Engineering The Future: A Summer Academy for Underrepresented Students

Eric L. Mann
Hope College, mann@hope.edu

Susan Ipri Brown
browns@hope.edu

Follow this and additional works at: http://digitalcommons.hope.edu/faculty_presentations

Part of the Engineering Commons

Recommended Citation

http://digitalcommons.hope.edu/faculty_presentations/177
Spring February 28, 2015.

This Presentation is brought to you for free and open access by Digital Commons @ Hope College. It has been accepted for inclusion in Faculty Presentations by an authorized administrator of Digital Commons @ Hope College. For more information, please contact digitalcommons@hope.edu.
Engineering the Future: A Summer Academy for Underrepresented Students

Before we begin: Find a couple of friends (or make a few new ones) and pick up a zip lock bag of supplies

Your task: To build the tallest free-standing structure out of 20 sticks of spaghetti, one yard of tape, one yard of string and a marshmallow. The marshmallow has to be on top.

Eric Mann  mann@hope.edu
Asst. Professor Mathematics Education
Susan Ipri Brown  browns@hope.edu
Director, Center for STEM Inquiry
Partnerships and Schools

- Hope College Natural and Applied Sciences and Social Sciences Divisions
- Muskegon Area Intermediate School District Math and Science Center
- Muskegon Heights Public School Academies
- Holland New Tech High School

Funding

- Michigan Space Grant Consortium
- Hope College
  - Natural & Applied Sciences and Social Sciences Divisions
  - Center for STEM Inquiry (Howard Hughes Medical Institute Grant)

The Marshmallow Challenge

- Who Consistently Performs Poorly?
  - Recent Business School Graduates
- Who Consistently Performs Well?
  - Recent Kindergarten School Graduates
- Why?
  - Business students tend to strive for the one best solution and only after the structure is built do they see if it will hold a marshmallow
  - Kindergarten Students – engage in the natural design process; smaller steps, testing materials and seeing what works as they plan and build prototypes arriving at a solution – an engineering approach

The Marshmallow Challenge Website with TED Talk Video is at http://marshmallowchallenge.com/Welcome.html
Science and Engineering Practices in the NGSS

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information
Real World Inquiry and the NGSS

- Cross Cutting Concepts
  1. Patterns
  2. Cause and effect
  3. Scale, proportion and quantity
  4. Systems and system models
  5. Energy and matter
  6. Structure and function
  7. Stability and change

Scientists and Engineers Areas of Activity
Scientific Method

Engineering Design

https://www.teachengineering.org/engrdesignprocess.php

Engineering? but I teach Science!

| Table 3. Results of the NGSS and the MSS Grade Level Content Expectations for K-7 |
|---------------------------------|---------------------------------|------------------|
| **Content Comparison Analysis** | **Next Generation Science Standards** | **Michigan Science Standards for K-7** | **Degree of Match** |
| Scientific and Engineering Practices | Science Processes | Low Match |
| NGSS Crosscutting Concepts | MSS Disciplines | Low Match |
| NGSS Disciplinary Core Ideas | MSS Disciplines | Moderate Match |
| Overall Degree of Match | Low to Moderate Match |

The NGSS Scientific and Engineering Practices and MSS Disciplines of Science Processes were fairly similar in how they address science; however, only the NGSS include references to engineering, developing and using models, and using mathematics and computational thinking.

Engineering the Future Academy
Summer 2014
The Center for STEM Inquiry at Hope College

- Public support for STEM education
- Saturday programs
- Summer high school academies
- Teacher workshops
- Education student field placements
- Student leadership and training

Engineering The Future Academy
Goals/Rationale

- motivate students to learn math and science concepts by illustrating relevant applications.
- fosters problem-solving skills, including problem formulation, iteration, and testing of alternative solutions.
- embraces project-based hands-on learning, and sharpen abilities to function in three dimensions
Engineering The Future Academy
Goals/Rationale

• increase students' awareness of and access to scientific and technical careers—to consider engineering as a career, so that they enroll in the necessary science and math courses in high school.

• Engineering and technological literacy are necessary for the 21st century.

Approach

• Boston Museum of Science's Engineering the Future, Unit 2 Sustainable Cities

• Participants recruited from Muskegon Heights Public School and Holland New Tech High Schools

• Assessments focused on both knowledge of engineering and the design process and students' attitudes and beliefs
A Teacher’s Perspective

• “The power of having a real world context that was centered in their community along with the hands on labs and activities created a strong level of engagement.”
• “When I think about the engineering context, I now feel like I have another way to think about my math content.”
A Pre-service Teacher’s Perspective

• “I learned that different people are good at different things”

• “It was helpful to see how all the classroom teachers handled the students because they all did it differently. I also really liked the experience of designing lessons because that is a concrete thing I will have to do in my life.”

