

Earth Science Seasons Lesson

NC State Science Standards:

EEn.1.1.2 Explain how the Earth's rotation and revolution about the Sun affect its shape and is related to seasons and tides.

EEn.1.1.3 Explain how the sun produces energy which is transferred to the Earth by radiation.

Essential Questions:

- How does the tilt of the Earth's axis result in seasons due to the amount of solar energy impacting the Earth's surface?
- How does the differential heating of the Earth's surface (water temperature vs. land temperature) affect weather and climate?
- How can NC maximize the amount of incoming solar radiation to meet energy consumption needs?

Brief Lesson Description:

Students will explore how the angle of solar radiation changes on Earth due to the tilt of the Earth on its own axis. Students will explore how the heating of the Earth due to incoming solar radiation is uneven due to the angle at which it reaches the tilted Earth as it revolves around the sun. Students will collect their own data as well as use data collected from scientists to see how this uneven heating affects North Carolina, specifically in regards to North Carolina's ability to produce solar energy for the power grid.

Performance Expectation(s) and Specific Learning Outcomes:

- Students will be able to explain how the angle at which solar radiation reaches the Earth changes due to the tilt of Earth on its axis and its position as in its revolution around the Sun.
- Students will create a model and use it to collect data to support this phenomena.
- Students will apply their knowledge of angle of insolation to determine if solar panels are a viable option for their school in NC.

Prior Student Knowledge:

- Understand differential heating of the planet from solar radiation
- Understanding of heat transfer: convection, conduction, radiation
- Basic understanding of solar panels

Possible Preconceptions/Misconceptions:

- The seasons are caused by the proximity of the Earth to the Sun.
- The Sun heats the Earth directly instead of light energy from the Sun being absorbed by Earth's materials and atmosphere. The Earth receives light from the Sun, not heat.
- The Earth receives equal amounts of sunlight all year round.

Materials:

All materials from the Supplemental Materials section

Class set of globes (inflatable work well)

Heat lamps

Thermometers

Mini PV cell

Protractors

Multimeters

Alligator clamps with wires

Various other materials students may request to set up their experiment such as cardboard, tape, glue, etc

Computers

LESSON PLAN - 5-E Model

ENGAGE: Opening Activity - Access Prior Learning / Stimulate Interest / Generate Questions:

Time: 30 Minutes

Engage Question: Should we put solar panels on the school roof?

1. Begin by telling students that their help is needed. The environmental club is advocating for placing solar panels on the roof of the school, but the administration does not think it is a good idea and will cost too much money. Administration doesn't even think solar panels will work in the winter in North Carolina. Tell students administration and the club decided to ask experts for help...that's you! As Earth Science students studying the dynamics of our planet, they felt you all would be the perfect experts. Your task is to figure out if our school would be a good candidate for solar panels on the roof and if they will even work in the winter.
 - a. *If you don't have an environmental club at your school, you can modify this storyline to fit your school's situation.*
2. Have students brainstorm what they would need to know in order to make an informed recommendation to the interested parties.
 - a. *You can use a variety of methods for brainstorming here. You can simply use post it notes on a whiteboard or you can use digital platforms such is Padlet or Mural. Encourage students to think about the problem from all angles.*
 - b. *When finished brainstorming, have students rank their brainstorming ideas in order of need to know first to last.*
3. Divide students into small groups (recommend groups of 4). Assign each student the role of Project Manager, Recorder, Researcher, and Spokesperson.
 - a. *These roles are suggestions. Modify roles to fit your classroom. Suggested resources on using student roles in the classroom: <https://my.pblworks.org/resource/using-roles-teams>, <https://my.pblworks.org/resource/formingteams>, <https://teachingcenter.wustl.edu/resources/teaching-methods/group-work-in-class/using-roles-in-group-work/>)*
4. Explain to students that before they begin to explore their school's roof and solar panels, they need to have an understanding of the way in which solar radiation reaches and interacts with the Earth. To do that, students will explore the Earth/Sun relationship through the seasons lab.

