Using Survey Data to Inform Engineering Student Retention Programming: A Case Study

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Outline

- Introduction and Background
- GEARS survey overview
- Research Results
- Institutional Impact
- Future Directions

GEARS: MISSION

The collaborative mission of GEARS (*Guild for Engineering Education Achievement, Retention and Success*) is to improve the learning and academic success of post-secondary students, with emphasis on engineering education.

GEARS: Goals

- Improve the success and retention of undergraduate engineering students through collaborative and interdisciplinary research
- Longitudinal study of different factors' that associate with achievement and retention in engineering.
- Formally established in 2012, informally 2010

GEARS: Members

- **Engineering Faculty**
  - Patricia Ralston, Jeff Hieb, Olfa Nasraoui, Jaqi McNeil; Nora Honken (University of Cincinnati)
- **Physics Faculty**
  - Ray Chastain
- **Education Faculty**
  - Kate Snyder, Jason Immekus, Tom Tretter, Stephanie Philipp
- **Psychology Faculty**
  - Kieth Lyle, Mari DeCaro
- **Delphi Center (CTL)**
  - Marie Brown
  - Il Barrow
- **REACH (Academic Success Resource Center)**
  - Geoff Bailey
- **Engineering Academic Affairs**
  - Heidi Neil

Graduate Students

- **Education**
  - Nora Honken (Ph.D. 2014), YuYun Liu, Jackson Painter, Allison Williams, Brittany Flanery, Terri Tinnell, Mary Mills
- **Psychology**
  - Joanna Weaver, Campbell Bego
- **Computer Science Engineering**
  - Cagla Acun Sener, Khalil Damik, Mariem Boujelbene

Data Collection

- GEARS researchers develop surveys
- Collaborate with Institutional Research (IR) and Institutional Effectiveness (IE) to deliver surveys using Blue survey software.
- Data is return to GEARS deidentified but linked to institutional demographic data such as
  - ACT scores, High School GPA, GRS cohort, race and gender
  - IR maintains the deidentification table.

GEARS Surveys

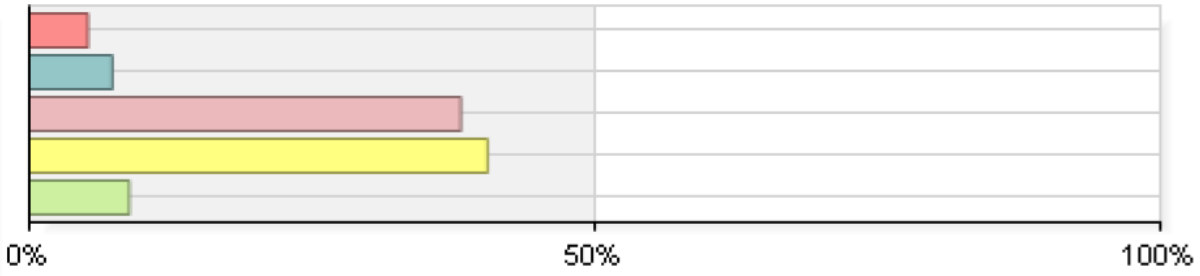
- Pre survey (2010 - 2017)
  - Entering freshman engineering students first week of the fall semester
- Post survey (2010-2017)
  - Same population of students during the last week of the fall semester.
- Week 8 survey (Fall 2012, 2013, 2014)
  - Administered to freshman students in an engineering math class (focus in text anxiety and mindfulness)

Sample Pre and Post Question:

What is your best guess as to the chances you will do each of the following?

1. Change engineering discipline within Speed School

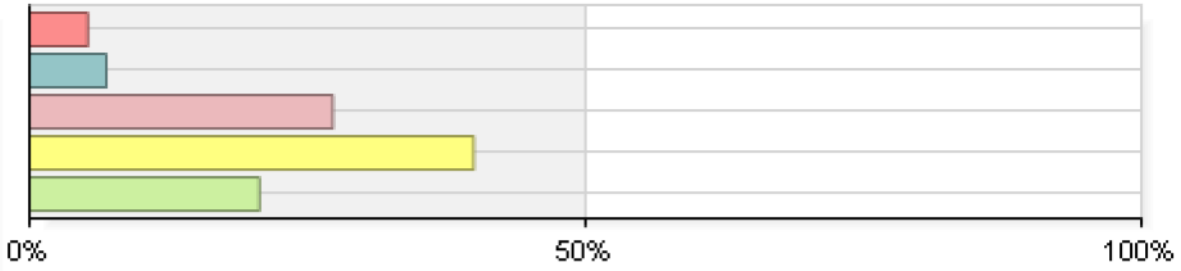
5 Very good chance	24	5.2%
4 Good chance	34	7.3%
3 Some chance	177	38.1%
2 Little chance	188	40.5%
1 No chance	41	8.8%
Total	464	



What is your best guess as to the chances you will do each of the following?

