



# Grand Challenges Modules for Freshmen Engineering Courses and Outreach

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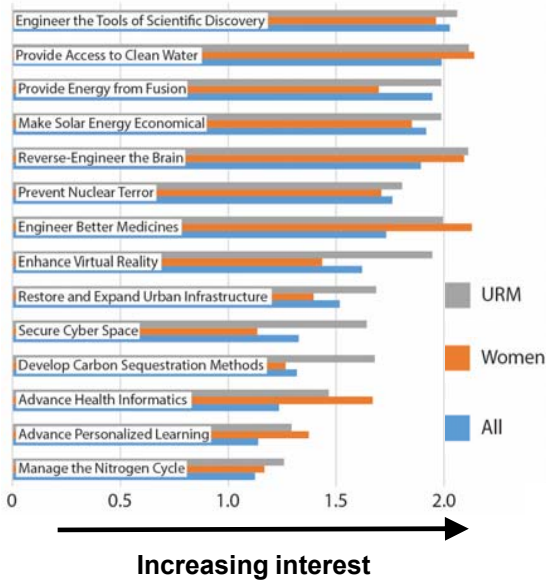
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## Student Interest Surveys (n > 1500)



## Impacts

- More than 500 students from three engineering departments used modules
- Three business entrepreneurship and technology students finalist in e4u2 contest
- Grand challenges incorporated into new course on integrated engineering theory and practice
- >150 Students in summer camps used portions of modules
- 40 Middle school teachers exposed to modules
- ~2000 Grade 4-12 students participated in outreach events that used portions of the modules
- Quantitative knowledge gains on nanotechnology
- Increased perception of engineering as an altruistic field
- Longitudinal study to evaluate effects on student retention in engineering in progress

## ABET Alignment (Access to Clean Water)

a. Mathematics, science, and engineering	Calculation of $[CaCO_3]$ , $[H^+]$ , $[OH^-]$
b. Conduct experiments, analyze data	Testing of local water sources, analysis of class data set, lab activity and analysis
d. Multidisciplinary teams	Team lab project and report
f. Professional and ethical responsibility	Importance of access to clean water grand challenge
g. Communication	Written report including tabular and graphical communications
h. Societal context	Importance of access to clean water grand challenge
i. Life-long learning	Changes in water supply, development of new technologies
j. Contemporary issues	Flint MI and Tri State Water Wars
k. Modern engineering	Improved Excel skills, use of test strips and meters

(c, e not addressed)

## Examples of Engineering Grand Challenges Module Content

### Reverse Engineer the Brain

<https://nanohub.org/resources/27050>

- Lively discussion of science fiction versus science fact and engineering ethics
- Students perform two-point distinction tests on hands and arms
- Visualizing brain waves and communicate via blinking with consumer grade EEG headsets
- Magnets, filings, and ferrofluid probes are used to detect hidden objects encased in a plaster of Paris "brain." Demonstrates importance of nanotechnology for tumor detection and treatment

### Provide Access to Clean Water

<https://nanohub.org/resources/27268>

- Students sample water from around campus and perform
  - Bacterial growth before and after filtration using various media including silver nanoparticle paper
  - Chemical tests with Bluetooth enabled Exact iDip Photometers and phone app
- Discussion of recent local and national water issues
- Data sets used to teach Excel skills, significant figures, precision and accuracy

### Restore & Improve Urban Infrastructure

<https://nanohub.org/resources/27312>

- Includes roads, buildings bridges, utilities, and internet infrastructure
- Importance of coatings
  - Photoactive paint
  - Hydrophobic coatings
  - Anti-graffiti paint
- Insulation
  - Aerogels
- Strength of materials
  - Biomimicry
  - Nanoscale structure
- Discussion of current issues

### Make Solar Energy Economical

<https://nanohub.org/resources/24553>

- Students conduct experiments on inexpensive solar panels in sun and shade
  - Learn how to use a multimeter
  - How to calculate power
- Students watch Delicious New Solar Technology1 video and then make and test solar cells using similar procedure
- Students summarize and reflect on what they have learned from activities, presentations, and online research in a team lab report

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