

Sources of Engineering Self-Efficacy: An Analysis of Open-Ended Responses

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Problems in Engineering



Need

(Jones, Paretti, Hein, & Knott, 2010)



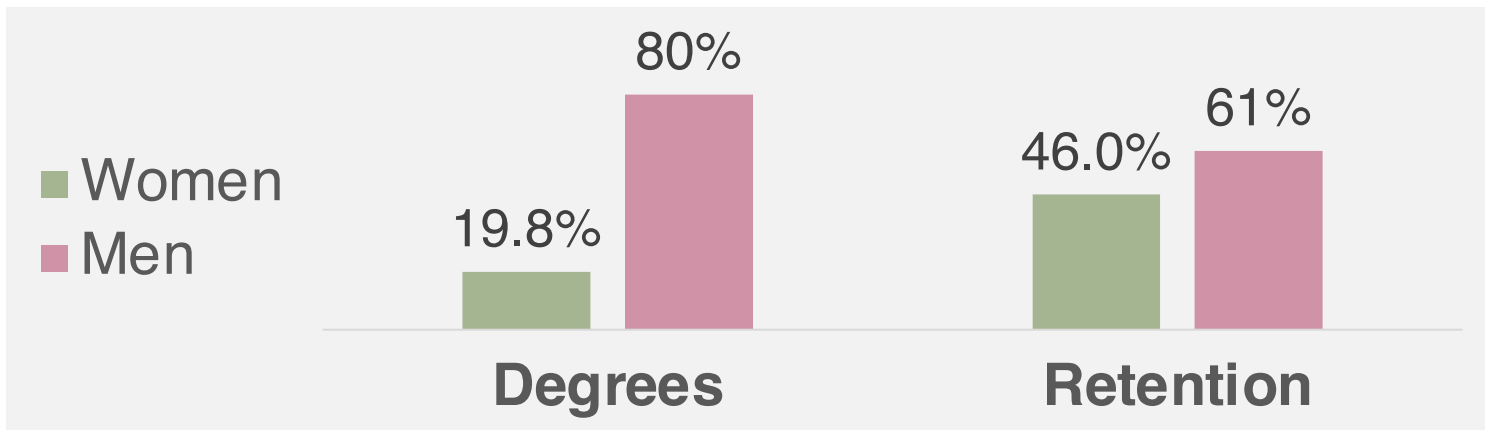
Degrees Conferred

(Ohland, Sheppard, Lichtenstein, Eris, Chachra, & Layton, 2008)



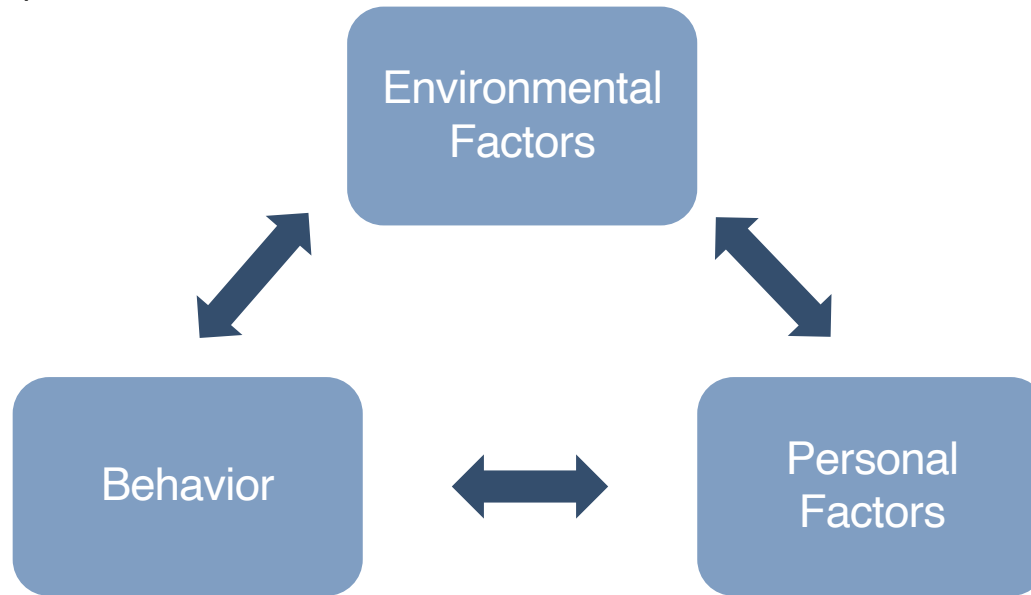
Retention Rates

(Hutchison, Follman, Sumpter, & Bodner, 2006)



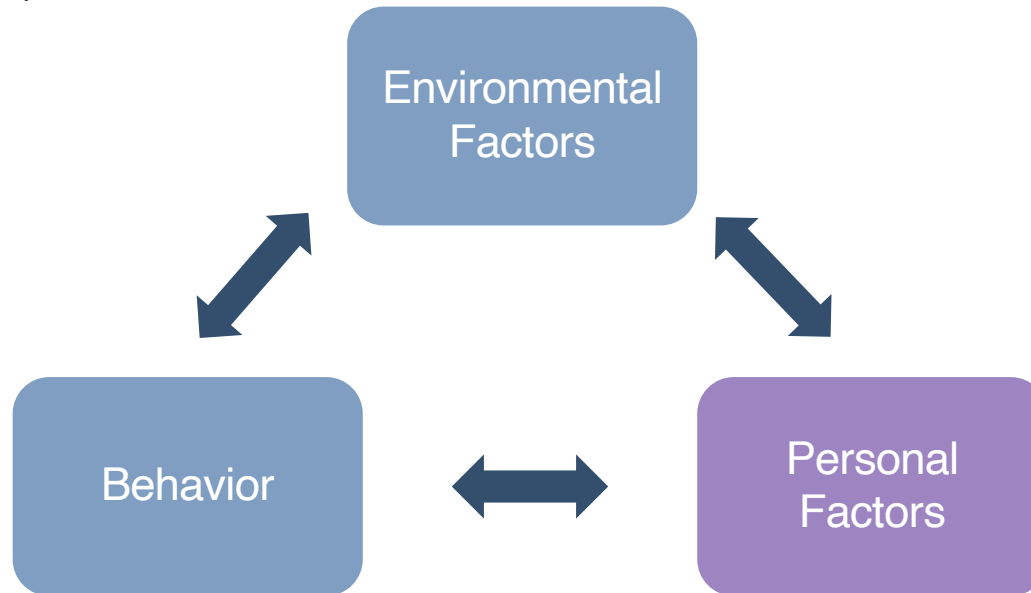
Social Cognitive Theory

(Bandura, 1986)



