



Chemical Differences in Emergency Energy Sources

Lesson 4: Research and Evaluate the Impact on the Environment and Society of Converting Natural Resources into PV Cells.

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DESCRIPTION

Students will engage in guided research to explore resource acquisition, material processing, and electricity generation associated with photovoltaic cells. Opportunity for differentiation exists in the level of assistance in guiding the research, the language and reading level of the texts, the depth of research, and the product expected. The lesson plan is developed for assessing research notes and expression of understanding during a Socratic seminar, but one could easily adapt this research opportunity to meet writing requirements for a co-curricular collaboration. This lesson also provides an opportunity to shorten or lengthen the designated time by adjusting the scope of the research project.

GRADE LEVEL(S)

7, 8

SUBJECT AREA(S)

Photovoltaic Cells, Silicon, Climate Change, Natural Resources

ACTIVITY LENGTH

Three (3) 80-minute blocks

LEARNING GOAL(S)

1. Students will evaluate information to describe the impact on society from resource extraction and materials-processing for PV cells.
2. Students will communicate their understandings of different impacts from converting natural resources into PV cells through participation in a Socratic Seminar.

EXPECTED CONTENT UNDERSTANDING

STUDENT BACKGROUND

Students participating in this lesson should be familiar with the following scientific concepts and practices:

- Reading non-fiction text for detail
- Using evidence from texts for argumentation
- Using academic language in class discussions
- Content from lessons 2 and 3:
 - Chemical structure of simple fuels, such as methane or propane, and the combustion reaction.
 - Explain the combustion reaction as a regrouping of atoms, with one of the products being carbon dioxide.
 - That most of the world's electricity is generated by burning fossil fuels, mainly coal, to heat water and turn a turbine.
 - Extended crystal structures of PV cells.
 - How PV cells are used to generate electricity.
- Global climate change and the effect of greenhouse gasses, including carbon dioxide, on global climate change.

EDUCATOR BACKGROUND

Socratic seminars are a formal discussion protocol to engage students in deep thinking about a text, idea, or issue. In this case, students will become informed about the natural and energy resources that go into making solar cells before developing their own questions and engaging in the dialogue. It is important to clarify for students that this is a dialogue, not a debate. The question is not “Is solar energy good?” Rather, the objective is for students to collectively develop an understanding of the processes and impacts of producing solar cells and using solar-generated electricity.

On day one, students will be introduced to the process of making solar cells through a brief video, followed by time to read and take notes on articles about the natural resources and processes involved, as well as the benefits and drawbacks of using solar energy to produce electricity.

For day two, students will finish making their research notes and develop questions. A question building sheet is provided in the lesson resources using [Costa's Levels of Questioning](https://drive.google.com/file/d/1WDQv6U8jNuWBisDOITr7WngofBXCvM-F/view?usp=sharing), (question building sheet link: <https://drive.google.com/file/d/1WDQv6U8jNuWBisDOITr7WngofBXCvM-F/view?usp=sharing>.)

If the questions students develop are level 1 or 2 in Costa's level of questioning (knowing and understanding or processing questions), they should attempt to answer their questions through further research. Level three questions that involve making

decisions (justify, evaluate, decide, choose, predict, assess) would be ideal discussion-building questions. For example, “Does solar cell production use a lot of energy?” could be more deeply stimulating of conversation if posed as, “Since a solar cell has the potential to generate electricity for decades, is the amount of energy that goes into its production justified?”

Day three includes a seminar discussion and debrief. During the debrief, students reflect on how their participation and the participation of others affected how they understand the topic now compared to before the dialogue, both in content and process. The debrief is also an opportunity for students to note what went well in the process and how the teacher and students can each contribute to a more successful dialogue in the next Socratic seminar.

There are several ways to arrange students for a Socratic seminar. A “Pilot / Co-Pilot” arrangement pairs two students. One student sits in an inner circle of chairs (pilot), the other behind them in another ring of chairs (co-pilot). The co-pilot, just as the pilot, has the supporting texts and their notes. They also have a pad of sticky notes and a pencil to silently pass their questions to the pilot. If the dialogue wanes, the teacher may call for a conference minute or two for the partners to come up with new questions or ideas to contribute, or can have the students swap seats, moving the co-pilot into the speaking circle.

The Literacy Cookbook, written by Sarah Tantillo

(<https://www.literacycookbook.com/page.php?id=31>) provides a good overview of Socratic seminars, with supporting documents and a video of an example from a 6th grade social studies class. She provides a discussion checklist and rubric which were used in this lesson.

REQUIRED MATERIALS

HANDOUTS/PAPER MATERIALS

- Print copies of articles from this lesson,(if students do not have access to internet connected devices)
- [Research guide with rubric](#)
- [Questioning Guide](#)
- [Socratic seminar rubric](#) and participation [observation checklist](#) from the [Literacy Cookbook](#), sourced above.

CLASSROOM SUPPLIES

- Sticky notes
- Pencils
- Highlighters

LESSON PROGRESSION

PLANNING AND PREP

Take the time to watch and read each of the videos or articles provided. Ensure that all links are still functioning correctly. As of 2018, the cost of solar panels fell roughly 70% over the past 10 years

(<https://www.businessinsider.com/solar-power-cost-decrease-2018-5>), with battery technology growing significantly. If students search for additional information, be sure to have them note, not only the source of information, but also the publication date.