1. Change engineering discipline within Speed School

5 Very good chance	19	5.2%
4 Good chance	25	6.9%
3 Some chance	99	27.3%
2 Little chance	145	39.9%
1 No chance	75	20.7%
Total	363	



Survey Data and Dissemination

- Survey responses from over 3500 engineering students
- Administered 19 different surveys over 7 years
- 7 Journal Publication
- 25 Conference Presentations

Factors and Scales

Sample Scales (18 total):

- Perceived Academic Underachievement Scale
- Self-Efficacy for Self-Regulated Learning
- Sense of Belonging to Engineering
- Implicit Beliefs about Intelligence Scale

Sample Factors (~88)

Career Choice, Critical Thinking, GPA expectation, Test Anxiety, First Generation College Student, Finances, many others.

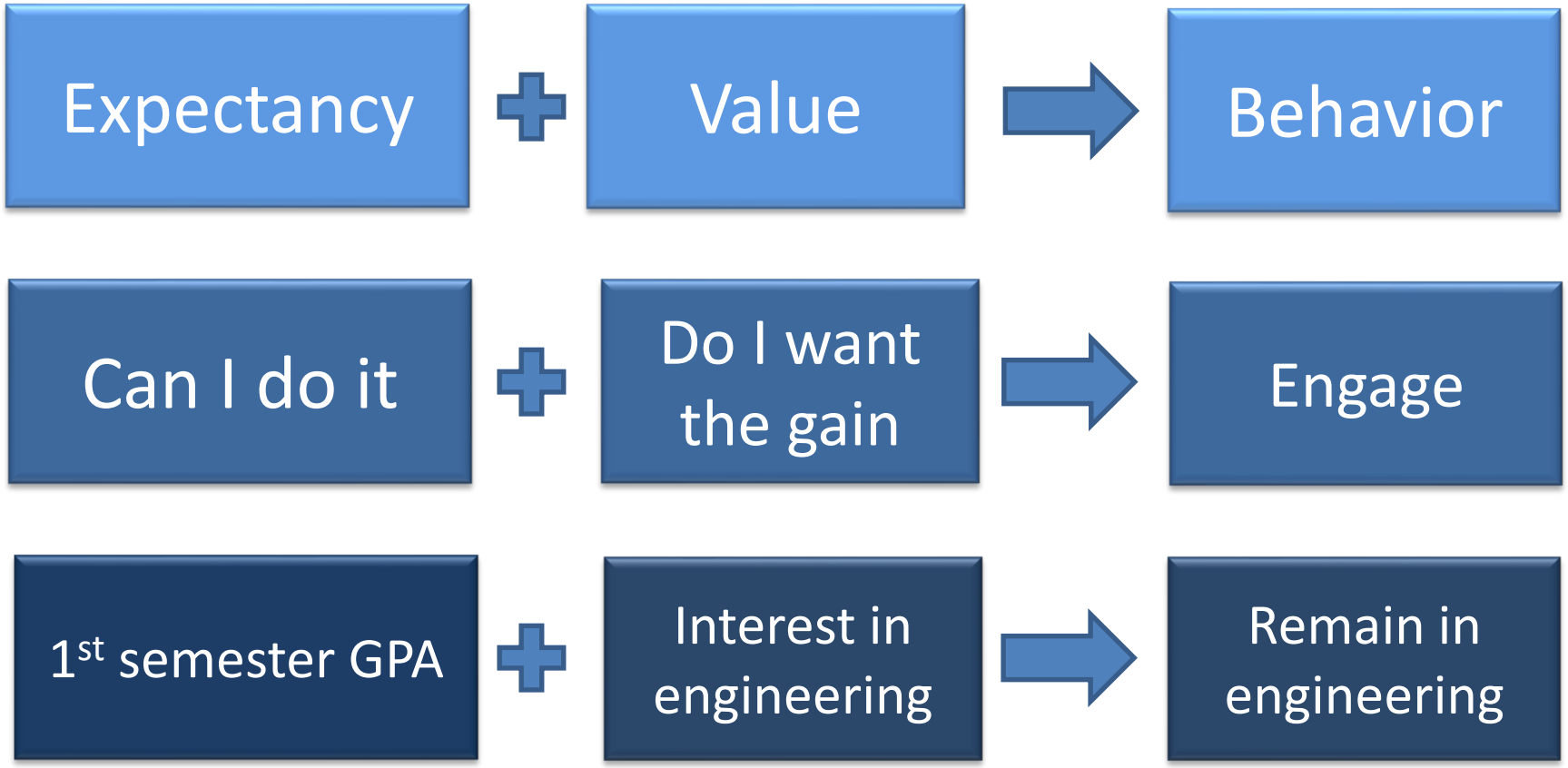
Response Rates by Year*

Year	Pre	%	Post	%
2017	548/599	91.49%	481/588	81.8%
2016	610/648	94.1%	486/623	78.01%
2015	577/599	96.33%	507/581	87.26%
2014	582/628	92.7%	507/626	80.99%
2013	544/622	87.5%	460/604	76.2%
2012	466/526	88.59%	366/439	83.4%

*Data not available for 2010 and 2011

RESEARCH RESULTS

Expectancy Value Theory



"There are many reasons that affect people's decision on what to study. This question relates only to your interest level in engineering. Which of the following statements best describes your interest in engineering?"

Very low interest - I'm not interested in engineering, I chose engineering for reasons other than interest.
Low interest - I have an interest in engineering but stronger interest in another field(s).
Medium interest - I am interested in engineering and equally interested in other fields(s).
High interest - I am very interested in engineering, but also think I could be happy in another field.
