Inside Engineering Lab Visit

Visitor Information

Group: SHPE/HISPA
Number of students: 25-30
Grade(s): 6-8
Date**:** October 7, 2016
Time: 10:15 am – 10:45 am
Length: 25-30 min
Lab: Esposito
Department: Chemical Engineering

Lesson Objectives

LO 1: Students will be able to describe engineering and chemical engineering, in general terms.
LO 2: Students will understand and be able to identify some pros and cons of solar energy.
LO 3: Students will see a demonstration of solar energy being converted to electricity.
LO 5: Students will discuss the impact of the lab's research/this topic.
LO 6: Students will understand the accessibility of science Ph.D. programs – students receive a stipend, etc.

Materials Needed

- Solar bugs
- Diagram/visual aid for electrolyzer process
- 3D printer
- Computer monitor
- Video of electrolyzer in action

Lesson Outline

1. Introduction (5 min)
    - Make introductions:
        - PI Name, title, department
        - Graduate students and researchers
    - Contextualize:
        - Ask students questions to gauge their STEM knowledge.
        - Ask or describe: What is Engineering?
        - Ask or describe: Specifically, what is Chemical Engineering?
        - Ask or describe: What does a Chemical Engineer do?
    - Research — Briefly cover any/all of the following * in lay terms, easily understood with only basic knowledge:
        - What is your research area?
        - What is the problem your research addresses?
        - What's been done so far?
        - What uses or solutions will (or could) your research bring about?

2. Lab Demos (10-15 min)
    - Highlight fundamental concepts and key equipment
    - Conduct the piezoelectric solar bugs demo. Briefly explain how they work. Mention that they are a simple illustration of one of the weaknesses/constraints of solar energy – there is energy when sun is shining but none when sun isn't.
    - If appropriate for age group: Using a visual aid, describe how applying voltage/inputting electrical energy converts water to chemical energy. Share that this lab works on developing materials and devices that make this conversion more efficient, e.g. by focusing on work using 3D printing to make hydrolyzer devices, producing items that are simpler, low-cost but high-efficiency, etc. Ask students why this is important.

- Demo using 3D printer. Describe how it works (analogy: it is a glorified hot glue gun).
- Visual to tie in to the chemistry: on the monitor, show a video of the electrolyzer. Point out how one side shows more bubbles and ask students why it is so.

3. Conclusion (5 min)
   - Discuss percent of total energy from solar and how it is increasing because solar tech is becoming cheaper.
   - Brainstorm some benefits and challenges of using solar. Try to tie in your work with the real world, why it's important, and why they should care about the topic.

   - Discuss the intersectionality of engineering types and how teamwork and collaboration is key. E.g. talk about different types of engineering that went into making something like the 3D printer.
   - Emphasize *accessibility* of science Ph.D. programs — students will get paid a stipend.

4. General Tips
   - Ask the audience a question early on to gauge their STEM knowledge
   - Ask questions throughout to encourage engagement
   - Ask for questions at the end
   - Avoid jargon as much as possible; students will be more likely to participate and ask questions
   - Emphasize big-picture ideas
   - When praising, praise the thought process, not intelligence (promote a growth mindset). More info on growth mindset: https://www.youtube.com/watch?v=NWv1VdDeoRY

Lesson Plan (Detailed)

Introduction:

1. Give a general intro to engineering. Ask: What is engineering? Give an answer that students will understand, e.g. *Engineering* is the application of scientific knowledge to solving problems in the real world. Ask students to give examples of engineering and what field it is (if they know), e.g. building bridges is civil engineering.
2. Give an intro to chemical engineering. Briefly discuss what your specific field of engineering is about. Give real-life examples of what you do that students could relate to. Sample definition: "In broad terms, *chemical engineers* conceive and design processes to produce, transform and transport materials — beginning with experimentation in the laboratory followed by implementation of the technology in full-scale production"(source: https://cheme.stanford.edu/admissions/undergraduate/what-chemical-engineering). Clarify difference between chemical engineering and chemistry.
3. Briefly share what your research is about. Ask students to think about why it is important throughout the demo as you will ask them at the end.

Demos

1. Ask students what percent of energy that comes from solar (answer = about 1%)
2. Show piezoelectric solar bugs. Explain how they work (they vibrate with electricity, get electricity from solar). Mention that they are a simple illustration of one of the weaknesses/constraints of solar energy – there is energy when sun is shining but none when sun isn't.
3. Using a visual aid, describe how applying voltage/inputting electrical energy causes water to split into H_2 and O, splitting water into chemical energy. Talk about converting sunlight to chemical energy, using water electrolysis to generate hydrogen. Splitting H_2O to make H_2 and O. Walk through formula of water, identify that there is H in there. Talk about applications. Talk about other chemicals we are interested in producing.
4. Share that this lab works on developing materials and devices that make this conversion process more efficient, e.g. by focusing on work using 3D printing to make hydrolyzer devices, producing items that are simpler, low-cost but high-efficiency, etc.
5. Optional — describe how using a membrane to separate the H and O necessitates somewhat more complex structure → experimenting with mesh electrodes. Walk students through design process for electrolyzer.
6. Demo using 3D printer. Describe how it works (analogy: it is a glorified hot glue gun).
7. Visual to tie in to the chemistry: on the monitor, show a video of the electrolyzer. Show before the electrolyzer is on, then when it is turned on and the bubbles form. Point out how one side shows more bubbles. Ask students why this is so. Answer: H 2 O — twice as much hydrogen as oxygen.

Conclusion

1. Discuss percentage of our total energy that comes from solar. The percentage is 1 but increasing; solar tech is becoming cheaper. Brainstorm some benefits and challenges of using solar. Try to tie in your work with the real world, why it's important, and why they should care about the topic.
2. Discuss the intersectionality of engineering types and how teamwork and collaboration is key. E.g. talk about different types of engineering that went into making something like the 3D printer.
3. Emphasize accessibility of science Ph.D. programs — students get paid a stipend and it can be an option.