Day 1: Watching videos and reading articles. Preview videos and read articles. Copy print resources for students.

Day 2: Review Costa's levels of Questioning and prepare questioning sheet for students.

Day 3: Set up classroom to accommodate your seminar.

LESSON SEQUENCE

Day 1: Background Information, Begin Research

1. (10 minutes) Have students do a think, pair, share as table groups to get ideas that they already have about the production and use of solar generated electricity down on paper.
2. (5 minutes) Show students this video, How Solar Cells Are Made, by the manufacturer BOSCH:

BOSCH Solar How Its Made. (2018). Retrieved from
<https://www.youtube.com/watch?v=2iRfbWOJtog>

3. (5 minutes) Introduce students to the text resources:

There are a wide range of texts here. The list is not meant to be read in its entirety by any one student. The Newsela articles are scalable in Lexile and are available in Spanish. Teachers should read the resources and decide what texts are appropriate for their students or subsets of students.

Solar Cell & Module - Animagraffs. (2018). Retrieved from
<https://animagraffs.com/solar-cell-module/>

Issue Overview: Solar energy. (2018). Retrieved from
<https://newsela.com/read/overview-solar-energy/id/21123>

MEC Fact Sheet. (2018). Retrieved from
https://mineralseducationcoalition.org/wp-content/uploads/mec_fact_sheet_solar_panel.pdf

Contaminating the Rockies. (2018). Retrieved from <https://opb.pbslearningmedia.org/resource/envh10.sci.life.eco.toxicmines/contaminating-the-rockies/#.Wuj4ktPwbBI>

How solar cell is made - material, manufacture, making, used, parts, structure, procedure, steps. (2018). Retrieved from <http://www.madehow.com/Volume-1/Solar-Cell.html>

Application of solar energy in refugee camps, such as the for the Rohingya refugees in Bangladesh, Global Citizen, 2017. (<https://www.globalcitizen.org/en/content/rohingya-refugees-solar-panels/>)

Physicians for Social Responsibility. 2022. Mining Raw Materials for Solar Panels: Problems and Solutions Retrieved from <https://blog.ucsusa.org/charlie-hoffs/mining-raw-materials-for-solar-panels-problems-and-solutions/>.

4. (60 minutes) Students work through the resources and complete the research guide.

Day 2: Deep Reading Texts, Note Taking and Question Generation 1. (50 minutes)
Students continue working through resources until their research outlines are complete.

2. (10 minutes) Review Costa's levels of questions with students. Pose the following questions and ask students to categorize them as levels 1, 2, or 3, with justification.

"What material is melted down to purify silicon?"

"What emits more carbon over the span of 5 years, electricity from a coal-powered electrical plant or from a rooftop solar system that is big enough to provide for all of a family's electrical needs?"

"In addition to the Rohingya refugee camp, what are some more examples of situations that have no source of electricity other than solar?"

"Are there times when solar is absolutely worth any cost because there are simply no other suitable energy solutions?"

"Discuss student classifications and come to a consensus as a class."

3. (20 minutes) Have students use the question generating guide to come up with questions that they need to seek answers to before the Socratic seminar (level 1 -2) and those that they would like to discuss during the seminar (level 2-3).

Day 3: Socratic Seminar and Debrief

1. (10 minutes) Students should take ten minutes to finish organizing their notes and reviewing questions.
2. (5 minutes) Review the rules of engagement for Socratic seminar: Discuss ideas, questions, and facts, not the people who contributed the idea; refer to the text / source when introducing new information; build off of what others are saying; listen actively; If the conversation moves on past a comment or question that you were waiting to say, let it go.
3. (45 mins) Conduct the Seminar. Have a few rich questions ready to pose in the case that the conversation stalls. Either have peers complete the participation checklist for a buddy, or the teacher should do so as students participate.
4. (20 minutes) Students complete a written reflection on the following prompts:

Two things that happened during the discussion that helped us to understand the topic better are:

Two things that we should work on next time we have a Socratic seminar are:

After the discussion, I have a better understanding of:

I still have questions about:

5. Collect research notes and score with the rubric.

ASSESSMENT AND EXTENSIONS

FORMATIVE ASSESSMENT

Teachers should circulate and ensure that students are making progress on the research notes. Ask students to paraphrase information to check for understanding.

SUMMATIVE ASSESSMENT

Students are assessed on the research notes and on verbal communication, using academic language and referring to the resources during the Socratic Seminar. Rubrics are provided for both in the [materials list](#).

LESSON EXTENSIONS

This lesson lends itself well to any variety of information processing and presentation: infographics, verbal presentations, mock advertisements, essays, interpretive dance. One could easily turn this into a co-curricular collaboration with a Language Arts class, or even work in various languages. Additionally, students could be assigned to research batteries and fossil fuels to support a richer discussion. The same research questions would work. For instance, a teacher could provide additional information resources for fossil fuels and batteries.