Very high interest - I am so interested in engineering that I could not imagine myself studying anything else.

Expectancy - First semester GPA

Students choose engineering because they think they are good in math and science

- 56% answered good or very good chance of getting a 3.5 or above
- 86% answered good or very good chance of getting a 3.0 or above
- 88% choose engineering because they were good in math and science

GPA obtained from student records

Step-Outs to Stars
Engineering Retention Framework

		GPA: Below average (Low)	GPA: Above average (High)
Interest	Equal or more interested in another field (Low)	STEP-OUTS (*n* = 38, 11%) Retained 21% Switched units 29% Left university 50%	SEARCHER (*n* = 36, 10%) Retained 67% Switched units 25% Left university 8%
	More interested in engineering than any field (High)	STRUGGLERS (*n* = 102, 29%) Retained 61% Switched units 15% Left university 24%	STARS (*n* = 176, 50%) Retained 94% Switched units 3% Left university 2%

Implicit Beliefs and Effort Beliefs

Examined implicit Beliefs about intelligence and effort beliefs of freshman engineering students during their first semester.

- Positive effort belief was associated with GPA
- At the end of the first semester engineering students reflected that the role of effort would play in undergraduate course work was less than what they had anticipated at the beginning of the semester.
- Incremental beliefs about intelligence did not predict academic achievement.

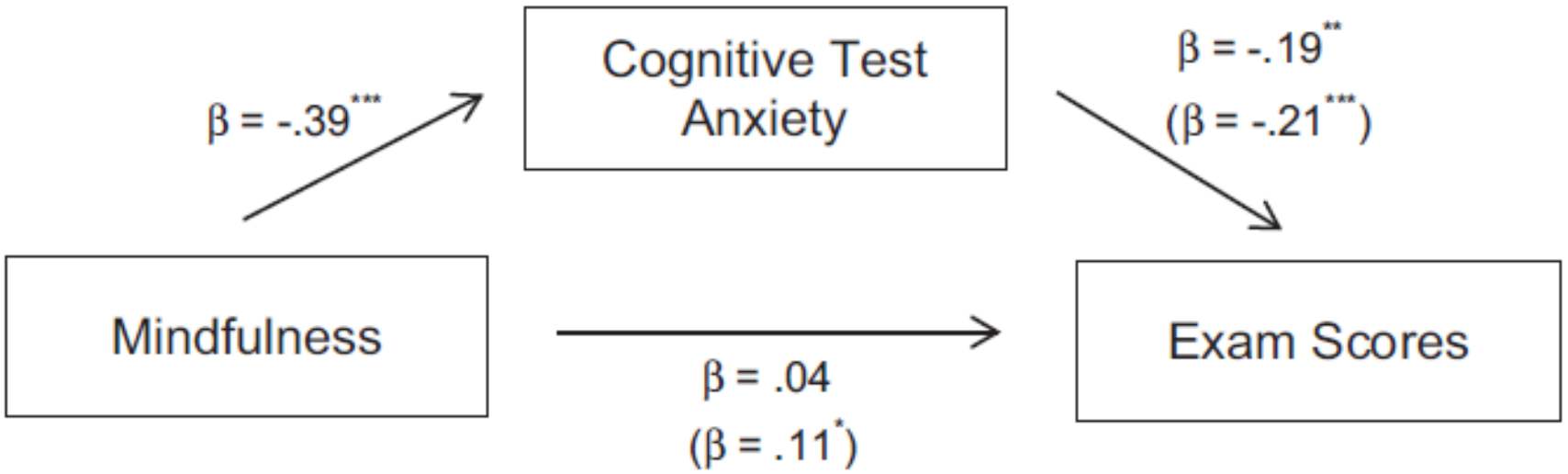
Snyder, K. E. , et al. (2018). "Navigating the First Semester: An Exploration of Short-Term Changes in Motivational Beliefs Among Engineering Undergraduates." Journal of Engineering Education **107(1): 11-29.**