Social Cognitive Theory

(Bandura, 1986)



Self-Efficacy

- Influences achievement and persistence (Marra, Rodgers, Shen, & Bogue, 2009; Mamaril, Usher, Li, Economy, & Kennedy, 2016)
- May be one reason for the lack of diversity in engineering (Lent, Brown, Sheu, Schmidt, Brenner, Gloster, Wilkins, Schmidt, Lyons, & Treistman, 2005; Litzler, Samuelson, & Lorah, 2014)

Sources of Self-Efficacy

(Bandura, 1997)



Zeldin, Britner, & Pajares (2008)
Hutchison-Green, Follman, & Bodner (2008)

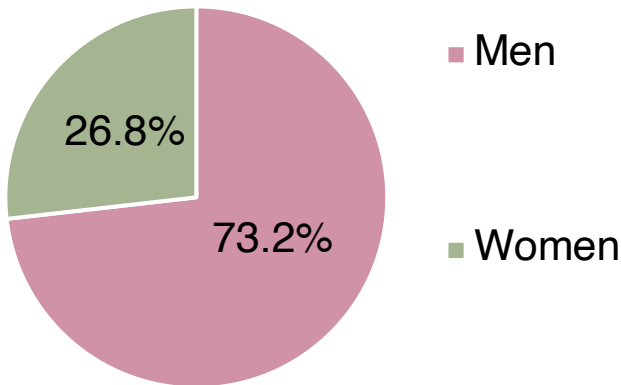
Purpose

- Identify **patterns** in students' written descriptions of their efficacy-relevant experiences in engineering
- Determine **gender or year-level differences** in the types of experiences that students describe

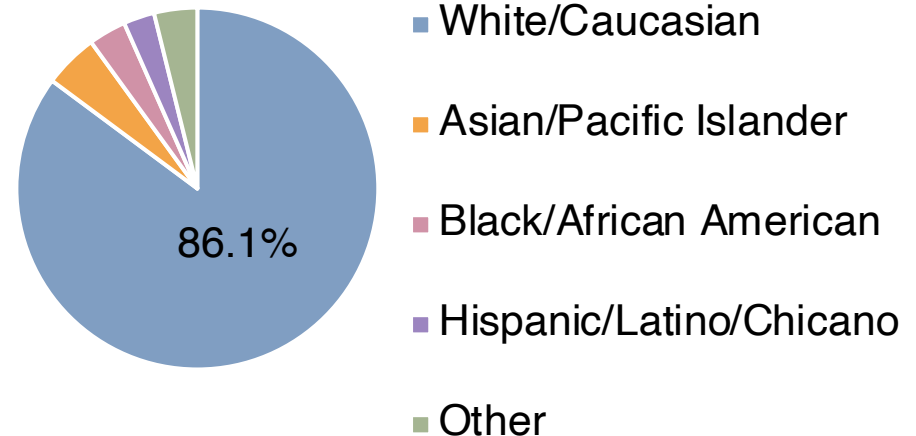
Participants

- 654 undergraduate engineering students
- Fall 2010 ($n = 150$) and Spring 2013 ($n = 504$)
- 2 public and research-intensive universities

Gender



Race/Ethnicity



Data Sources: Open-Response Items

1. What events have affected your confidence in your engineering skills? How did the event(s) affect your confidence?
2. Can you think of a specific event that made you feel *more confident* in your capabilities? Please describe.
3. Has anyone encouraged or inspired you to be an engineer? If so, who? How did they encourage you?
4. Please describe how you typically feel when doing engineering work.

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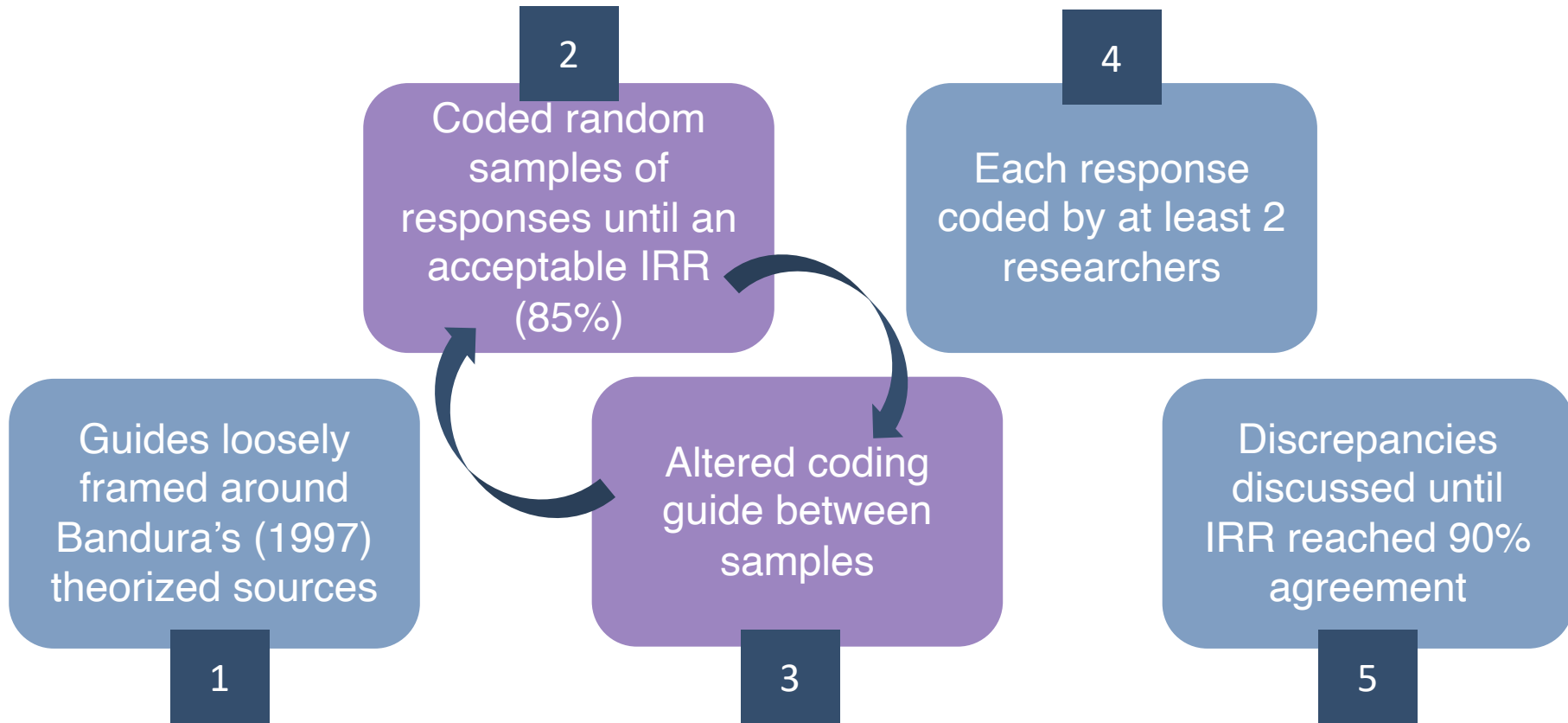
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Analyses

