High School Students' Perspectives on Pre-college Engineering Education Course (Fundamental)

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Background[1]

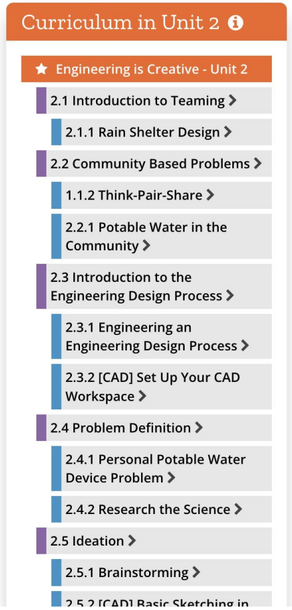
Engineering for US All (e4usa) is an NSF-funded program that offers pre-college engineering **curriculum**, **professional development** for teachers, and conducts **research** in engineering education research (EER). To date, e4usa involves 91 participating high schools with over 7,500 students.

Background[2]

1 e4usa curriculum

- Unit 1 - Engineering is Everywhere
- Unit 2 - Engineering is Creative
- Unit 3 - Engineering is Human-Centered
- Unit 4 - Engineering is Responsive
- Unit 5 - Engineering is Intentional
- Unit 6 - Engineering is Iterative
- Unit 7 - Engineering is Personal
- Unit 8 - Engineering is Reflective
- Unit - Meet the Engineer

2 Unit Example



3 Lesson Example

2.6 Design Selection

Weighing the pros and cons of multiple ideas helps engineers select the best design

Purpose/Summary

When engineers are brainstorming ideas for a design, they will likely come up with multiple solutions that need to be narrowed down. In this lesson and activity, students will come together as a whole class and use a shared set of criteria and a common, agreed upon scoring system to make a decision on the design of their personal water device.

This engineering curriculum aligns to Next Generation Science Standards (NGSS).

Research Questions

RQ1: What characteristics of high school engineering courses contribute to fostering an environment that engages students in learning?

What is good?

RQ2: How does exposure to an engineering course affect high school students' interest in pursuing engineering careers?

How good?

SCCT Theory

RQ1: What characteristics of high school engineering courses contribute to fostering an environment that **engages students** in learning?

RQ2: How does exposure to an engineering course affect high school students' interest in pursuing engineering **careers**?

SCCT Theory

Social Cognitive Career Theory (SCCT) indicated that contextual variables influence individuals' **career** interests and choices by shaping **learning experiences**. [3]

Methods

Participants

- 2022-2023 academic year
- 33 schools across 20 states
- 788 students
- Pre-test (n=623) & post-test (n=296)

Table 1. Distributions of the Demographic Data.

Category	Subcategory	Pre-test (%)	Post-test (%)
Ethnicity	White	24	27
	Black/African American	16	9
	Latino/Hispanic/Mexican American	40	13
	Asian	8	13
	Mixed	6	6
	Other	1	1
Gender	Male	53	44
	Female	36	26
	Non-binary	3	2
Grade	9th	12	21
	10th	33	25
	11th	17	20
	12th	25	20

Methods

Qualitative

Two rounds of thematic coding

1) What did you like best about this class?
2) What did you like least about this class?

What is good?

Quantitative

"What do you foresee as your desired profession?"

1) "Engineering"
   "STEM but not engineering"
   "Not STEM".
2) Chi-square tests (pre- & post-test)

How good?

Main Findings

RQ1: What is Good?

1) Best

Best Liked Aspects	Count	Freq (%)
Projects	207	70
Engineering Design Process	156	39
Flexibility and Creativity	100	25

2) Least

Least Liked Aspects	Count	Freq (%)
Assignment and Writing	108	36
Projects	73	24
Timeframe	22	7

Main Findings

RQ1: What is Good?

The ability to research, develop, text, and implement solutions to real-world problems given by stakeholders is simply unmatched. I love the freedom the class provides, while still having a clear set of guidelines. The class offers a good introduction to not just engineering in general, but what pursuing such a career has to offer.

The immense amount of paperwork, my peers who are already in college have told me they never have to do the intense amount of paperwork we have and the amount of time it takes us to get through paperwork puts a strain on how much we can do in the year.

Main Findings

RQ2: How good?

Distribution of Students' Professional Aspirations.

Category	Pretest (n=402)		Posttest (n=296)		Pre-post
	Count	Freq (%)	Count	Freq (%)	P-value
Engineering	105	26	105	35	0.008**
STEM but not engineering	120	30	81	27	0.474
Not STEM	115	29	91	31	0.541

Main Findings

RQ2: How good?

Chi-square Tests on Students' Professional Aspirations across Gender.

Category	Pre-post p-value		
	Male	Female	Non-binary
Engineering	0.068	0.037*	0.186
STEM but not engineering	0.506	0.609	0.513
Not STEM	0.934	0.203	0.350

Main Findings

Results discuss five emergent themes impacting students' engagement in pre-college engineering courses: Projects, Engineering Design Process, Flexibility and Creativity, Assignment and Writing, Timeframe. We also noted a significant **increase** in students' **interest in engineering** in the post-test, especially for **female students**.

References

[1]Engineering for us all democratizes and demystifies engineering for all. e4usa. (n.d.). https://e4usa.org/node/148
[2]Teachengineering.TeachEngineering.(n.d.).https://www.teachengineering.org/e4usa
[3] Lent R. W., Brown S. D., Hackett G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. J. Vocat. Behav. 45, 79–122. 10.1006/jvbe.1994.1027

Thank you!

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