Unit: Understanding Science and Engineering Through Solar Power

Lesson 1 Setting Expectations for Science and Engineering Projects

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DESCRIPTION: Begin this session by setting some ground rules for science discourse. Explain to students that as we work on this unit, and science in general throughout the year, they will be asked to share their thinking about science concepts.

GRADE LEVEL(S): 2, 3, 4, 5

SUBJECT AREA(S): Science inquiry, engineering design, scientific method

ACTIVITY LENGTH: 30 minutes

LEARNING GOAL(S): Establishing guidelines for the unit; students will also have a better understanding of the scientific method.

STANDARDS MET:
Common Core:

- W.2.8. Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1)
- W.3.7 Conduct short research projects that build knowledge about a topic.
- W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic
- W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research

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Student Background:

- Students should be familiar with discussing their ideas with their peers and teacher.

Educator Background:

- **Solar cells** or **modules** are thin wafers of **silicon** that convert sunlight or **light energy** into **electrical energy** using the **photovoltaic effect**.
- A **circuit** is a circular path by which electricity flows from a power source (solar module in this case) to a device that does work (water pump in this case) and then back to the power source. Several power sources can be linked together in a circuit series to produce more energy.
- **Scientific inquiry** is the "diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work." *(National Science Education Standards*, p. 23). Scientific inquiry requires students to form testable questions about the natural world that they have observed. After developing a hypothesis (or educated guess) related to their question, students design and conduct experiments to test whether or not their hypothesis is correct. Conducting an experiment includes gathering data and recording observations. Often time scientists display their data using graphs, which is good practice for students. Students then analyze the data gathered during the experiments and draw conclusions about whether or not their hypothesis was correct.
- **Engineering design** is a process by which students identify or are given a problem to solve. The problem must have given constraints (time, materials, money etc.). Students then design a solution to the problem, create a prototype, and test their design. Data from testing the prototype is collected and the design is evaluated. The prototype is then modified based on the results from the first test and then tested and evaluated again. Finally both designs are evaluated against the criteria of the problem to determine effectiveness. The process can continue iteratively until the design criteria are met.

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Lesson Details:

1. The National Science Teachers Association (NSTA) position statement on scientific inquiry states that:

   > The *National Science Education Standards* (*NSES* p. 23) defines scientific inquiry as "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world." Conducting scientific inquiry means forming a question, or hypothesis, to investigate a phenomenon, and designing a methodology to gather theories (or hypotheses) based on evidence observed, prior knowledge (http://www.nsta.org/about/positions/inquiry.aspx).

2. For this lesson, students will agree upon a set of guidelines related to making observations, stating and sharing a hypothesis, and then drawing conclusions based on fair tests. Basically students will gain familiarity with the scientific method and how to communicate about the process.
3. Start by asking students what they think science is. Write their ideas on a board or large sheet of poster board for everyone to see. Leave up in case students want to add or change their ideas after the lesson is finished.

4. Next, ask students what science does or what the point/goal of science is. Write their ideas on a board or a large sheet of poster board for everyone to see. Leave up in case students want to add or change their ideas after the lesson is finished.
5. Finally, ask students how they would go about conducting a science experiment. Write their ideas on the board, separating them into steps and/or categories as student ideas are shared.
6. Write or draw the cycle of the scientific method (scientific inquiry) near or next to where their student ideas on how to conduct a science experiment are. Compare the scientific method to their ideas on how to conduct a science experiment. Highlight similarities and differences.
7. Review what a hypothesis is (an educated guess about why or how something happens in nature). Ask students to come up with a hypothesis about how solar modules work or something similar in nature (maybe something related to another topic students are studying). Have students write down their hypothesis and then share with a partner both their hypothesis and the reasons they believe it to be true.
8. Ask each partner to either agree or disagree with their partner's hypothesis and state why they agree or disagree. This is a good exercise to help students get used to respectfully agreeing/disagreeing and stating their reasons.
9. Next, explain to students the other steps in the scientific method and process including
    a. Observations
    b. Fair Tests
    c. Collecting Data
    d. Analyzing Data
    e. Making Conclusions
    f. Proving or disproving the hypothesis

Explain to students that the teacher will be using the following prompts to promote discussion about each student's hypothesis:

- "Say more about that."
- "Who can repeat or rephrase what she/he just said?"
- "Why do you think that?"
- "Where do you see evidence for that claim?"
- "So, are you saying…? Do I have that right?"
- "Do you agree or disagree with what was said, and why?"
- "Who can add on to the idea that 'Joe' is building?"

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