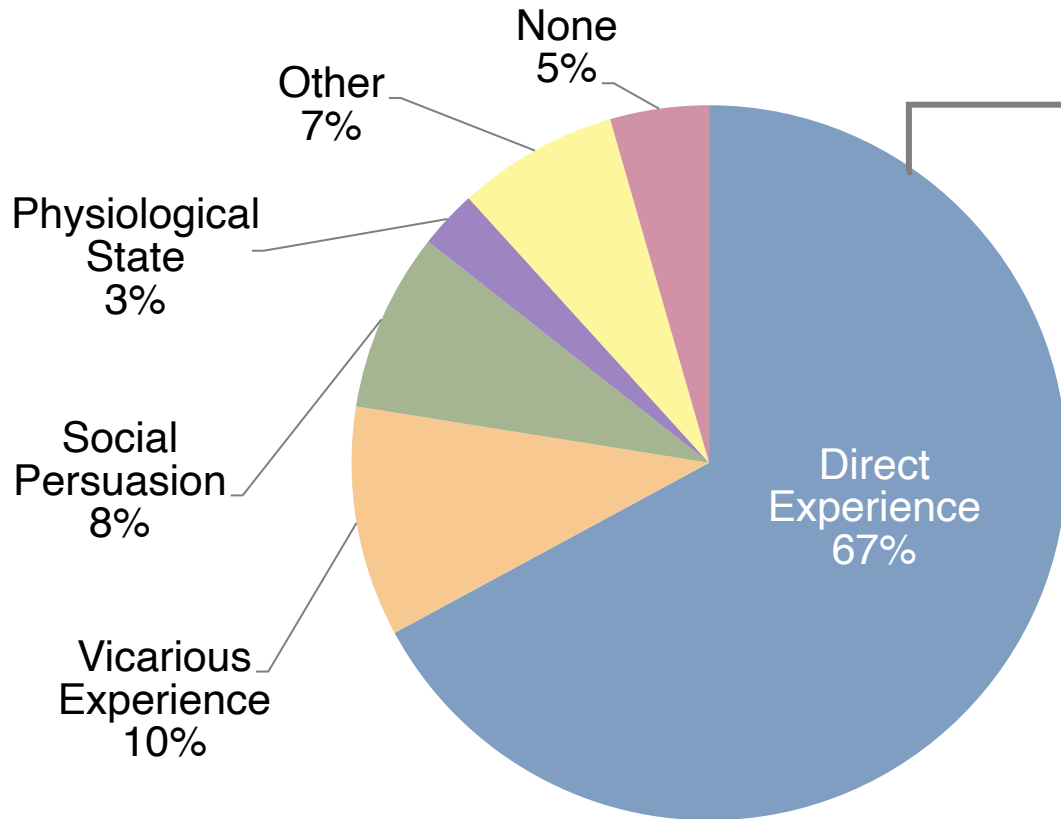


Results: Q1

What events have affected your confidence in your engineering skills? How did the event(s) affect your confidence?

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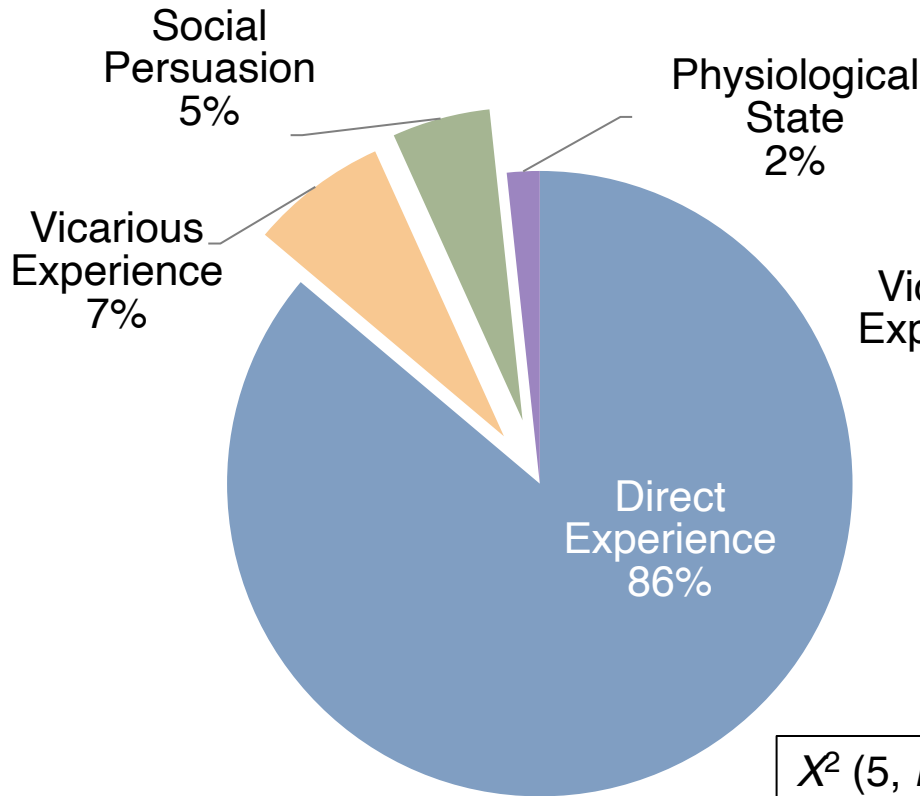
Direct Experiences	
Academic	72.7%
Coop/internship	12.8%
Work	4.2%
Extracurricular	3.0%

Lent, Lopez, & Bieschke (1991);
Mamaril, et al. (2016)