The Student’s Perspective

• … I learned about the process of making a building from start to finish. Starting with looking at an empty lot, and looking at the area around it to find out what needs to be there and what isn’t in the area around it. Then learning about urban sprawl and other population difficulties and figuring out the best materials for our building. Lastly we got to design the floor plans of our building and then presented our designs to an engineer…

• (9th grade, male Holland New Tech)
The Students’ Perspective

…we had to build things with only a certain amount of objects. And we got to make concrete and it was fun… (9th grade female, Muskegon Heights)

We did a lot of fun things that really make you think… (9th grade male, Muskegon Heights)

The Student’s Perspective

Engineering is about creating things, designing things, improving things and breaking things. Engineering is more than just designing, much more. (10th grade male, Holland New Tech)

…we built buildings and designed buildings and that metal can stretch! (9th grade male Muskegon Heights)
The Student’s Perspective

...I learned how to work better in a team and did engineering activities... (10th grade female, Holland New Tech)

Impact – Quantitative assessment

• Few students (13 of 33, 39%) chose to participate in our follow-up survey distributed several months after the summer academy
• Insufficient quantitative data to assess the effect of participation on student engagement in school

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Efficacy</td>
<td>4.03</td>
<td>4.27</td>
<td>4.15</td>
</tr>
<tr>
<td>Avoiding Novelty</td>
<td>2.52</td>
<td>2.42</td>
<td>2.46</td>
</tr>
<tr>
<td>Mastery Goal Orientation</td>
<td>4.44</td>
<td>4.23</td>
<td>2.40</td>
</tr>
<tr>
<td>Performance Approach Goal Orientation</td>
<td>3.35</td>
<td>3.18</td>
<td>4.20</td>
</tr>
<tr>
<td>Performance Avoidance Goal Orientation</td>
<td>3.67</td>
<td>3.27</td>
<td>2.92</td>
</tr>
<tr>
<td>Skepticism of the Relevance of School</td>
<td>2.21</td>
<td>2.01</td>
<td>1.95</td>
</tr>
</tbody>
</table>
Your turn: Measuring Elasticity

Retro City
8th Street Rec Center

Tulip City Resort
The Hot Spot

8th Street Outlet
M-Pac

Cafa & Drive In Movie Theatre
Thank you!

Support NGSS for All Michigan Students

@Sci4MIKids
Have Your Photo Taken Today!
Look for the Volunteers with this Poster
Engineering and Technology Education Resources (1 of 4)

- A brief list of some of the curriculum programs and internet resources available.
- A starting point for you to explore options for getting your students involved in engineering activities

**Elementary**

- Engineering is Elementary  [http://www.mos.org/eie/](http://www.mos.org/eie/)
- Partnerships Implementing Engineering Education  [http://www.wpi.edu/Academics/PIEE/Resources/lessons.html](http://www.wpi.edu/Academics/PIEE/Resources/lessons.html)

Engineering and Technology Education Resources (2 of 4)

**Middle School**

- Project Lead the Way Gateway  [https://www.pltw.org/our-programs/pltw-gateway](https://www.pltw.org/our-programs/pltw-gateway)
- Learning by Design™  [http://www.cc.gatech.edu/projects/lbd/home.html](http://www.cc.gatech.edu/projects/lbd/home.html)
Engineering and Technology Education Resources (3 of 4)

High School

• Engineering the Future http://www.mos.org/etf/
• Engineering Projects In Community Service-learning (EPICS) – High School http://epics-high.ecn.purdue.edu/
• Project Lead the Way Engineering https://www.pltw.org/our-programs/pltw-engineering
• Design Squad PBS http://pbskids.org/designsquad/parenteducators/index.html
• Rube Goldberg Machine Contests http://www.anl.gov/Careers/Education/rube/

Engineering and Technology Education Resources (4 of 4)

More Information/Resources

• National Assessment of Educational Progress (NAEP) Technology and Engineering Literacy (TEL) Assessment http://nces.ed.gov/nationsreportcard/tec/moreabout.aspx#framework
• American Society for Engineering Education http://teachers.egfi-k12.org/
• National Science Digital Library https://nsdl.oercommons.org/
• National Center for Technological Literacy http://www.mos.org/nctl/
• International Technology and Engineering Educators Association http://www.iteaconnect.org/
• Teacher’s Domain-Engineering http://www.teachersdomain.org/sci/engin/index.html
• PBS Learning Media: Engineering Design http://www.pbslearningmedia.org/search/?q=selected_facets=supplemental_curriculum_hierarchy_nodes%3A270&selected_facets=
• Engineering in K-12 Education: Understanding the Status and Improving the Prospects http://www.nap.edu/catalog.php?record_id=12635
• NASA Endeavor Certificate in STEM Education http://www.us-satellite.net/endeavor/index.cfm
References