Social-Belonging

Social Belonging:

- ✓ A social-belonging intervention effected a change in **perceptions of belonging** among underrepresented students in engineering.
- ✓ The intervention did not benefit **academic outcomes**, such as grades or retention.

Tests anxiety



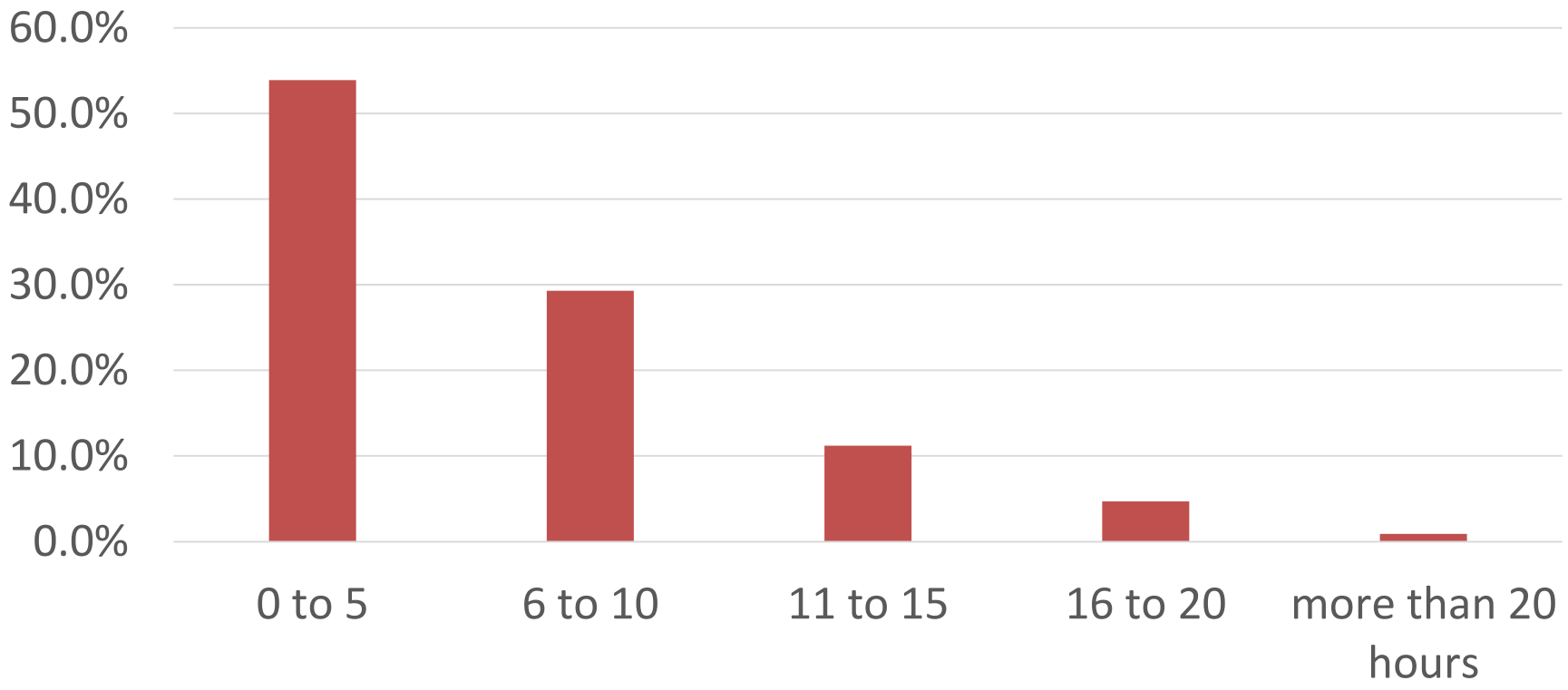
Mindfulness had a significant indirect effect on Exam scores through the mediator of Cognitive Test Anxiety

