Engineering for All: Where middle school engineering design meets social justice. A new curriculum for technology teachers.

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Today’s Agenda

• Introductions
• Key concepts
  - EfA
  - Engineering design and global needs
• Impact of EfA on middle school students and teachers
• Q&A
Who we are

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Getting to know you

For the following items, write in the chat box what number(s) apply to you.

Have you ever?

1. Led or participated in a project about significant global and community-based issues and concerns?
2. Heard about a “food desert?”
3. Learned about the global water needs?
4. Worked with middle school children?
5. Heard of engineering thinking?
Goals for this session

• To discuss the EfA curriculum and how it infuses social justice into an engineering-based curriculum

• To discuss some ways social justice can be fostered within an engineering and technology literacy setting
Some basics: What is EfA?

A $1.7M National Science Foundation-funded curriculum development project led by Hofstra University and the ITEEA.
A high-level overview of the EfA curriculum

• Grounded in technology and engineering design
• Designed for middle school students
• Shows potential of engineering as a social good (in addition to being a career path)
• Aligned with technology and education and education standards
• Participants across the United States
So, how exactly does EfA integrate engineering design and social justice?

• Students are given a “grand design challenge” to solve that relates to food scarcity (Food Unit) or water scarcity (Water Unit). (Classes are assigned to either Unit.)

• Students employ “informed engineering design” as they spend time acquiring knowledge and skills needed to design an effective solution. These explicit learning events called knowledge and skill builders (KSBs).
So, essentially...

Informed engineering design is not *trial-and-error* gadgeterring!
Let’s think about what you typically do when you have to design something...

Which best describes what you typically do? Write in the chat which answer choice best applies to you.

A. I think carefully, then create a final model
B. I use trial and error to figure out a solution
C. I create a model, then refine it
Can you identify which is most closely resembles Informed Engineering Design? Write your answer in the chat.

A. I think carefully, then create a final model
B. I use trial and error to figure out a solution
C. I create a model, then refine it
The EfA Curriculum

The curriculum progresses in 3 key phases:

First Four Days
- Societal needs and informed engineering design introduced.
- Pre-test of engineering design literacy given.

KSBs
- Explicit learning engineering design literacy events (KSBs) related to grand design challenge.
- Project based learning.

Grand Design Challenge
- Students design and present their solutions of their grand design challenge.
- Post-test of engineering design literacy given.
Let’s take a closer look at the Water Unit

The Water Unit

• Introduces concept of water scarcity
  https://www.youtube.com/watch?v=iRGZOCaD9sQ

• Introduces where in the word is the water crisis is
Let’s take a closer look at the Water Unit

The Water Unit “The World in Crisis” KSBs:

- KSB 1: Water is Life
- KSB 2: Turbidity Matters
- KSB 3: Heavy Metals!
- KSB 4: Clean Up Your Act!

Grand Design Challenge: Safe Water for Bangladesh
Develop a device that can produce 20 liters per day of safe drinking water, using materials native to the developing country of Bangladesh.
Students learn the measure of turbidity is a key test of water quality. All drinking water contains some contaminants; some are harmless and some can make the water unsafe to drink.
Water Unit Grand Design Challenge
Safe Water for Bangladesh

Students asked to build a multilevel filtering system to supply 20 liters of safe water per day to a family of 5 in Bangladesh based on in-class student investigations.
Let’s take a closer look at the Food Unit

The Food Unit

1. Introduces concept of food deserts, particularly in urban areas
   https://www.youtube.com/watch?v=_lZwBMeogG8

2. Vertical farming is the practice of growing produce in vertical stacked layers, with or without soil
Let’s take a closer look at the Food Unit

The Food Unit Vertical Farming: Fresh Food for Cities KSBs:

KSB 1: Welcome to Fresh Food Engineers
KSB 2: Design and Build a Platform
KSB 3a: Engineer a Hydroponics System
KSB 3b: Engineer an Ebb and Flow System
KSB 4: Hydroponic Farming
KSB 5: Modeling with Computer Aided Design

Grand Design Challenge: Vertical Farming.
Demonstrate a working hydroponic system and illustrate a design for a vertical farm on a building of your choice.
Food Unit KSB 1: Welcome to Fresh Food Engineers

- Students told they’ve been hired to build hydroponic system.

- Introduces students to:
  - Food scarcity
  - What and where food deserts in are
  - Hydroponics
Hydroponics 101!

• A method of growing plants in water **with or without soil**.

• Plants provided with nutrients and conditions needed to thrive.
Food Unit Grand Design Challenge
Vertical Farming: Fresh Food for Cities

Students asked to demonstrate a working hydroponic system and illustrate a design for a vertical farm on a building of their choice.

We are going to have green houses on top of the building to grow the plants a bit before we put them on the side of the building.

You can harvest the plants by getting on these structures that lift you up and down on the side of the building.

Our plans are on the south side of the building so that they take advantage of the sunlight.

The water is going to be drained to the bottom of the building after it waters the plants then it will be piped back up to the water tower.
So, are you wondering - what does actually EfA look like?

https://www.youtube.com/watch?v=OQkowF2g53Q
What did we learn about EfA?

We are evaluators, so we ask what's the impact:
- Are students learning?
- Do they understand the social issues?
- Is it feasible for educators to use EfA?
In terms of learning we found:

Teachers showed

• Increases in content and pedagogical content knowledge

• Increases in positive attitudes toward and interest in engineering/engineers/related careers

• Perceptions of the social relevance of engineering
In terms of learning we found:

Students showed

• An understanding of informed engineering design and the underlying themes within engineering (i.e., design, modeling, systems, resources, human values)

• Increases in positive attitudes toward and interest in engineering, engineers, and related careers

• Perceptions of the social relevance of engineering
What we learned about integrating social justice and global needs into middle school technology classes:

• The Informed Engineering Design approach easily aligned with discussions about global and social issues

• Students often “assumed” they understood the issues, but were surprised by the facts.

• Similarly, teachers were also often surprised by the facts. Many made local connections for their students.

• By embedding the academic content within the social justice framework students were easily engaged and persisted in their project.
Our recommendations for infusing social justice into an academic class:

• Don’t assume educators will immediately understand the social needs.
• It is sometimes helpful to make connections between the global needs and local (community) needs. Share lots of facts.
• Don’t assume there is a “one size” fits all approach. Be flexible and allow teachers to adapt.
• Include videos, pictures, real stories, even guest speakers engaged students in the topics.
Want more information about EfA?

• Center for Advanced Study in Education, CUNY (our Center)
  www.gc.cuny.edu/case
  twitter.com/casecuny

• Hofstra Center for Stem Research (The Developer of EfA)
  www.hofstra.edu/academics/colleges/seas/ctl/ctl_stem_education_k16html

• ITEEA (The International Technology and Engineering Educators Association)
  www.engineeringbydesign.org
  (The Unit can soon be accessed as a stand-alone course or as part of our Engineering byDesign™ (EbD) course, Technological Systems™, although a paid subscription will be needed.)
Any questions?

If there’s anything you’d like to ask us directly feel free to write your name and email on this blank slide.
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