
‘You’re Hired!’ – Looking at the Impact of an Authentic STEM Experience Based on Gender

Kristin Brevik, North Dakota State College of Science



Motivation

- A greater, more diverse number of engineering students is needed. [1]
- Schools are being pushed to incorporate STEM and 21st Century Skills into their already full course schedules. [2]

[1] Wilson, S. Developing a plan for recruiting and retaining women and minorities in engineering technology at Western Kentucky University. Proc., 2000 ASEE Annual Conf., American Society for Engineering Education, Washington, D.C. 2000.

[2] R. Marzano, T. Heflebower. Teaching & Assessing 21st Century Skills. Bloomington, IN: Marzano Research Laboratory, 2012.



What is needed

- Students ^[3]
 - Self motivation
 - Use of problem solving strategies
 - Uses of computer applications
 - Immediate feedback on success of efforts
- Teachers/Schools ^[2]
 - A rubric for assessing 21st Century Skills
 - A rubric for assessing the Engineering Design Process
 - Science Technology Engineering Math environments for students
 - Professional development on how to assess students' skills
 - Alignment of projects to current standards
- In order to scale and sustain the project it is important that:
 - Surveys are electronic
 - Projects are easily shipped or contain supplies that can be found at a local grocery store (rural communities)

[3] T. Fantz, T. Siller, M. DeMiranda, "Pre-Collegiate Factors Influencing the Self-Efficacy of Engineering Students," Journal of Engineering Education, vol. 100, pp. 604-623, 2011

[2] R. Marzano, T. Heflebower. Teaching & Assessing 21st Century Skills. Bloomington, IN: Marzano Research Laboratory, 2012.



You're Hired!

- An intense, coherent set of STEM-focused experiences that:



- Use the Engineering Design Process
- Infuse 21st Century Skills to solve real-world problems
- Implement interdisciplinary STEM experiences for all students and teachers

8 Projects Have Been Developed

1. **Oil Spill** – Using a hydrophobic nano covering on sand to clean up an oil spill.
2. **Texting While Driving** – Is texting while driving a bad thing? – Prove it!
3. **Nutrition in Schools** – Don't just complain about it – Understand it.
4. **Contamination** – How fast can a flu epidemic break out in a school – How can we minimize this?
5. **Energy Efficiency** – How much energy can be saved by switching from incandescent to LED lights? Is it worth it?
6. **Non-Newtonians** – Did you know that there is a non-Newtonian fluid in your knee – Synovial Fluid. Can you replicate it?
7. **MaKey-Making the World a Better Place** – Use a MaKeyMaKey to create a new invention that will help the community/world
8. **Cancer** – With the idea of a lab on a chip, use a cantilever to calculate the frequency of a sample in order to determine the mystery disease.

You're Hired! – Project Description

Problem Statement

Greener Ways has developed a break-through product that is predicted to clean oil spills easily and effectively. They have developed a product known as Magic Sand that they would like to use to clean up such incidences. Your company is expected to test the magic sand and determine if it would work to effectively clean up oil spills. Your company will need to use the engineering design process to come up with a method to clean up the oil spill that includes estimates of materials and cost.

Your company has been chosen to be one of the finalists in our search for a company that will be able to use the Magic Sand to clean up an oil spill.

Boardroom Time Limit: 10 Minutes

6 Minutes: Maximum presentation time

4 Minutes: Boardroom questions

You're Hired! – Project Description

- In the morning students are given an introduction to the problem. (8:30-8:45)



