Deepening Math and Science Skills in Middle School Students through Civil Engineering-based Learning Modules
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Middle School Outreach Program
Goals of Program:
• Increase student’s understanding of engineering profession and its relation to math and science
• Increase student’s desire to continue with math and sciences throughout high school
• Provide introduction to foundational high school mathematical concepts (i.e. trigonometry)

Inaugural Implementation
• Launched during the spring session of DAPCEP (Detroit Area Pre-College Engineering Program).

Program Outline
• Week 1 – Introduction
  • Week 2 – Surveying Buildings
  • Week 3 – Introduction to Bridges
  • Week 4 – Strength of Materials
  • Week 5 – Exposition

Participant demographics:
• Number of participants – 12
• Gender – 2 female, 10 male
• Grade level – 8th and 9th grade students

Pre- and post-test was administered to determine:
• Interest in engineering as a profession
• Comprehension of mathematical concepts covered in class

Curriculum Development
Week 1: Surveying Buildings
• Discuss history of and motivation for surveying
• Learn/review necessary trigonometric principles
• Make a basic surveying tool
• Use tool to determine the heights of various buildings

Week 2: Introduction to Bridges
• Learn about types of bridges, tension and compression
• Apply trigonometric principles to compute loads in simple trusses
• Build and test a popsicle stick bridge

Week 3: Strength of Materials
• Learn about the strengths and weaknesses of materials commonly used in construction
• Test the strength of a clay specimen and determine its design properties

Conclusion
The learning modules increased students’ awareness of the discipline, confidence in their ability, and math and science skills

Interest Survey Results

<table>
<thead>
<tr>
<th>Statement</th>
<th>Avg. Pre-Test</th>
<th>Avg. Post-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I know what engineering is.</td>
<td>4.27</td>
<td>4.55</td>
</tr>
<tr>
<td>2. I know what civil &amp; environmental engineering is.</td>
<td>3.55</td>
<td>4.65</td>
</tr>
<tr>
<td>3. I will choose to study engineering when I go to college.</td>
<td>3.55</td>
<td>3.55</td>
</tr>
<tr>
<td>4. I will choose to study civil and environmental engineering when I go to college.</td>
<td>3.00</td>
<td>3.09</td>
</tr>
<tr>
<td>5. I am very confident in my math skills.</td>
<td>4.45</td>
<td>4.64</td>
</tr>
<tr>
<td>6. I am very confident in my science skills.</td>
<td>4.09</td>
<td>4.27</td>
</tr>
<tr>
<td>7. I am confident that I can apply basic math skills to solve engineering problems.</td>
<td>4.91</td>
<td>4.55</td>
</tr>
<tr>
<td>8. I am confident that I can apply basic science skills to solve engineering problems.</td>
<td>4.36</td>
<td>4.09</td>
</tr>
</tbody>
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1.0 – Very Untrue, 5.0 – Very True

Math Survey Results
4 Questions (worth 2 points each) that tested students ability to apply sine, cosine and tangent relationships and the Pythagorean theorem.

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</tr>
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<tbody>
<tr>
<td>Points earned = Mean ± Std Dev</td>
<td>0.80 ± 0.92</td>
<td>2.40 ± 1.84</td>
</tr>
<tr>
<td>Avg. student confidence level</td>
<td>2.05</td>
<td>2.52</td>
</tr>
</tbody>
</table>

1.0 – Very Uncertain, 4.0 – Very Certain

Future Work
• Revise surveys to better test a student’s comprehension of material and likelihood to continue with math and science through high school
• Assess long term impact of the program