Integrating social context in engineering experiences to promote interests of diverse learners

Mrs. Kayla Renee Maxey, Purdue University, West Lafayette (College of Engineering)

Kayla is a doctoral student in the School of Engineering Education at Purdue University. Her research interest includes the influence of informal engineering learning experiences on diverse students’ attitudes, beliefs, and perceptions of engineering, and the relationship between students’ interests and the practices and cultures of engineering. Her current work at the FACE lab is on teaching strategies for K-12 STEM educators integrating engineering design and the development of engineering skills of K-12 learners.

Mrs. Jessica Rush Leeker, Purdue University-Main Campus, West Lafayette (College of Engineering)

Jessica Rush Leeker earned her undergraduate degree from Penn State with a focus in Supply Chain and Information Systems and a minor in international business. She attended Purdue University, receiving an MBA with specialization in Sustainability and Operations.

Before business school, Jessica spent a summer in Haiti, delivering shoes to those in need and creating a more efficient supply chain for urban water projects. Jessica has worked for many successful consumer product companies including Unilever, and Georgia Pacific.

Currently, Jessica is completing her Ph.D. in Engineering Education at Purdue University to focus on practical methods of corporate outreach in STEM for minority communities. In her free time, writes children’s books, teaches yoga to children, and enjoys her family.

Dr. Monica E Cardella, Purdue University, West Lafayette (College of Engineering)

Monica E. Cardella is the Director of the INSPIRE Research Institute for Pre-College Engineering and is an Associate Professor of Engineering Education at Purdue University.

Dr. Morgan M Hynes, Purdue University-Main Campus, West Lafayette (College of Engineering)

Dr. Morgan Hynes is an Assistant Professor in the School of Engineering Education at Purdue University and Director of the FACE Lab research group at Purdue. In his research, Hynes explores the use of engineering to integrate academic subjects in K-12 classrooms. Specific research interests include design metacognition among learners of all ages; the knowledge base for teaching K-12 STEM through engineering; the relationships among the attitudes, beliefs, motivation, cognitive skills, and engineering skills of K-16 engineering learners; and teaching engineering.
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Presented By:
Kayla Renee Maxey
Jessica Rush Leeker
Dr. Monica E. Cardella
Dr. Morgan M. Hynes
Engineering Experiences

• Professional internships and co-ops
• Undergraduate engineering courses
• Engineering learning through service
• Study abroad
• Undergraduate engineering research
• High School engineering courses
• Outreach programs

• Summer camps
• Clubs
• Middle school courses
• Elementary school courses
• Science center exhibits
• Television Shows
• Online communities
Our experiences in college, high school, and even preschool can impact our decisions to participate in engineering.
Educational Practice identifies and motivates which results in educational research. Educational research leads to questions and ideas which help improve practice, and insights and answers that result in further educational research.
Some groups of students are more likely to be interested in engineering if they are able to see how engineering can make a positive impact on our world.
**Personal interests** are the characteristics of a person that influence his or her engagement in interactions with the social or nonsocial environments.

**Situational interests** is the interestingness of the social or nonsocial environments that evoke or encourage interactions with people or objects.


**Research Question:**

What is the alignment between the personal interests of children in 3rd-5th grade and their perceptions of engineering?
Hollands Career Center

Mechanical Engineers

http://www.utsa.edu/careercenter/images/riasec/riasec.png

http://www.onetonline.org
Fit of Personal Interests and Perceptions of Engineering Survey (F-PIVES)

- **Interests (N=715)**:
  - Realistic: 2.57
  - Investigative: 2.55
  - Artistic: 2.50
  - Social: 2.80
  - Enterprising: 2.63
  - Conventional: 2.42

- **Perceptions (N=653)**:
  - Realistic: 2.66
  - Investigative: 2.77
  - Artistic: 2.58
  - Social: 2.67
  - Enterprising: 2.57
  - Conventional: 2.49