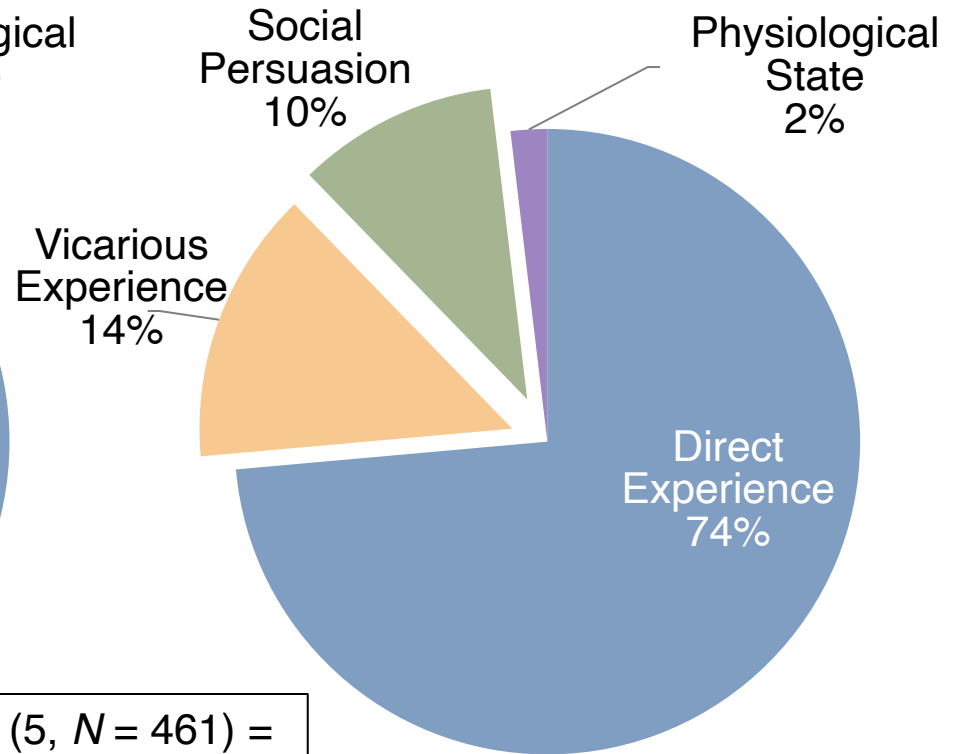
Results: Q1

What events have affected your confidence in your engineering skills? How did the event(s) affect your confidence?

MEN



WOMEN

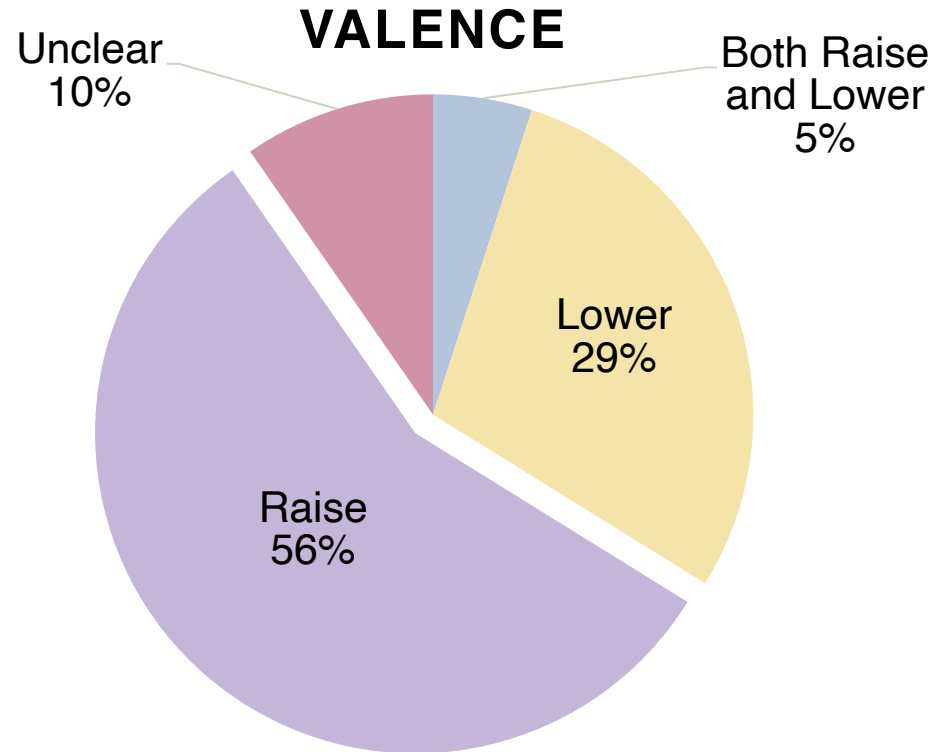


$\chi^2 (5, N = 461) = 12.59, p < .05$

Lent, Lopez, & Bieschke (1991);
Mamaril, et al. (2016)

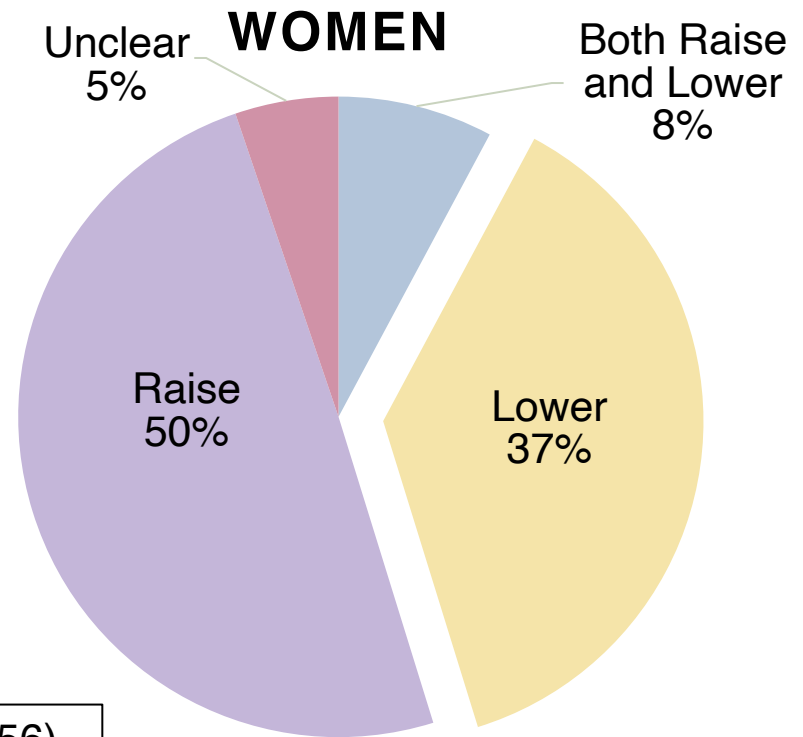
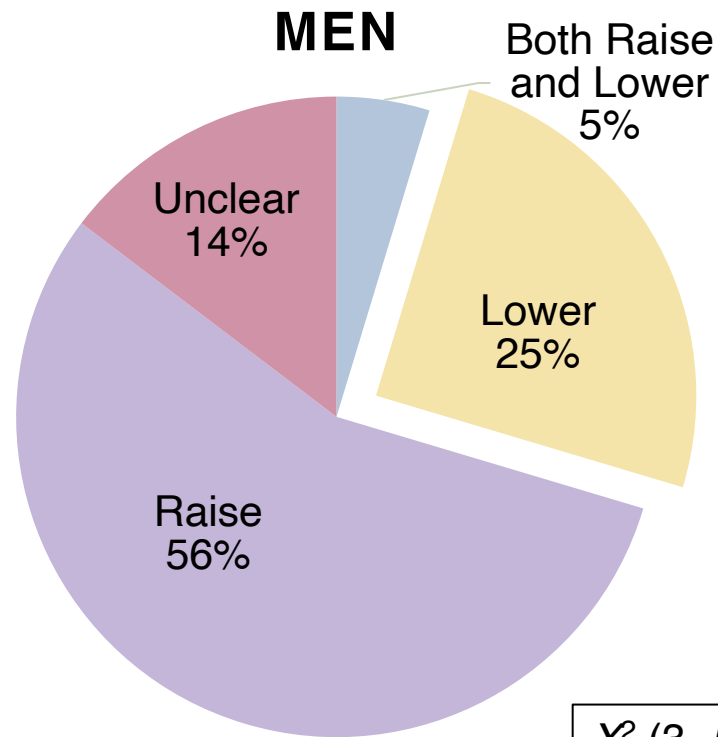
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$\chi^2 (3, N = 456)$
 $= 13.15, p < .01$