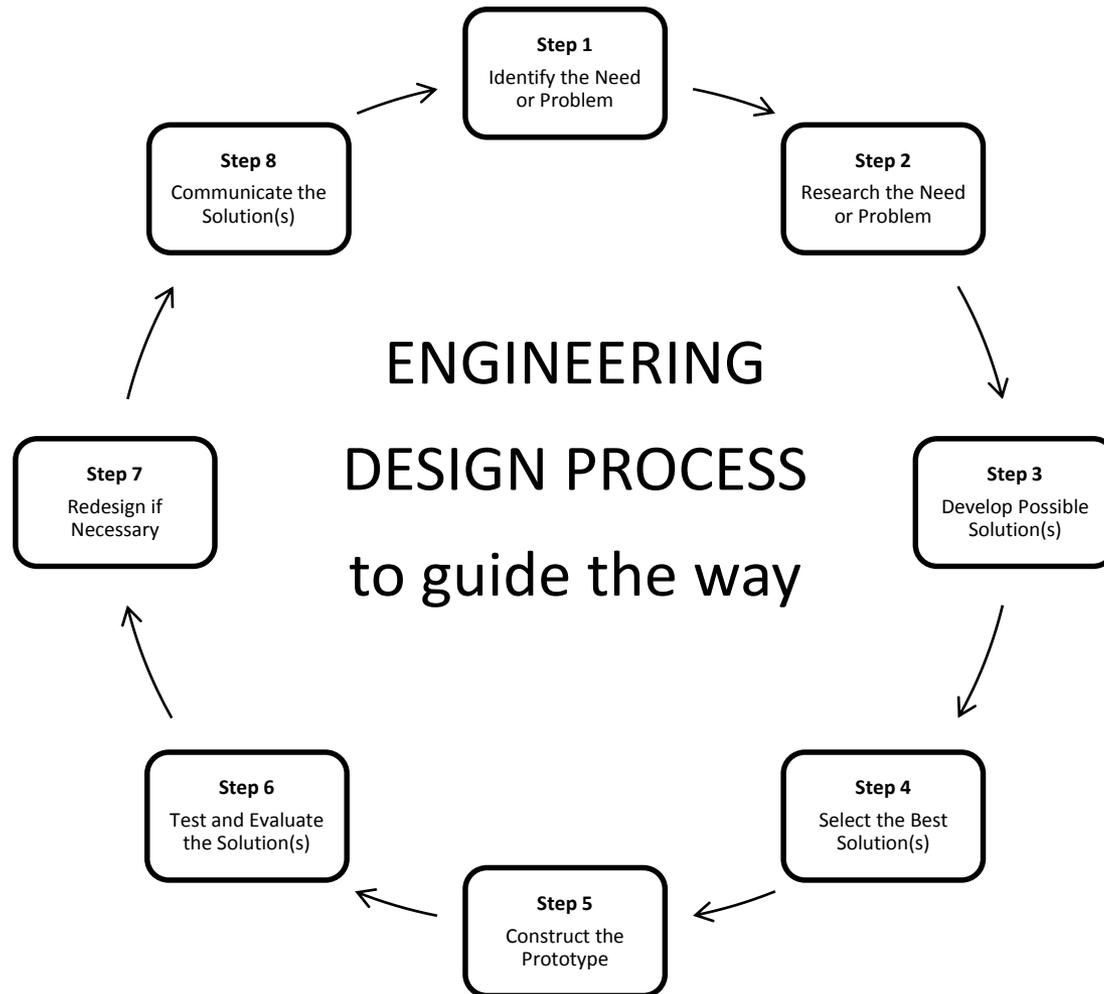
Students split into their companies and determine company roles

Students turn in Company Information Sheets (9:30)



Students then spend the day working together to find a solution to the problem (9:30-2:00)

You're Hired! - EDP



You're Hired! – Project Description



Students come up with a solution they think will win over the boardroom



Students present their solutions to the boardroom – school board members, local industry representatives, etc. – NOT teachers (2:00-3:00)

Assessment Methodology

- 15 schools during pilot year (2012-2013)
 - 1,850 students participating in 2 states
 - 3 cohort schools



- School A – 83 7th grade students
- School B – 23 10th grade students
- School C – 179 7th and 8th grade students
 - 130 females total
 - 155 male students total

Question:

Can a program such as 'You're Hired!' impact students' attitudes towards future STEM careers?

Assessment Methodology

- Electronic pre- and post- survey questions by category
 - Attitudes towards engineering (pre- and post-surveys)
 - Attitudes and understanding of the various types of work engineers do
 - Self-Efficacy (pre- and post-surveys)
 - A student's belief in their ability to do something
 - Project Impact (post-survey only)
 - What kind of impact did the project have on the students

Descriptive Statistics Comparing Pre- and Post-Survey Results for All Students

Question	Survey	N	Don't Know		
			Agree	Disagree	Know
1 Engineers mainly work on machines and computers.*	Pre	281	62%	26%	13%
	Post	240	48%	39%	13%
2 Engineers mainly work with other people to solve problems.*	Pre	278	52%	27%	21%
	Post	239	77%	15%	8%
3 Engineers work on things that help the world.	Pre	278	79%	9%	13%
	Post	240	83%	8%	9%
4 Engineers can choose to do many different kinds of jobs.*	Pre	278	62%	17%	22%
	Post	238	80%	10%	10%
5 Engineers mainly work on things that have nothing to do with me.*	Pre	274	15%	62%	23%
	Post	238	24%	61%	15%
6 I don't know what engineers do.	Pre	265	23%	64%	13%
	Post	237	17%	72%	11%
7 Do you think you want to be an engineer?	Pre	285	23%	45%	32%
	Post	240	22%	51%	27%

* $p < 0.05$



Descriptive Statistics Comparing Pre- and Post-Survey Results for All Students

Question	Survey	N	Don't		
			Agree	Disagree	Know
1 Engineers mainly work on machines and computers.*	Pre	281	62%	26%	13%
	Post	240	48%	39%	13%
2 Engineers mainly work with other people to solve problems.*	Pre	278	52%	27%	21%
	Post	239	77%	15%	8%
3 Engineers work on things that help the world.	Pre	278	79%	9%	13%
	Post	240	83%	8%	9%
4 Engineers can choose to do many different kinds of jobs.*	Pre	278	62%	17%	22%
	Post	238	80%	10%	10%
5 Engineers mainly work on things that have nothing to do with me.*	Pre	274	15%	62%	23%
	Post	238	24%	61%	15%
6 I don't know what engineers do.	Pre	265	23%	64%	13%
	Post	237	17%	72%	11%
7 Do you think you want to be an engineer?	Pre	285	23%	45%	32%
	Post	240	22%	51%	27%