EXPLORE: Lesson Description - Materials Needed / Probing or Clarifying Questions:

Time: 120 minutes

1. Begin by showing students the following image: <https://www.livescience.com/25202-seasons.html>
2. Have students draw a diagram of what they think the Earth/Sun positions are during each of these 4 images.
 - a. A template for the diagram is located in the Supplemental Materials section. This can be printed and used or students could just draw the diagram in their notebooks.
3. Have students divide into their previously assigned groups and carry out the Angle of Insolation Investigation.
 - a. *This lab requires students to complete a Claim Evidence Reasoning chart. If you have never used CER with your students, here is a link to a great article on how to incorporate and use it with your students: <https://www.edutopia.org/blog/science-inquiry-claim-evidence-reasoning-eric-brunsell>*
4. Bring students back together to discuss their findings. Refer back to their brainstorm.
 - a. Did they learn the information they needed to know in order to start investigating their solar panel problem? If not, what further items do they need to know?

EXPLAIN: Concepts Explained and Vocabulary Defined:

Time: 45 Minutes

1. Show students the video: <https://www.youtube.com/watch?v=01QWC-rZcfE>
2. Have students revisit the image from the beginning of the lab: <https://www.livescience.com/25202-seasons.html>
 - a. Discuss what position the Earth is in each of the images. Include the tilt of the Earth in relation to the Sun.
3. Ask students to make changes to their original diagram based on what they learned from the lab.
 - a. Students can either modify their original diagram or draw a new diagram.
 - b. Tell students to make sure they label the diagram with angle of insolation for the Northern Hemisphere (direct, indirect, or equal), season for that position, and average temperature for their location during that season.
 - c. Have students use the following website to get these temperature ranges: <https://www.ncdc.noaa.gov/cdo-web/datatools/normals>
 - d. You may also choose to include the Spring and Autumn Equinox and the Summer and Winter Solstice dates. *Depending on grade level and differentiating instruction, you may choose to draw and label this as a whole class or individually.*

Vocabulary: Angle of insolation, solar radiation, revolution, rotation, summer, winter, spring, autumn, tilt, axis

ELABORATE: Applications and Extensions:

Time: 90 Minutes

1. Explain to students that they are going to use the information they have learned from the investigation to try to answer the question of whether or not our school would be a good candidate for solar panels.
 - a. We know that the angle of insolation changes the amount of incoming solar radiation at different times of the year. So, now we need to know if solar panels will work for our school. What are the angles at which we can collect solar energy near our school?
 - a. Explain to students that they will now design an experiment and collect data to determine if solar energy can be collected near the school. They will be conducting their experiment outside so they are using the sun as their energy source.
 - b. Remind students of their roles in their groups and pass out the Solar Panel Project Student Guide (located in the Supplemental Materials Section).

EVALUATE:

Time: 90 Minutes

Formative Monitoring (Questioning / Discussion):

Formative assessment can be included throughout the lesson as students are discussing, exploring, and designing.

Summative Assessment (Quiz / Project / Report):

1. Explain to students they will create a presentation to inform administration and the environmental club of their recommendation for solar panels for the school.
 - a. They must include pros, cons, and a cost benefit analysis. They must include elements of their investigations to support their recommendations. (See Solar Panel Project Student Guide for all of the guidelines).
 - b. They can use a variety of platforms: google slides, infographic, flipgrid, etc)
 - c. Guide students in using the Solar Panel Project Rubric to make sure they meet all the elements.

Elaborate Further / Reflect: Enrichment:

Time: 45 Minutes

1. Ask students to write a recommendation letter to the school administration and board based on their research and investigations.
2. Students could choose to send their letters in the hopes that their district would invest in solar panels for the school. *This could go in a variety of directions for advocating for reducing the carbon impact the school has on the Earth.*