Bellinger, D. B., DeCaro, M. S., & Ralston, P. A. S. (2015). Mindfulness, anxiety, and high-stakes mathematics performance in the laboratory and classroom. *Consciousness and Cognition*, *37*, 123-132. http://dx.doi.org/10.1016/j.concog.2015.09.001.

INSTITUTIONAL IMPACT

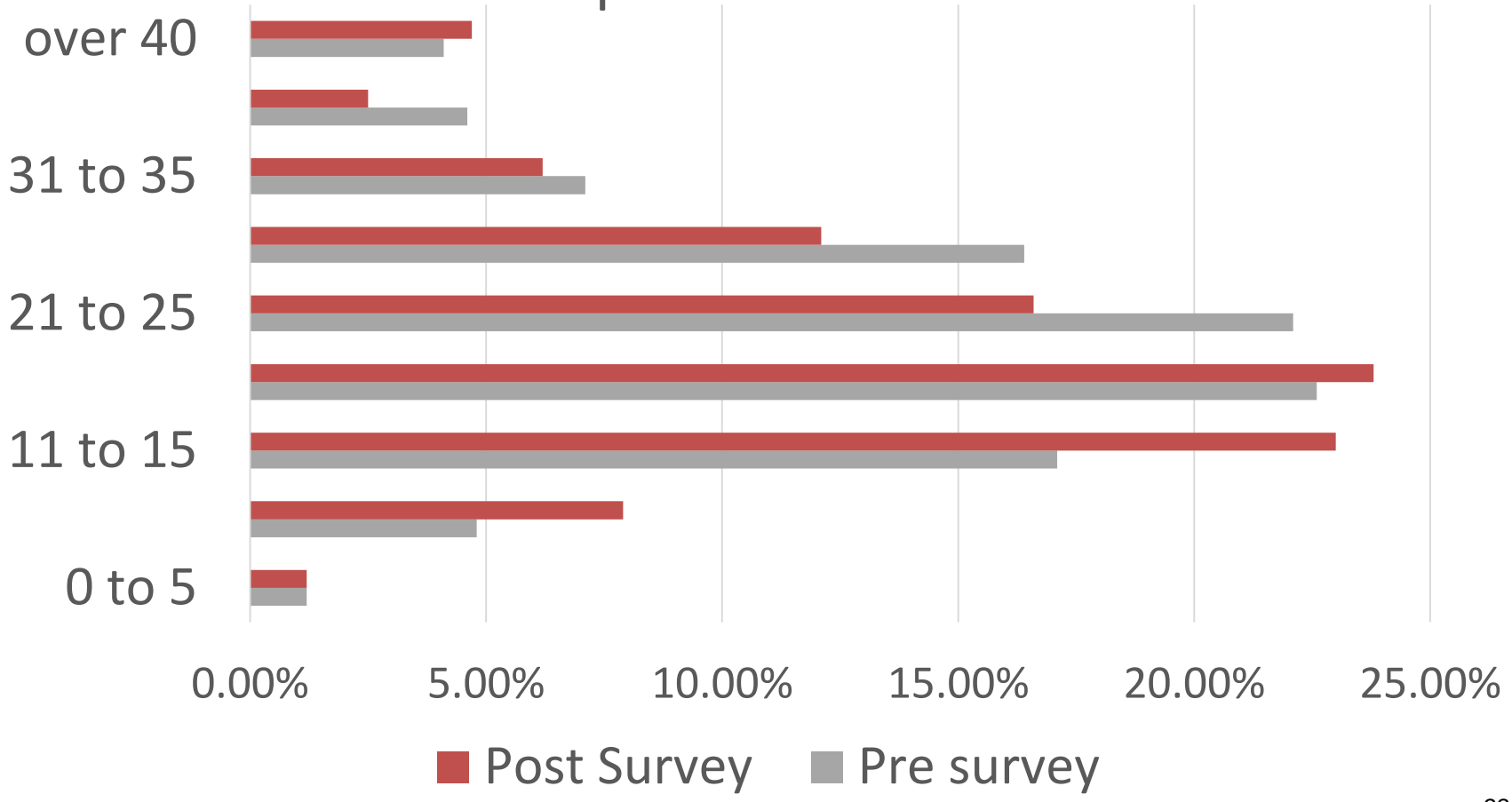
Time spent studying in High School

How many total hours a week of homework/study time did it take for you to be successful in high school?



