Do Students Value the Pro-Social Side of Electrical Engineering??

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⇒ PFE = Professional Formation of Engineers
   (Award # 1544147)

- the formal and informal processes and value systems by which people become engineers.
Do Students Value the Prosocial Side of Electrical Engineering?

- **RFE**: The end goal is people working in the engineering profession.

We lose quantity.

We lose diversity in thinking.

We lose the investment.

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**This work supported by:**

**K-12 (3M/yr)**

**U.S. STEM Higher Ed**

**U.S. STEM Workforce (8M)**

Retire
What Do Value Systems have to do with PFE?

1) COGNITIVE

- Our intellectual skills.
- The first thing we think of when we talk about “learning”.

In engineering we tend to live in the cognitive domain.
Value Systems & PFE

• What Do **Value Systems** have to do with PFE?

1) COGNITIVE
- Our intellectual skills.
- The first thing we think of when we talk about "learning".

2) AFFECTIVE
- Our feelings (attitudes, motivation, willingness to participate, value of what is being learned).
- Heavily influences success of cognition.

3) PSYCHOMOTOR
- Motor skills.
- Cognition is underlying component, but practice-makes-perfect.

But higher ed is starting to pay attention to the impact of this domain.
Theoretical Framework (part 1)

- Expectancy-Value Theory of Motivation

Motivation
Theoretical Framework (part 1)

- Expectancy-Value Theory of Motivation

Motivation

More than just wanting good grades & lots of money...

- Propels learning and fuels engagement during the engineering formation process.
- Will the person “choose” an engineering degree?
- Will the person “choose” an engineering career?
- Will the person “choose” to remain in engineering?
Theoretical Framework (part 1)

- Expectancy-Value Theory of Motivation

Motivation = Expectancy x Value

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- Will the person “choose” an engineering career?
- Will the person “choose” to remain in engineering?

(Atkinson 50’s 60’s, Eccles 80’s)
Theoretical Framework (part 1)

- Expectancy-Value Theory of Motivation

Motivation = Expectancy x Value

Beliefs about one’s own ability and chances for success.
- self efficacy
- self confidence

(Atkinson 50’s 60’s, Eccles 80’s)
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Theoretical Framework (part 1)

• Expectancy-Value Theory of Motivation

Motivation = Expectancy x Value

Beliefs about the importance of the task.
- attainment (importance for identity)
- intrinsic (enjoyment or interest)
- cost (effort)
- and utility (relevance).

(Atkinson 50’s 60’s, Eccles 80’s)
Theoretical Framework (part 2)

• Goal-Congruity Theory

People are more motivated to pursue careers that afford the values that they endorse

Values an individual personally endorses

Values a profession affords

(Diekman 2010, 2011)
**Theoretical Framework (part 2)**

- **Goal-Congruity Theory**

  *People are more motivated to pursue careers that afford the values that they endorse*

  (Diekman 2010, 2011)
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Theoretical Framework (part 2)

- Goal-Congruity Theory

People are more motivated to pursue careers that afford the values that they endorse

- Agency
  self-oriented, power, wealth

- Prosocial
  Other-oriented, Working with and helping others, giving back to community

Values an individual personally endorses

Values a profession affords

(Diekmann 2010, 2011)
• Goal-Congruity Theory

People are more motivated to pursue careers that afford the values that they endorse

Values an individual personally endorses
Values a profession affords

Agency
Self-oriented, power, wealth

Prosocial
Other-oriented, Working with and helping others, giving back to coommunity

Most people want careers that allow them to work with others and give back to society
Theoretical Framework (part 2)

• **This is a good thing!**
  – The problems society faces in the 21\textsuperscript{st} century are massive.
  – We need an engineering workforce that wants to benefit society.
  – We need an engineering workforce that wants to work with others to solve large-scale problems.

![World Population Growth Through History](image)

**Do Students Value the Prosocial Side of Electrical Engineering?**
Do Students Value the Prosocial Side of Electrical Engineering?

Theoretical Framework (part 2)

- The problem (affordance beliefs)
  - Engineering isn’t always perceived as affording high prosocial value.
  - Prosocial trait endorsement has been shown to diminish over time in engineering.
Theoretical Framework (part 3)

• The problem (trait endorsement)

Technical skills are most valued.
Theoretical Framework (part 3)

- The BIG Problem: Diminishing Prosocial Trait Endorsement

Over time, engineering students become less engaged.

(Cech 2014)
Theoretical Framework

- What are we doing to these kids???
The Aim of our Study

- **Measure Prosocial Engagement within Electrical Engineering**

  R1: Do the prosocial affordance beliefs about EE diminish between freshman and senior year?

  R2: Do the prosocial trait endorsements of EE students diminish between freshman and seniors?