**Preliminary Results: Interest**

Integrate Social Contexts in Engineering Activities
Developing skills and knowledge related to the engineering design process is a core focus for many pre-college programs—Curriculum, summer programs, science center exhibits, etc.
Compared to freshmen & seniors:

Experts took more time to “design a playground”

• Experts took more time overall
  Experts $M = 137$ min, $SD = 29$ min; Seniors $M = 112$ min, $SD = 32$ min; Freshmen $M = 106$ min, $SD = 41$ min

• Experts took more time performing each major mode of design activity
  • Most noticeably, experts spent approximately twice as much time developing a deep understanding of the problem

![Mean Time Spent by Mode of Design Activity](chart.png)

- Problem scoping
- Developing alternative solutions
- Project realization

Average time spent (minutes)
Integrate Social Contexts in Engineering Activities

Cardella, Svarovsky, Dorie 2013
Integrating Social Contexts in Engineering Activities

• Helps children see how engineering connects to their own social interests

• Helps children develop problem scoping skills
How might we change this activity?

EXAMPLE
Tallest Tower Challenge

Objective: Using only the materials provided to your team, please design and build the tallest tower in 30 minutes.

Challenge Rules

- You must use only the materials provided for the challenge.
- The tower must be free-standing, and it must be constructed on top of the table (or another flat surface).
- Your goal is to build the tallest tower with the materials provided.
- You may want to sketch some ideas before you begin.
- There are many different ways to complete this challenge. Be creative!
Objective: Using only the materials provided to your team, please design and build a model of a tower that could be added to a playground at your school.

Challenge Rules
- You may use only the materials provided for the challenge
- Your goal is to build a model of a tower with the materials provided
- Remember, the tower model you are creating is for a tower that would be added to a playground at your school
- You may want to sketch some ideas before you begin
- There are many different ways to complete this challenge. Be creative!
- Think about questions you can ask your mentors to learn more about this challenge!

Challenge Rules (not included in Student Manual - for Leaders only)
- You have 30 minutes to complete the challenge
- The tower must be free-standing, and it must be constructed on top of the table (or another flat surface)
- Materials that students can use include...
How might we change this activity?

EXAMPLE
PAPER TABLE CHALLENGE

Challenge:
• Design and build a table out of newspaper tubes. Make it at least eight inches tall and strong enough to hold a heavy book.

Challenge Rules:
• You must use only materials provided
• The table must be free-standing, and it must be constructed on top of the table (or another flat surface)
• There are many different ways to complete this challenge.
• Be creative!

Materials:
• 1 piece of cardboard or chipboard
• Heavy book
• Masking tape
• 8 sheets of newspaper
The story....begins in El Salvador

By 1997 only 2% of original forests existed

Salvadoran Rain Forest in the 1600s
• Some companies in El Salvador can generate as much as 0.9 pounds of paper waste per employee in one day.

• Percentage of households headed and sustained solely by a woman in some of the poorest regions of the country 77%
Your Design Challenge

• Project goal: Use paper waste to make a functional and marketable piece of furniture (i.e. a table, chair, etc.) to be assembled by coop
• Today: Work in teams to make a prototype using available materials
Novel Engineering

Using classroom literature as context for engineering to engage students in STEM through the integration of engineering and literacy.

http://novelengineering.org
Novel Engineering activities

Complex, rich problems

Characters with needs, attitudes, and abilities

Situational context with resources and competing constraints
Bilateral benefits

The text helped support rich problem-framing.

Problem-framing supported diggingg into the text.

Engineering prompted exploration of vocabulary.

In this exploration, kids are also redefining the problem space.
Other notes

• Fantastical solutions
• Changing the book (for the better?)
• Referring back to text/story
• Biomimicry/Prior art (Idea generation strategies)
Implementation

• Identify single problem for class
• Let teams choose own problem
• Solve problem midway through book
• Identify STEM related concept and/or problem
• Increase writing activities
• Without construction/building
• Adding social context can:
  – be a relatively small adjustment to an existing activity
  – Help students connect their own interests to engineering
  – Help students develop problem scoping skills that are critical for engineering design