Results: Q1

What events have affected your confidence in your engineering skills? How did the event(s) affect your confidence?

I typically do well on test, normally above the class average even if I am not super happy with how I did. This helps to boost my confidence but I try to not let it go to my head. I also tend to be super competitive and when people figure things out before me it lowers my confidence.

*Direct Experience (Academic)
Social Comparison
Both Raise and Lower*



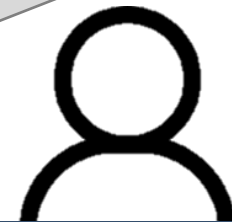
Male Senior
Chemical Engineering

Results: Q1

What events have affected your confidence in your engineering skills? How did the event(s) affect your confidence?

Co-op has greatly affected my confidence level in engineering skills. My **co-op terms have given me real-world work experience** and shown me what a career in engineering would be like after graduation. I was able to **apply my classroom knowledge to real-world problems**, and I found that I enjoy engineering for more than just the university curriculum.

*Direct Experience (Coop)
Raise*



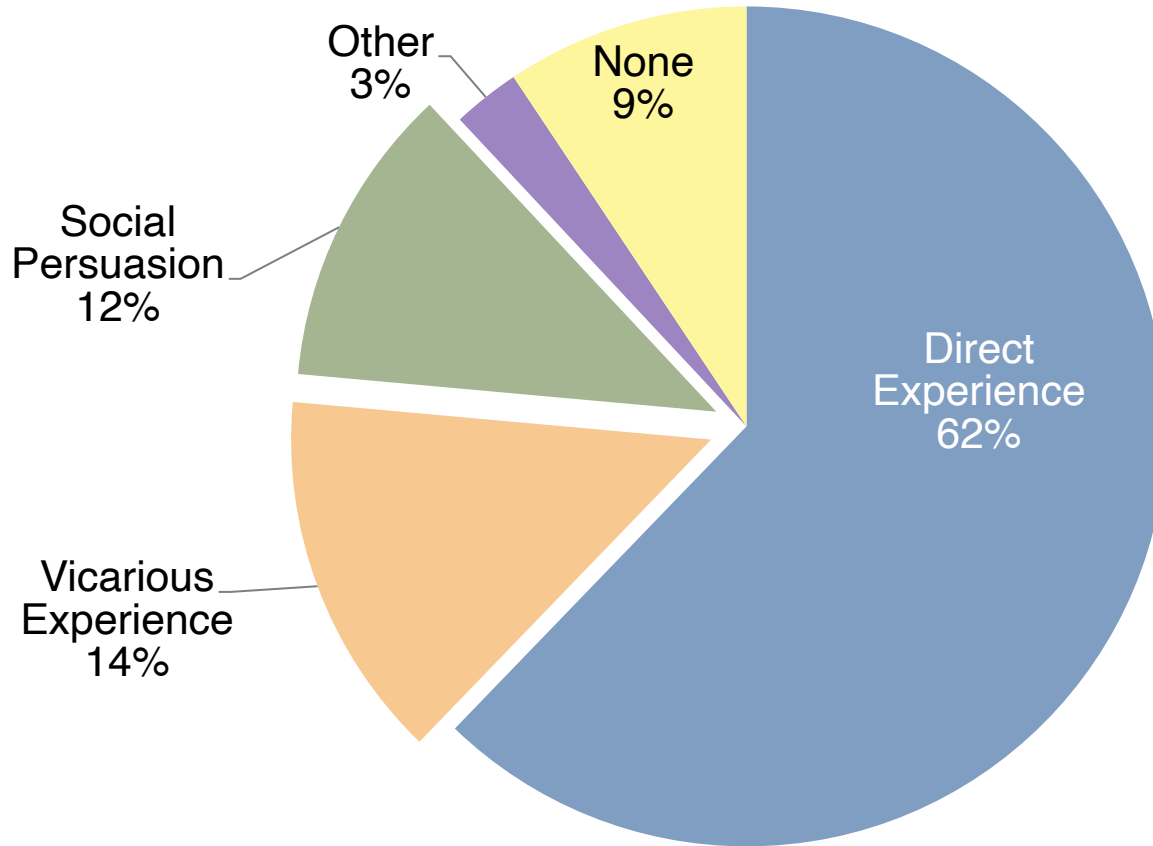
Female Junior
Chemical Engineering

Results: Q2

Can you think of a **specific event** that made you feel *more* confident in your capabilities? Please describe.

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Results: Q2

Can you think of a **specific event** that made you feel *more* confident in your capabilities? Please describe.

When I was told that one course was a weed-out course for the first time, I truly believed that it was a joke. The fact that I couldn't even comprehend that people had trouble with work which made me fairly confident that I am capable.



