Polymers in the Classroom: Developing a Summer Workshop for High School Science Teachers (Resource Exchange)

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Alex Jannini is a third-year PhD student at Syracuse University in the Biomedical and Chemical Engineering Department. His current research consists of developing tough and elastic double network hydrogels that have adhesive, self-healing, and biomimetic properties. His Master's research focused on implementing pharmaceutical engineering concepts into lab-based, introductory engineering courses. He has had experience in the classroom as an adjunct professor at Rowan University. In this role, he helped develop a series of experiments for a freshman engineering course that explored introductory engineering concepts through chocolate manufacturing, and another series of experiments involving dissolvable thin films for a similar course. Alex is also the president of the Syracuse University Chapter of ASEE, and has been working diligently with his executive board to provide seminars and workshops for their fellow graduate students. Alex's plans upon graduation involve becoming a professor or lecturer, specifically at a primarily undergraduate institution.

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POLYMERS IN THE CLASSROOM: DEVELOPING A SUMMER WORKSHOP FOR HIGH SCHOOL SCIENCE TEACHERS

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Workshop Description

- Polymer science experiments can be a multifaceted tool for K-12 science teachers, as they can meet several Next Generation Science Standards (NGSS), while also instilling in students an interest in STEM.
- To promote the benefits of these experiments, a two-day polymer science workshop was developed for high school STEM teachers to provide a module to easily incorporate polymer science into the curriculum.
- The workshop presented a customizable module of four labs that can be implemented into present curricula.
- All labs used inexpensive materials and required little to no specialty products.
- Demonstrations on the current progress in the field were also highlighted.
- Assessment confirms positive views from attendees, with high likelihood that labs will be incorporated into curricula.

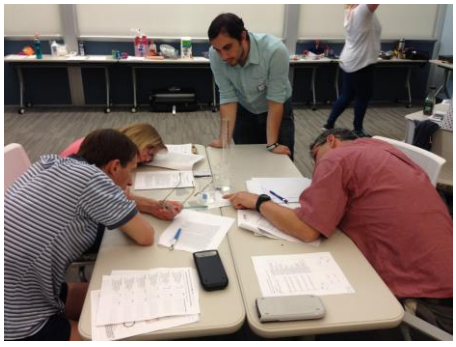
Labs

- Crunch and Munch Lab
  - Introduces the concepts and vocabulary of polymers using food-based models.
  - Polymer chain models are made using cheese puffs (monomers), cheese balls (initiators), and cheese crunchies (crosslinkers), connected with toothpicks.
  - Available at http://matse1.matse.illinois.edu/polymers/d.html
  - NGSS Met: HS-PS1-2, HS-PS1-5, HS-PS1-6
- Polyethylene Lab
  - Relates mechanical properties of materials to their chemical structure.
  - The density of two different types of polyethylene was determined.
  - Available at http://polymerambassadors.org/activities/
  - NGSS Met: HS-PS1-1, HS-PS1-3, HS-PS2-6

Workshop Structure

- For each lab, teachers were grouped into groups of three to four.
- A brief introduction was given to discuss how to frame the experiment.
- Focus was given on how to incorporate inquiry-based learning by starting with some introductory questions.
- Lab handouts and materials were given to each group, and they were tasked with completing the lab.
- Once finished, a post-lab discussion was held.
  - What were the benefits of the lab?
  - What would you change about the lab?
  - What did you learn from the lab?
  - How could you incorporate the lab into your curriculum?

The Crunch and Munch Lab



The Polyethylene Lab

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Labs (continued)

- Recycling Plant Lab
  - Builds on the relation of mechanical properties to chemical structure.
  - Participants simulate a recycling plant and determine how to sort out different types of recyclable material.
  - Available at http://polymerambassadors.org/activities/
  - NGSS Met: HS-LS2-7, HS-ETS1-2, HS-ETS1-3
- Natural Polymer Lab
  - Shows how polymers exist in nature.
  - A model of DNA is made using craft material "nuddles".
  - Available at http://polymerambassadors.org/activities/
  - NGSS Met: HS-PS1-3, HS-PS3-2, HS-LS1-2

Demonstrations

- Demonstrations were shown to participants so that they could see the current field of polymer science, and to give them useful anecdotes for class discussions.
- First demonstration was on light-activated, shape-memory polymers.
  - Let participants run a mini experiment.
  - Have participants use markers to color on polymer sheets.
  - Let them hypothesize how line color and thickness would affect the shape-change of the polymer sheet.
- Another demonstration was on how to make silver nanoparticles.
  - Depending on the concentration of salt used, diameter of particles would change.
  - Diameter change meant color change of the solution.

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Assessment

Overall, feedback shows likelihood of incorporation is high. Numbers shown are mean ± SD. A Likert scale of 1 (strongly disagree) to 5 (strongly agree) was used.

Fits my STEM curriculum/goals:	**4.15±0.23**
Presented tools and activities I can use:	**4.33±0.26**
Provides valuable information /content:	**4.37±0.19**
Quality of instruction /instructor:	**4.59±0.10**
Overall opinion of this module:	**4.50±0.10**

The nanoparticle demonstration

The Recycling Plant Lab

The Natural Polymer Lab

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