* $p < 0.05$

Descriptive Statistics Comparing Pre- and Post-Survey Results for Female and Male Students

Question	Gender	Agree	Disagree	Don't Know
		(Pre : Post)	(Pre : Post)	(Pre : Post)
1 Engineers mainly work on machines and computers.	Female*	60% : 43%	22% : 45%	18% : 12%
	Male	63% : 51%	29% : 34%	8% : 15%
2 Engineers mainly work with other people to solve problems.	Female*	54% : 78%	21% : 16%	25% : 6%
	Male*	50% : 76%	32% : 14%	18% : 10%
3 Engineers work on things that help the world.	Female*	76% : 89%	9% : 6%	15% : 4%
	Male	81% : 78%	9% : 9%	11% : 13%
4 Engineers can choose to do many different kinds of jobs.	Female*	61% : 84%	13% : 9%	25% : 7%
	Male*	62% : 77%	19% : 11%	19% : 12%
5 Engineers mainly work on things that have nothing to do with me.	Female*	17% : 26%	56% : 61%	28% : 13%
	Male	14% : 22%	68% : 62%	18% : 16%
6 I don't know what engineers do.	Female	29% : 21%	57% : 68%	14% : 12%
	Male	19% : 13%	69% : 75%	12% : 11%
7 Do you think you want to be an engineer?		Yes	No	Don't Know
	Female	12% : 11%	62% : 65%	27% : 24%
	Male	32% : 32%	31% : 39%	37% : 29%

* $p < 0.05$



Descriptive Statistics Comparing Pre- and Post-Survey Results for Female and Male Students

Question	Gender	Agree	Disagree	Don't Know
		(Pre : Post)	(Pre : Post)	(Pre : Post)
1 Engineers mainly work on machines and computers.	Female*	60% : 43%	22% : 45%	18% : 12%
	Male	63% : 51%	29% : 34%	8% : 15%
2 Engineers mainly work with other people to solve problems.	Female*	54% : 78%	21% : 16%	25% : 6%
	Male*	50% : 76%	32% : 14%	18% : 10%
3 Engineers work on things that help the world.	Female*	76% : 89%	9% : 6%	15% : 4%
	Male	81% : 78%	9% : 9%	11% : 13%
4 Engineers can choose to do many different kinds of jobs.	Female*	61% : 84%	13% : 9%	25% : 7%
	Male*	62% : 77%	19% : 11%	19% : 12%
5 Engineers mainly work on things that have nothing to do with me.	Female*	17% : 26%	56% : 61%	28% : 13%
	Male	14% : 22%	68% : 62%	18% : 16%
6 I don't know what engineers do.	Female	29% : 21%	57% : 68%	14% : 12%
	Male	19% : 13%	69% : 75%	12% : 11%
7 Do you think you want to be an engineer?		Yes	No	Don't Know
	Female	12% : 11%	62% : 65%	27% : 24%
	Male	32% : 32%	31% : 39%	37% : 29%

* $p < 0.05$

<i>Descriptive Statistics for Program Impact for Each Gender</i>						
Question	Gender	N	Mean	Std Error*	95% C.I.	
					Lower	Upper
10 Helped me understand problem solving better **	Female	113	2.593	0.0870	2.422	2.764
	Male	127	2.339	0.0821	2.177	2.500
11 Increased my interest in studying engineering in college **	Female	110	2.009	0.0991	1.814	2.204
	Male	127	2.354	0.0923	2.173	2.536
12 Increased my confidence in my ability to participate in engineering projects or activities	Female	112	2.214	0.0971	2.023	2.406
	Male	125	2.472	0.0919	2.291	2.653

* Std Error uses a pooled estimate of error variance, ** p < 0.05

- Answer choices: A Great Deal, Moderately, Slightly, Not at All
- These answers were converted to a Likert scale where:
 - A Great Deal – 4
 - Moderately – 3
 - Slightly – 2
 - Not at All – 1
- We could then analyze gender differences based on numerical data.

Conclusion

- Post-survey results do show a change in students' attitudes and understanding of engineering.
- The pilot year data does not indicate if the changes in attitudes are a result of the You're Hired! project or not.
- Biggest outside factor – School Curriculum?
 - You're Hired! is 3 days out of a school year

Future Work

- In the school year 2013-2014 - 20 schools with over 2,000 students participated including 2 control groups.
- As of the school year 2014 – 2015 – ‘You’re Hired!’ has worked with 28 schools and over 4,000 students
- Future plans for the project are to:
 - Continue to research and redesign the project to make it more effective.
 - Form a focus group of students to assess the current pre- and post-survey questions.
 - Develop assessments for the Engineering Design Process and 21st Century Skills for teachers to use in and out of the project.

Acknowledgements

- North Dakota State College of Science
- University of North Dakota
- North Dakota State University
- Participating schools
- North Dakota CTE
- NSF #0940143
- NSF #0942278