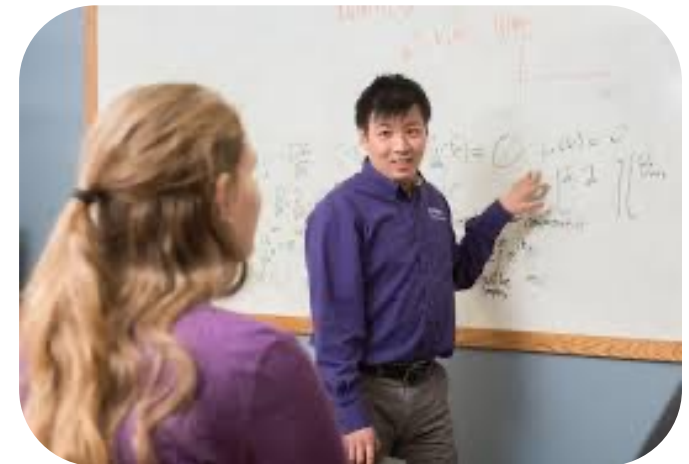
Male Junior
Mechanical Engineering

Direct Experience (Academic)
Social Comparison
Both Lower and Raise

Results: Q3

Has anyone encouraged or inspired you to be an engineer? If so, who? How did they encourage you?

WHO?	
1. Parents	33.6%
2. Family	17.9%
3. Teachers	12.3%
4. Peers	6.2%
5. Adults	6.1%
6. Self	3.6%



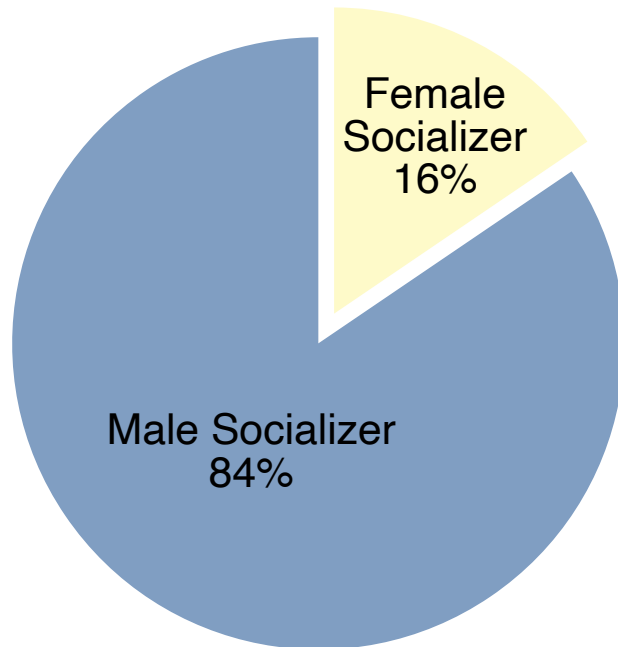
Martin, Simmons, and Yu (2014);
Zeldin, Britner, and Pajares (2008)

Results: Q3

Has anyone encouraged or inspired you to be an engineer? If so, who? How did they encourage you?

MEN WHO RESPONDED

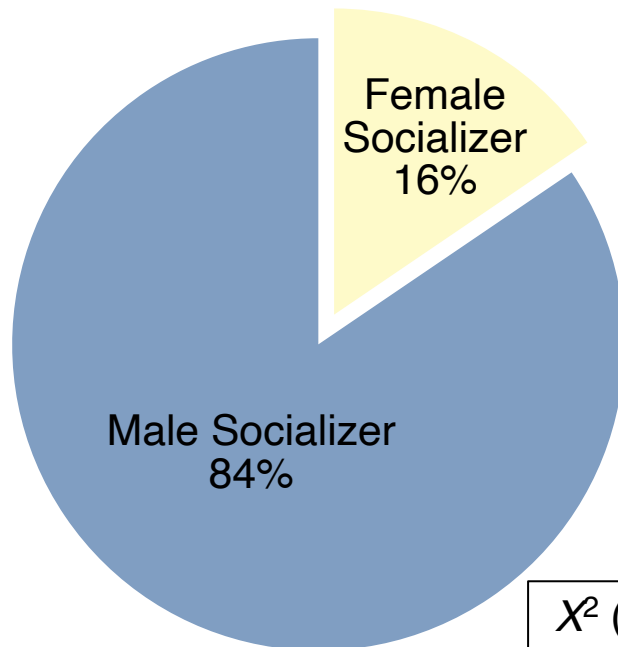
WOMEN WHO RESPONDED



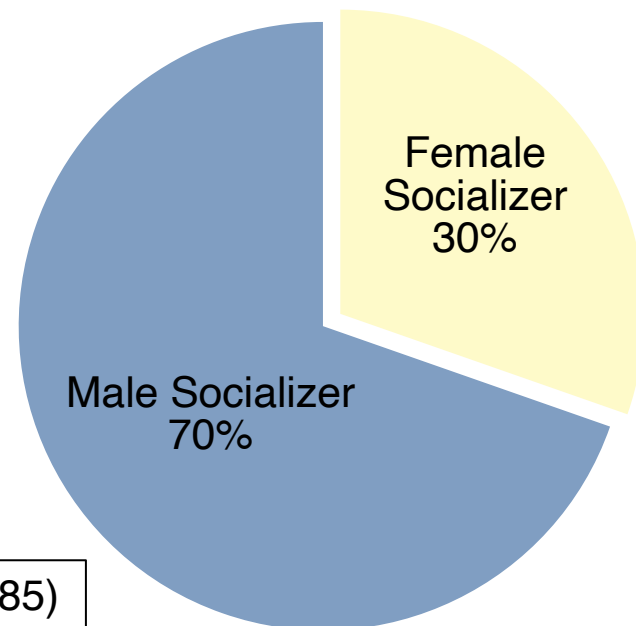
Results: Q3

Has anyone encouraged or inspired you to be an engineer? If so, who? How did they encourage you?

MEN WHO RESPONDED



WOMEN WHO RESPONDED



$X^2 (1, N = 185)$
 $= 5.38, p < .05$

Results: Q3

Has anyone encouraged or inspired you to be an engineer? If so, who? How did they encourage you?

