Current Practices in On-line Learning

ACI Spring 2014 Convention
March 23 - 25, Reno, NV

TYLER LEY is an Associate Professor and the Williams Energy Professor in the Department of Civil and Environmental Engineering. His research focuses on concrete durability, hydration, and improving constructability.

Effectiveness of Elementary Engineering Outreach with Personal Instruction and Videos

Tyler Ley, P.E., Ph.D.
Nicole Colston, Toni Ivey, Julian Utley
Julie Thomas University of Nebraska

Acknowledgements

- National Science Foundation
  CMMI/Career - 1150404
- OSU Provost Grant

Summary

- Introduction
- Outreach for 5th graders
- Results
- Working with pre service teachers
- Conclusions

A Grand Challenge
A Grand Challenge

• Future engineers must provide sustainable, durable, and rapidly constructed infrastructure at similar or lower costs
• They also must maintain existing infrastructure for as long as possible.

A Grand Challenge

• $2.2 trillion is needed to restore US infrastructure.
• US National Academy of Engineering has listed infrastructure renewal as one of its grand challenges.

A Grand Challenge

• Less students are choosing engineering as a major (Jeffers et al., 2004)
• Snell and Snell (1992) found that only 1% of 6th graders wanted to be an engineer, while almost 22% wanted to be a medical doctor.

A Grand Challenge

• Many sources report that by 6th grade, students have already decided whether they are interested in a career in advanced math and science
• At OSU students that start in a math below calculus have <1% to graduate in engineering

A Grand Challenge

• The US Education System is trying to “adjust”
• “Next Generation Science Standards” now includes engineering in elementary education

A Grand Challenge

• Current teachers are not comfortable with engineering and don’t really know what it is
• Many Superintendents have suggested re labeling science as engineering with little changes
A Grand Challenge

- We need to find ways to introduce engineering careers and concepts to elementary age students in engaging ways
- We also need to help their teachers to become more comfortable teaching these topics

What Can We Do?

Why is outreach important?

- Essential for future generations
- Rewarding
- Promotes your organization
- Required on many grants

A Research Question

- How can I best use my time to positively impact the attitude and knowledge of engineering for 5th grade students?
  
  Cost – benefit analysis = impact / my time

Overview

- To do this we:
  - Developed age appropriate and engaging lessons
  - Quantified the knowledge and understanding of engineering concepts before and after my lessons
  - Used three delivery models that used to technology to develop the same content with different amounts of my time

Curriculum

- Created three modules that are 25 minutes each
- Two objectives for each module
- Hands on / lesson / hands on
Lesson 1

- Hands on 1 – ball point pens
- What types of engineers are there?
- What subjects do engineers use?
- Hands on 2 – Engineering scavenger hunt
As you push down the ball is pushed up and the ink flows out.

Lesson 2
- Hands on 1 – block towers
- What is a structural engineer?
- How do engineers use math?
- Hands on 2 – block towers with clay
Lesson 3

- Hands on 1 – digital microscopes
- What is a materials engineer?
- How do engineers use science?
- Hands on 2 – microscope scavenger hunt

How to quantify change?

- Pre/post questionnaires
  - What is an engineer?
  - What is technology?
  - Attitudes towards engineering
- Draw an engineer at work

Pre Test
How to quantify change?

- A rubric is used to evaluate:
  - Engineering Concepts
  - Use of Math
  - Use of Science

Delivery Models

- **Expert led**
  - I teach all modulus

- **Expert visit then virtual lessons**
  - I teach first module and videos for others

- **All virtual lessons**

****A one day workshop was held for the participating teachers

Results

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Pre</th>
<th>Post</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What is an Engineer?</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expert Led</td>
<td>14</td>
<td>39.09</td>
<td>50.2</td>
<td>0.004</td>
</tr>
<tr>
<td>Expert Visit</td>
<td>80</td>
<td>39.61</td>
<td>60.59</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Virtual</td>
<td>73</td>
<td>41.31</td>
<td>52.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>What is Technology?</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expert Led</td>
<td>14</td>
<td>57.5</td>
<td>67.86</td>
<td>0.009</td>
</tr>
<tr>
<td>Expert Visit</td>
<td>80</td>
<td>50.25</td>
<td>59.31</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Virtual</td>
<td>73</td>
<td>51.51</td>
<td>58.01</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Engineering Attitudes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expert Led</td>
<td>14</td>
<td>53.79</td>
<td>53.5</td>
<td>0.81</td>
</tr>
<tr>
<td>Expert Visit</td>
<td>80</td>
<td>56.36</td>
<td>59.96</td>
<td>0.01</td>
</tr>
<tr>
<td>Virtual</td>
<td>73</td>
<td>60.33</td>
<td>65.3</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

**Eng Concept**
- **Not significant** > .05
- **Moderate** .05 - .01
- **Strong** .01 - .001
- **Very strong** < .001

**Draw an Engineer**
Summary

- For these students and measurement techniques:
  - The expert led students did not show increased change when compared to the other delivery methods
  - There was little difference between whether I visited once or never

- This suggests that subject experts should spend their time developing curriculum and training teachers on how to present it

What is the best way to train the teachers?

- We repeated our experiment with senior education majors at OSU
  - Expert visit then virtual lessons
    - I teach first module and videos for others
  - All virtual lessons

- We repeated our experiment with senior education majors at OSU
  - Expert visit then virtual lessons
    - I teach first module and videos for others
  - All virtual lessons

What should we do different?

- The teacher results does not match the 5th grade student data
- The expert visit was more effective then the virtual lessons
- Neither group showed an understanding of how engineers use math and science

- Perhaps we need a different approach to train teachers
- Changes could be made in:
  - Different curriculum
  - Increased expert time with teachers
  - Use assignments where they prepare curriculum
The Future!

- We already reach 280 students/year
- We will keep reaching this with no extra money
- It costs us roughly $350 to add a new school to the program (70 kids)
- This one time cost will cover that school for roughly 5 years (350 kids or $1 per child)

How Can you Help?

- If you know a company, individual, or grant that would be interested in helping sponsor a school then please let me know
- The teacher needs one day of training
- Please do your part and help out locally
- I know we are all busy but these efforts can make a big difference

Conclusion

- Developing our future engineers is important!
- The outreach curriculum presented was shown to make a positive impact on 5th graders about engineering concepts and professions
- Impact was observed for all of the curriculum delivery models

Conclusion

- There was no measurable difference for the impact on 5th graders despite the difference in the time commitment by the subject matter expert
- It is recommended to use subject matter expert time to develop content and train teachers on how to deliver it

Conclusion

- The education majors did not have the same response as the 5th graders.
- More work is needed to improve these lessons
- Quantitative comparison methods are useful to determine the effectiveness of outreach efforts

www.engineeringiseverywhere.com
Questions???

Greetings Concrete Fans and Welcome to HydrationTheater.com!

www.tylerley.com