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 (Deroit Area Pre-College Engineering Program.

•Program Outline

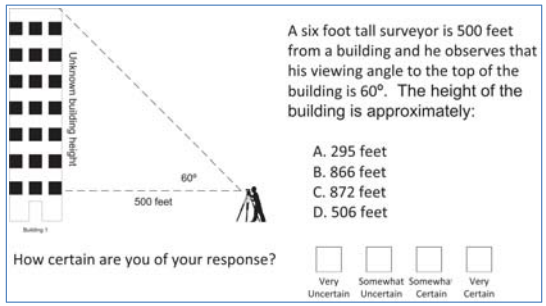
- Week 1 – Introduction
- Week 2 – Surveying Buildings
- Week 3 – Introduction to Bridges
- Week 4 – Strength of Materials
- Week 5 - Exposition

•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



Example math question of pre and post-test surveys

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

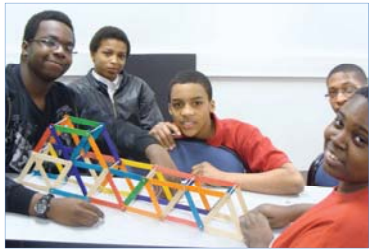
Student exploring trigonometry with surveying tool

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



Students building popsicle stick bridge design

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

Statement	Avg. Pre-Test	Avg. Post-Test
1. I know what engineering is.	4.27	4.55
2. I know what civil & environmental engineering is.	3.55	4.65
3. I will choose to study engineering when I go to college.	3.55	3.55
4. I will choose to study civil and environmental engineering when I go to college.	3.00	3.09
5. I am very confident in my math skills.	4.45	4.64
6. I am very confident in my science skills.	4.09	4.27
7. I am confident that I can apply basic math skills to solve engineering problems.	4.91	4.55
8. I am confident that I can apply basic science skills to solve engineering problems.	4.36	4.09

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.

Statement	Pre-Test	Post-Test
Points earned – Mean ± Std Dev	0.80 ± 0.92	2.40± 1.84
Avg. student confidence level	2.05	2.52

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