previous day.
- Ask students what information was left out in the experiment that was key to the design process.
  - Students should realize that the location of the sun and time of day were not taken into account in the testing of the designs.
- Today students will be aligning their houses to the original design specifications to see what impact it makes.
- To complete this part, students will use a digital multimeter to register the amount of energy that would be gathered by the panel(s) based on the location of the house on the earth.
- In groups, students will hold up the LED flashlight in position with the solar cell, acting as the sun.
- Another group member will attach the solar panel leads to the digital multimeter.
- Students will have 5 minutes to position the "sun" in the best position to gather light for their home but have to be a foot away from the panel.
- After each group has tested, they will need to provide support as to why that angle and location were best for their location on the globe to collect the most amount of energy.
- Each group will present their design and discuss why and how it fit their needs best.

Day 6:

- Bring back the concept maps from the first day.
  - Ask groups to look back through and fill in any answers they may have now regarding solar energy at home.
  - Ask them to add any new questions they may have from the experiment.
- Allow time for a class wide discussion over any questions.
- Students will have the opportunity to gain a better understanding about solar use where they live and how efficient it would be to install and utilize at their homes by going to Google's Project Sunroof at: https://www.google.com/get/sunroof#p=0.
  - Call students attention to the color scale on the lower right corner regarding shade and sun.
- As an exit ticket, have students write on sticky note or piece of paper any question they have from the day's lesson. Have students turn in exit ticket.

Differentiation

- Google translate and speech to text is available online and may be utilized for ELL or special needs students.

- Students may choose to create their drawings on websites like SmartDraw or the sketch option in Microsoft Word.

Assessment

Formative assessment:

- Using the solar energy at home concept map, the teacher can quickly pre assess the students' prior knowledge of solar energy.
- By using the *Mapping the World Energy Sources* video discussion, the teacher can assess the students' understanding of solar energy in different places around the world.
- The teacher can use the students' design drawing to check that each group is progressing towards the final product.
- The exit tickets will be used as a short check for students' understanding and answering any questions.

Summative assessment:

- The final product of the solar paneled home can be used to assess the students' understanding of solar energy.
- The responses to the questions the students wrote on their concept map on the first day can be used to assess their understanding.

Instruction Guide

You are being given the task to design a house for a location in the world. The house must meet the needs of the family that will be living there. You are going to have to think about the house design given the location and account for snow or available resources when you plan your roof. Additionally, each house will need to have at least one LED light and utilize roof solar panels for electricity.

Each member of your team must take a on a role.

-Time Keeper
-Lead Data Tracker
-Leader
-Materials Manager

When you are given directions by the teacher, you may open your scenario envelope. There you will find a description of a family living in a location on the globe. You will be designing and building a model of the home you think will best meet their needs and their region. Be respectful, thoughtful and encouraging as you work through this as a team.

Scenario 1:

Family: Dubois

Number of Members: 6 (3 adults and 3 children)

Location: Lyon, France

Distance to Equator: 3,150 miles south

Family Requirements:

The Dubois family requires a dining room, they prefer not to eat in the kitchen. They also only allow their two boys to share a room, their daughter has to have a room of her own. The father would prefer for the front door to be facing the east.

Scenario 2:

Family: Banda

Number of Members: 5 (2 adults and 3 children)

Location: Lilongwe, Malawi

Distance to Equator: 966 miles north

Family Requirements:

The Banda family lives in an area of the country that has limited supplies. Wood is a difficult resource to come by, most families use the dirt ground as their floor. The two adults in the family share a room. However, the father is up late at night working on balancing the books for his small store.

Scenario 3:

Family: Johnson

Number of Members: 4 (1 adult and 3 children)

Location: Auburn, Alabama

Distance to Equator: 2,256 miles south

Family Requirements:

The Johnson family loves to read. The mother would like to have a room dedicated to reading. The family has to be up bright and early, before the sun, in order to make the drive to school. The mother does not make a lot of money but works hard to support her family.

Scenario 4:

Family: Hansen

Number of Members: 8 (4 adults and 4 children)

Location: Oslo, Norway

Distance to Equator: 4,144 miles south

Family Requirements:

The Hansen family is a big one. The grandparents decided to move in with the family a few years ago. Family dinners are important to this group. They also spend a lot of time in the living room, given that for many months they experience limited sunlight given their location on the globe.

Solar Design

In the space below, create a design for your house that will be equipped with solar power. Be sure to include measurements in your design. Also keep in mind that the tallest your house can be is 12 inches and the widest dimensions for the base are 12” x 12”. Be sure to label north, south, east and west on your design based on the best alignment for your solar panels and location. There is some additional information on the back of this page that your group may want to take into account when creating your design.

- Each LED requires 3V of electricity to operate
- Each solar panel is about 2" x 4"
- Each panel provides about 6v of electricity