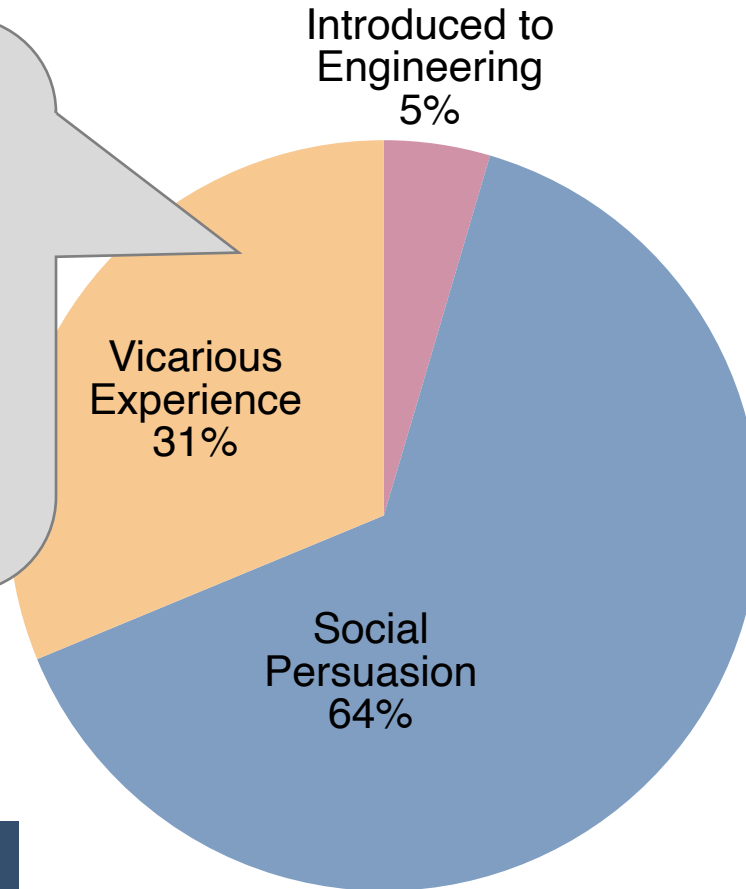
Results: Q3

Has anyone encouraged or inspired you to be an engineer? If so, who? How did they encourage you?

Yes, grandparent, uncle and brother, all of whom are engineers. I am inspired to do great things **because of all that they have done, I know that I can.**



Male Junior
Computer Engineering

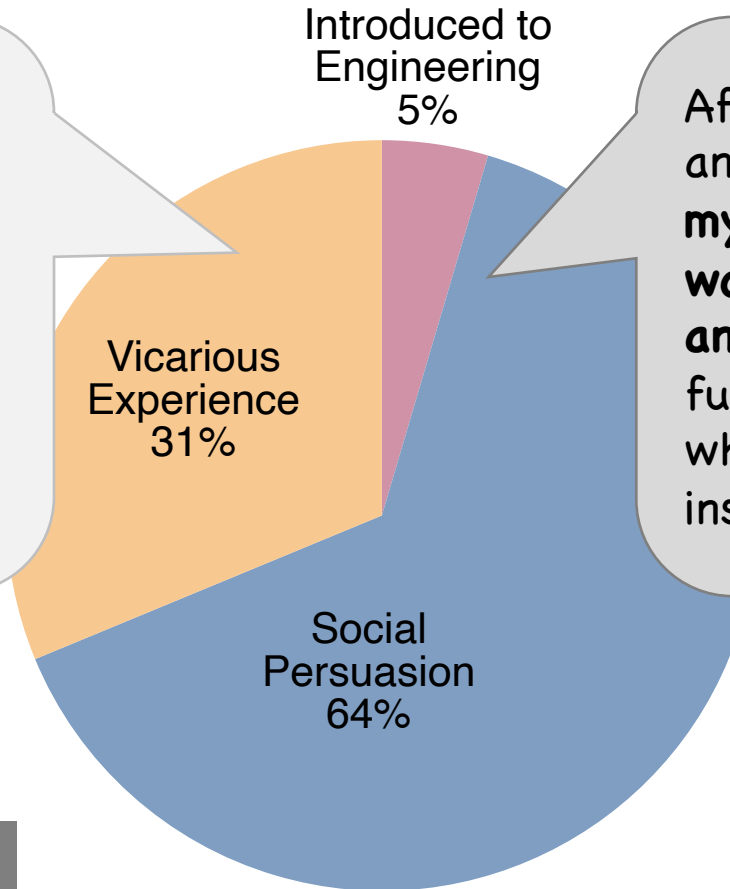


Results: Q3

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Male Junior
Computer Engineering



After actually working for an engineer last summer, **my boss gave me several words of encouragement and advice** regarding my future in engineering—which was also very inspiring.

Female Senior
Civil Engineering

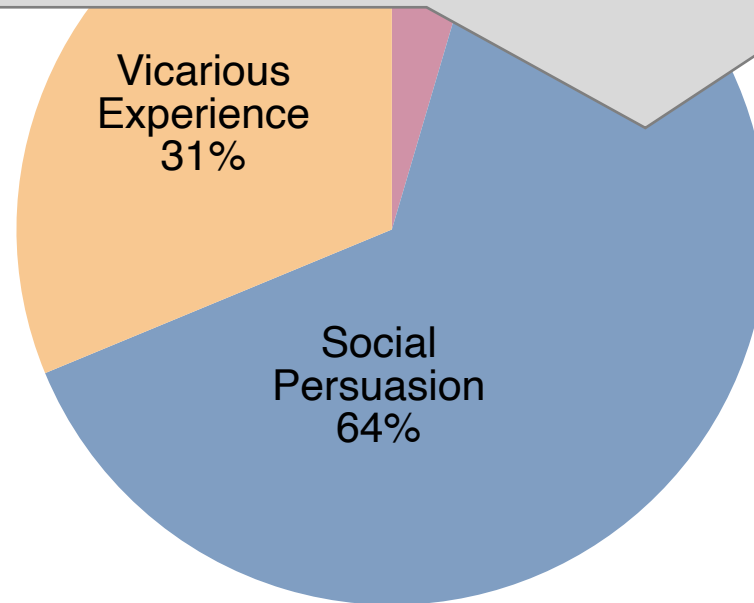
Results: Q3

Has anyone encouraged or inspired you to be an engineer? If so, who? How did they encourage you?

I met and spoke with a woman who had been a civil engineer and she told me that **she thought I had the right skills and personality to succeed as a woman in engineering. This gave me confidence** about engineering even before I knew that I wanted to be an engineer.

