Changing How Students Learn: Using Engineering to Teach Innovation, K–College

Chris Rogers

Tufts University | Center for Engineering Education and Outreach

NSF | NATIONAL INSTRUMENTS | LEGO education
Science and Engineering

http://coolwallpaper786.blogspot.com

http://www.nps.gov/
What Should We Teach?
What is the Ultimate Teaching Goal?

1. curiosity \textit{(why?)}
2. passion for finding answers \textit{(learning)}
3. test validity of answers \textit{(reflection)}
4. self-confidence \textit{(transfer)}

What are the Beginnings of Engineering?
What are we trying to do as teachers?
What does the class now look like?

Solution Diversity
Listening to kids

john heffernan
Solution Diversity

D = 0

http://www.straighterline.com

University of Zurich
It looks like kids telling their stories

What Is SAM Animation?

- What are their ideas?
- Can teams agree on a story?
S.A.M.
Telling the Imaginary Story
It looks like kids questioning
S.A.M.
Time Lapse
LEGOEngineering:
Who is it?
It looks like kids making their inventions

Dr. E's Challenges

fueled by WeDo, MINDSTORMS, and your creativity!

Dr. E's Challenges gives you a chance to build a LEGO robotics creation and share it with other creators around the world. Each month, there will be a new MINDSTORMS challenge and a new WeDo challenge to try.

Dr. E's Challenges is a project developed by [Details]
LEGO Math: Controls

Diagram showing a control system with desired position, error, controller, plant (LEGO Bricks), and measured position.
DrEs
It looks like evidence-based learning

http://morganlinton.com/
The Research Needed

• Why does it work? Evidence-based Education

• Quantitative Research
  • large scale studies – looks at means
  • Role of Engineering in science

• Qualitative Research
  • in-depth investigations – looks at outliers
  • Beginnings of Engineering
Research

- 1st graders: planning
- 3–5th graders: Reading and engineering
- 4, 5th graders: Science through engineering
- 5th graders: Seeing the unseen
- 6th grade teachers: Math through engineering
- 6–8th grade teachers: Role of self confidence
- 8th graders: Role of culture in learning
- High schoolers: RoboBooks and disabilities
- High schoolers: Physics by Design
- High schoolers: STOMP as a class
- College: STOMP and service teaching engineering
- College: Musical instrument design
Designing in IEL Activities

- Complex, rich problems
- Characters with needs, attitudes, and abilities
- Situational Context (resources and constraints)
Framing the problem

...it would take longer.

But how would they get the wood?

I don’t think it would be like, they have to pay for it.
Awakening Innovation

- All kids are budding engineers eager to build, fail, iterate

- Teachers are a key part of the equation just-in-time response to child thoughts

- The Classroom makes a difference desks versus tables

http://www.ceeo.tufts.edu
Music Engineering