  R3: Are prosocial (or agency) beliefs about the EE profession associated with intentions to persist?
Method

• Survey Design – Overview
  – 133 question survey that took 10-15 minutes to complete.
  – Administered in required 100 and 400 level electrical engineering courses.
  – Given 6th week into the semester.
  – Cover story was that we were collecting feedback on classroom environment preferences for future engineering building (under construction next door).
  – $10 amazon.com gift card offered for completion.
  – Deception questions added about learning environment preferences.
  – Attention check questions added throughout.
  – Voluntary, confidential, no impact on student grades.
Method

• Survey Design – Instrument Selection
  – Used instruments that were tested for validity and reliability in other studies.
    • Prosocial Trait Endorsement (trait empathy, concern for public welfare)
    • Agentic and Communal Affordance Beliefs about the EE Profession.
    • Experience of Interest
    • Persistence Intensions
### Participants

<table>
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<tr>
<th></th>
<th>Freshman Class</th>
<th>Senior Class</th>
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</thead>
<tbody>
<tr>
<td>Enrollment</td>
<td>117</td>
<td>66</td>
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<tr>
<td>Took Survey</td>
<td>85 (73%)</td>
<td>53 (80%)</td>
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<tr>
<td>Major</td>
<td></td>
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<tr>
<td>- EE</td>
<td>51 (60%)</td>
<td>34 (64%)</td>
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<tr>
<td>- Computer Eng</td>
<td>24 (28%)</td>
<td>14 (26%)</td>
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<tr>
<td>Gender</td>
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<tr>
<td>- Male</td>
<td>65 (76%)</td>
<td>40 (75%)</td>
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<tr>
<td>- Female</td>
<td>13 (15%)</td>
<td>8 (15%)</td>
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<tr>
<td>Race</td>
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<tr>
<td>- White</td>
<td>62 (73%)</td>
<td>39 (74%)</td>
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</table>

Note: Only reporting most significant groupings.
• One-sample T-tests were conducted to find strength and direction of rating.

• Independent t-tests were conducted to test for degree and direction of differences between freshman and senior students.

• Where applicable, a paired sample t-test was conducted to test for differences in ratings between two constructs.

• Relationship among variables were tested with a specified path analysis with a maximum likelihood estimation and indirect effects using bootstrapped standard errors.
Results

- **Descriptive Statistics and T-Test Values**

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Note 1: EE = Electrical Engineering.
Note 2: †Tested value was the midpoint of the scale. Greater numbers indicate stronger endorsement.
Note 3: All items are on a 1 to 5 scale (midpoint = 3) with the exception of empathetic concern, which was on a 1 to 6 scale (midpoint = 3.5).
Note 4: * indicates a significance level of at least $p < .01$ as required by Bonferroni correction.
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Seniors had significantly lower prosocial affordance beliefs about the EE profession than freshman.
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Both freshman and seniors believed ethical responsibilities were important for the EE profession.
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Seniors had significantly lower empathic concern for the impact of EE decision than freshman.
Do Students Value the Prosocial Side of Electrical Engineering?

Results

• Descriptive Statistics and T-Test Values

<table>
<thead>
<tr>
<th>Variable</th>
<th>Class</th>
<th>n</th>
<th>M (SD)</th>
<th>Between Group T-Test</th>
<th>Cohen’s d Senior vs. Freshman</th>
<th>One Sample T-Test*</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE Agency Affordance</td>
<td>Advanced</td>
<td>51</td>
<td>3.88 (.84)</td>
<td>0.68</td>
<td>0.13</td>
<td>7.52*</td>
</tr>
<tr>
<td></td>
<td>Novice</td>
<td>77</td>
<td>3.78 (.72)</td>
<td></td>
<td></td>
<td>9.63*</td>
</tr>
<tr>
<td>EE Prosocial Affordance</td>
<td>Advanced</td>
<td>51</td>
<td>3.52 (.81)</td>
<td>3.84*</td>
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<td>4.56*</td>
</tr>
<tr>
<td></td>
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<td>77</td>
<td>4.01 (.64)</td>
<td></td>
<td></td>
<td>13.96*</td>
</tr>
<tr>
<td>Ethical Responsibilities</td>
<td>Advanced</td>
<td>49</td>
<td>3.98 (.74)</td>
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</tr>
<tr>
<td></td>
<td>Novice</td>
<td>79</td>
<td>4.20 (.93)</td>
<td></td>
<td></td>
<td>11.34*</td>
</tr>
<tr>
<td>Empathic Concern</td>
<td>Advanced</td>
<td>51</td>
<td>2.49 (1.13)</td>
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</tr>
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<tr>
<td>Persistence</td>
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<td>-</td>
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<tr>
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Both freshman and seniors showed significant interest in the EE profession.
Results

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Overall, freshman showed significant intentions to persist in the EE curriculum.
Results

• Testing associations between affordance beliefs and intentions to persist.
  – Both prosocial & agency beliefs were correlated to interest.
  – *Interest* was correlated to *Intentions to Persist*
  – We created a process model to control for agency vs. communal
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The more students believed EE afforded prosocial value (and not agency), the stronger their intentions to persist.
Freshman students (predominantly MALE) enter the program with high levels of prosocial affordance beliefs about EE and high levels of prosocial trait endorsement.

- This is good! The students with the values we need to solve the grand challenges facing society are entering EE programs.
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Discussion

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• Prosocial affordance beliefs about the EE profession diminished between freshman and senior students.
  – Why: Did students that viewed EE as affording prosocial value leave the program? or did the curriculum marginalize this value? Or both?

• Trait Empathy of EE students diminished between freshman and senior students.
  – Why: Did students with high levels of trait empathy leave the program? or did the change the students? Or both?
Conclusion

- A longitudinal study is needed to answer the research questions created in this study.
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• If the curriculum is to blame for diminishing prosocial affordance beliefs, there are a number of low-effort, high-impact interventions that can be implemented from the field of Utility-value.

• If the curriculum is actually diminishing the prosocial traits of our students, we need to step back and re-think engineering education.
Questions