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Current Practices in On-line Learning

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

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Effectiveness of Elementary Engineering Outreach with Personal Instruction and Videos

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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 = $\frac{\text{impact}}{\text{my time}}$

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

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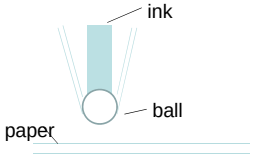
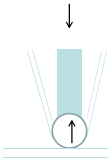
Lesson 1

- Hands on 1 – ball point pens
- What types of engineers are there?
- What subjects do engineers use?
- Hands on 2 – Engineering scavenger hunt



cross section of a ball point pen



As you push down the ball is pushed up and the ink flows out

ink

Lesson 2

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

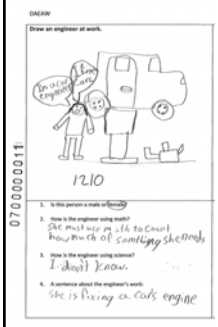
Lesson 3

- 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?

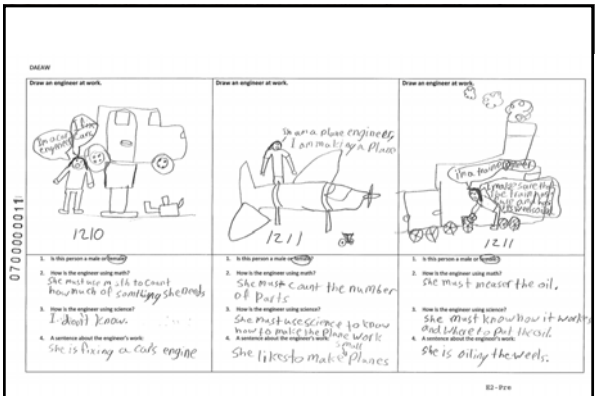
- Pre/post questionnaires
  - What is an engineer?
  - What is technology?
  - Attitudes towards engineering
- Draw an engineer at work

Pre Test



Pre Test

Pre Test



Pre Test

Post Test

How to quantify change?

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

How to quantify change?

- 3, 2, 1 cards
- Three things you learned
- Two things you want to know more about
- One question

Delivery Models

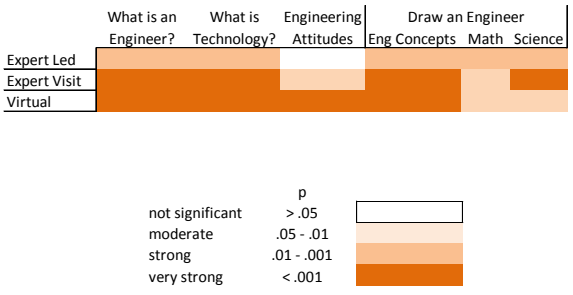
- Expert led — Most
  - I teach all modulus
- Expert visit then virtual lessons — Middle
  - I teach first module and videos for others
- All virtual lessons — Least

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

Time

Results

	n	Pre	Post	*p*
		Mean	*Mean*	
What is an Engineer?				
Expert Led	14	39.09	50.2	0.004
Expert Visit	80	39.61	60.59	<.001
Virtual	73	41.31	52.2	<.001
What is Technology?				
Expert Led	14	57.5	67.86	0.003
Expert Visit	80	50.25	59.31	<.001
Virtual	73	51.51	58.01	<.001
Engineering Attitudes				
Expert Led	14	53.79	53.5	0.81
Expert Visit	80	56.36	59.96	0.01
Virtual	73	60.33	65.3	<.001



Summary

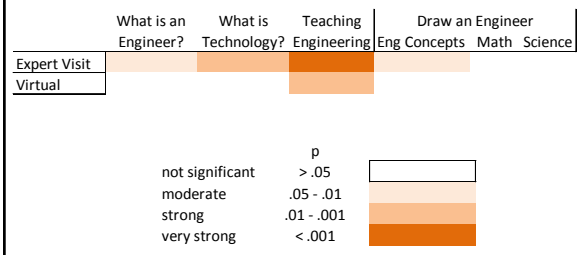
- For these students and measurement techniques:
- The expert led students did not show increased change when compared to the other delivery methods
- There was little difference between whether I visited once or never

Summary

- 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



Summary

- 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

What should we do different?

- 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

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Questions???

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