First-Year Engineering Students Explore Nanotechnology in Engineering

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Nanotechnology

Why should we teach it?

- Impacts every aspect of our world (Roco, Mirkin, & Hersam, 2010)
- Future opportunities and need for students (Roco et al., 2010)
- Promotes a multidisciplinary learning environment (Lu, 2009)
- Engaging topic and broadens participation (Lu, 2009)
nanoHUB is used for teaching and research, but the focus of this study is learning about nanotechnology.
Previous Study - User Informatics

Opportunity Gaps in Courses using nanoHUB

First-Year Engineering Students

Other Engineering Fields of Study
Purpose of Study

Nanotechnology in Engineering

• **Researchers’ perspectives** about nanotechnology:
  » It is a multidisciplinary and interdisciplinary field (Chari, Howard, & Bowe, 2012)
  » It impacts all types of engineering (Kennedy, 2006)

• **Purpose**: investigate students’ perspectives

• **Research Questions**:
  » What engineering fields of study do first-year engineering students investigate in a nanotechnology-related assignment?
  » Do first-year engineering students demonstrate awareness of nanotechnology related to their intended field of study?
2 projects in Spring semester

First ½ of Semester
- NanoRoughness Model-Eliciting Activity (MEA)
  mathematical modeling open-ended problem

Second ½ of Semester
- Nanotechnology-based Design Project
  computational-based open-ended problem
NanoRoughness Model-Eliciting Activity (MEA)

Spring 2013
1528 FYE Students

Open-ended modeling problem that challenges teams to predict roughness of a nanoscale surface given AFM image data.

Nanotechnology-based Design Project

Spring 2013
600 FYE Students

Open-ended design project that challenges teams to create a GUI to teach their peers about some nano Big Ideas (e.g. size & scale).
Prior to projects, students individually completed a context setting assignment to introduce them to nanotechnology.

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<tr>
<th>Context Setting Assignment</th>
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<tr>
<td>“Nanoscience and nanotechnology is impacting every field of engineering. Use and document (with proper citations) at least two external and trustworthy resources to <strong>learn three things about how nanotechnology is impacting your intended field of study in engineering. ...list, in your own words, the three things you learned about nanotechnology.”</strong></td>
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Provided Resource to Investigate Nanotechnology

- Spring 2013 group page on nanoHUB.org

Resources for Engineering 132  ➤  Overview

Introduction to Nanotechnology for Freshman Engineering Students

The purpose of this page is to introduce freshman engineering students to the broad and growing field of nanotechnology. According to Official Website of the US National Nanotechnology Initiative, "nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers — which is one billionth of a meter." (See http://www.nano.gov/nanotech-101/what/definition for more details). This is 10⁻⁹ of a meter. If you want to get a feel for how small the magnitudes are in nanotechnology, check out this original video called the Powers of Ten (1977).

IMPORTANT: This video is just a start. Scroll down this page to view more cool resources for you to learn about nanotechnology and its many great applications.
• Setting and Participants
  » First-Year Engineering Program (Spring 2013)
    ✓ Sections (up to 120 students) ✓ 2 credit hours (2 sequential courses)
  » Student responses to Context Setting Assignment
  » Sample: 619 students from 6 sections
    ✓ 537 students completed assignment and indicated 1 field

• Data Analyses
  » Qualitative analysis to elicit patterns
  » Categories:
    ✓ intended field of study (14 engineering fields)
    ✓ nanotechnology-focused content (connected to field = YES)
  » Quantified results to enumerate frequency
Results - Fields of Study

- Mechanical: 29%
- Electrical: 10%
- Chemical: 11%
- Civil: 8%
- Environmental and Ecological: 1%
- Electrical and Computer: 5%
- Agricultural and Biological: 3%
- Industrial: 8%
- Materials: 3%
- Biomedical: 9%
- Nuclear: 2%
- Aeronautical and Aeronautics: 10%
- Multidisciplinary: 0.1%
- Construction and Management: 1%

$n_T = 537$ first-year engineering students
Zero per cent (0%) would mean no person from the respective major related nanotechnology to their intended field of study.
Results

Engineering Fields related to Nanotechnology

$n_T = 537$ first-year engineering students

- Aeronautical and Astronautics: 55 students (90%)
- Agricultural and Biological: 17 students (95%)
- Biomedical: 48 students (95%)
- Chemical: 62 students (95%)
- Civil: 42 students (100%)
- Construction and Management: 6 students (100%)
- Electrical and Computer: 29 students (100%)
- Environmental and Ecological: 5 students (0%)
- Industrial: 42 students (100%)
- Materials: 14 students (0%)
- Mechanical: 154 students (90%)
- Multidisciplinary: 1 student (0%)
- Nuclear: 10 students (0%)

% students that explicitly related their indicated field of study to nanotechnology
First-Year Engineering Program > Kelsey Rodgers

Engineering Fields related to Nanotechnology

- Aeronautical and Astronautics: n = 55
- Agricultural and Biological: n = 17
- Biomedical: n = 48
- Chemical: n = 62
- Civil Construction and Management: n = 6
- Electrical and Computer: n = 29
- Electrical: n = 52
- Environmental and Ecological: n = 5
- Industrial: n = 42
- Materials: n = 14
- Mechanical: n = 154
- Nuclear: n = 10
- Multidisciplinary: n = 1

\[ n_T = 537 \text{ first-year engineering students} \]

% students that explicitly related their indicated field of study to nanotechnology

Two fields: < 90% related to nanotechnology explicitly to their intended field

- 65%
- 0%

Results
Results

What about the 67 students (12.4%) that did not explicitly connect nanotechnology to their intended field?

• Half of the students discussed nanotechnology connected to other fields (most commonly biomedical, materials, industrial, or environmental and ecological)
• Less than half discussed other applications and facts
• A few students discussed only facts (e.g. nanometer = 1x10^{-9} meter)
• Students from all engineering disciplines can engage in nanotechnology through this assignment
  
  » Context is an inclusive way to potentially connect to a greater audience of engineers in classroom activities, on the nanoHUB education cite, and other learning environments

• Question prompted by this study:
  
  » Why do mechanical engineering students struggle the most with connecting to nanotechnology to their field of study? (struggle with their identity?)
Questions?

http://nanohub.org

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