No significant
gender
differences

$\chi^2 (2, N = 356)$
 $= 3.68, p = .159$



Female Sophomore
Computer Engineering

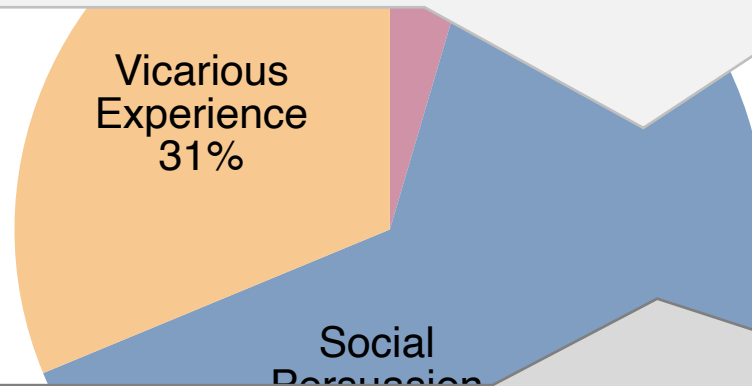
Results: Q3

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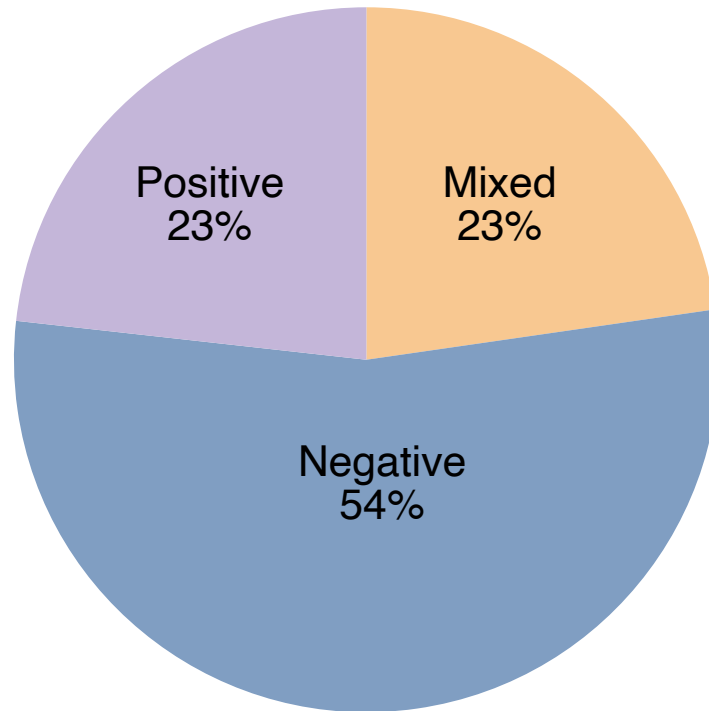
Female Sophomore
Computer Engineering

Female Junior
Mining Engineering

What helps my confidence the most is **when I am told by individuals that I cannot succeed in engineering as I am female.** When I hear that, it **makes me want to finish my degree just to show them wrong.** I also am not a quitter.

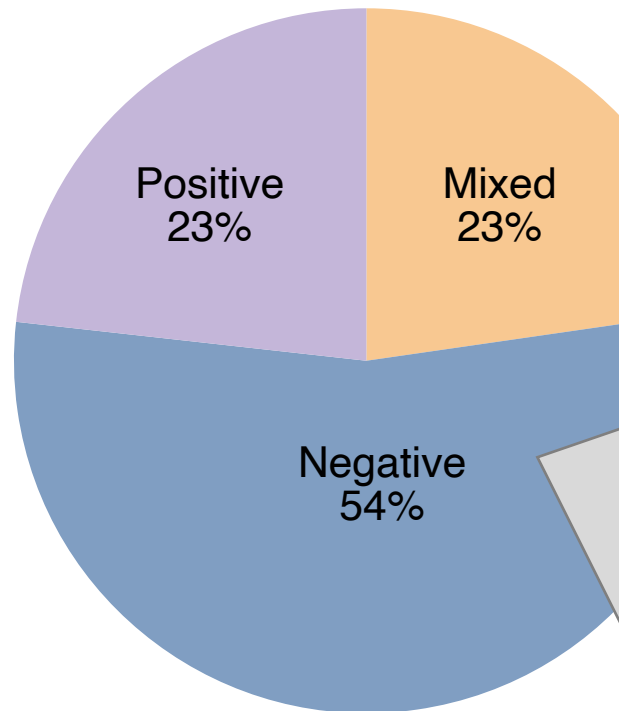
Results: Q4

Please describe how you typically feel when doing engineering work.



Results: Q4

Please describe how you typically feel when doing engineering work.



Terrible, demoralized, and incredibly anxious. A homework set rarely seems to establish the basics before delving into more complicated procedures. Sometimes, I understand a problem perfectly on a conceptual level, but there is so much monotonous number crunching that it still **feels like a hopeless nightmare.**

Male Sophomore
Biosystems Engineering

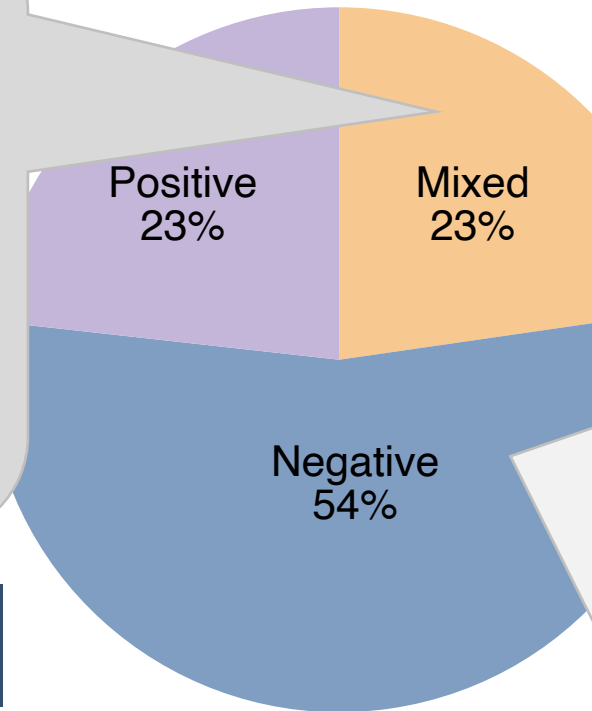
Bandura (1997)

Results: Q4

Please describe how you typically feel when doing engineering work.

I feel **challenged and sometimes stressed**. However, I always feel a great **sense of accomplishment and pride** whenever I finish an assignment or do well on an engineering exam.

Male Junior
Chemical Engineering



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Male Sophomore
Biosystems Engineering

Linnenbrink (2006)

Implications

- Authentic experiences in engineering tend to raise students' self-efficacy
- Men and women may pay attention to different things
- The competitive culture of engineering can be harmful

Bandura (1997); Usher & Weidner (2018);
Hawks & Spade (1998); Rask & Bailey (2002)

Questions?



Thank you!

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