Pre and Post Survey

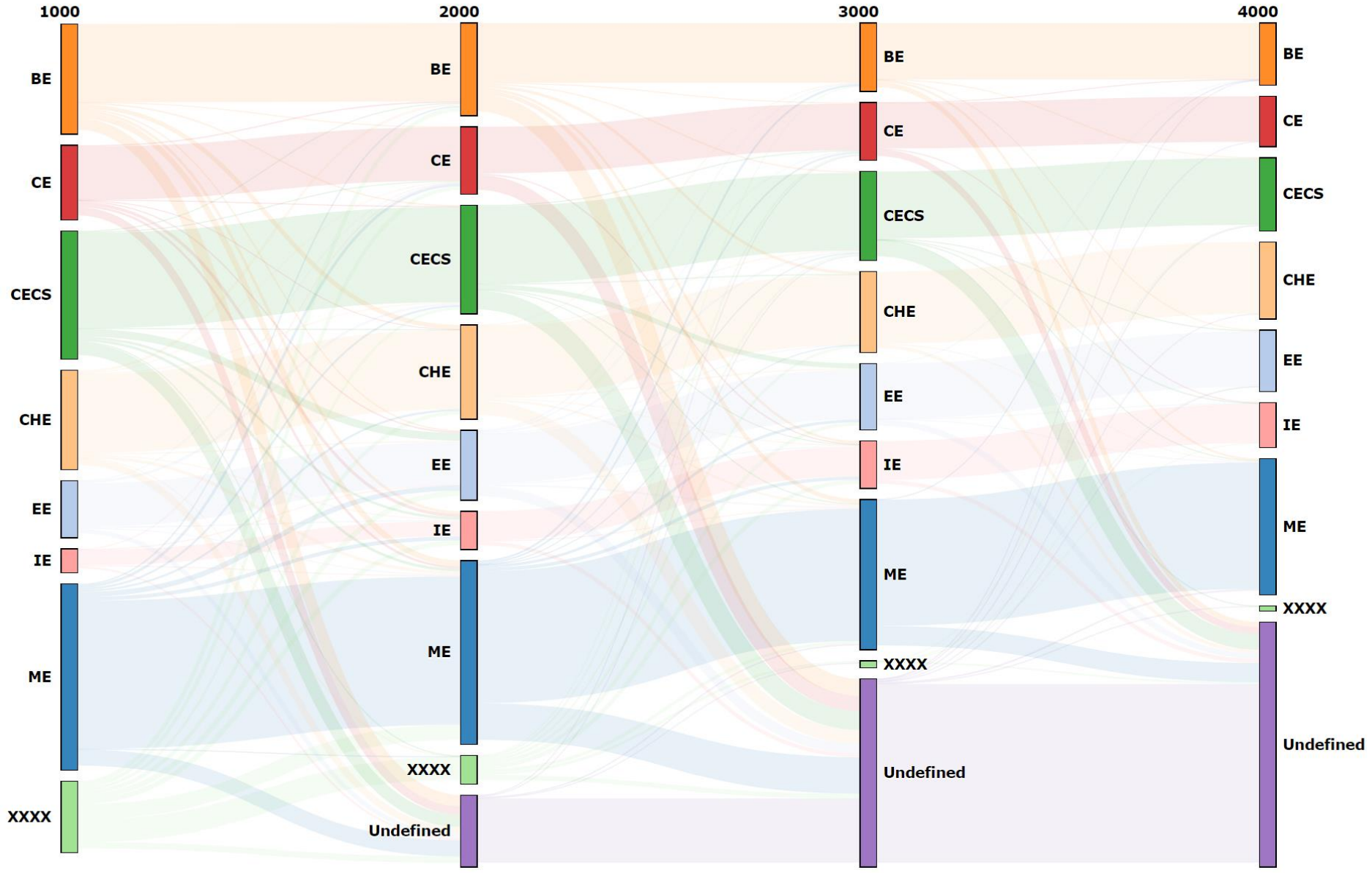
How many total hours a week of homework/study time do you expect to study and do homework to be successful in Speed School?



Introduction To Engineering

- Topics:
  - Engineering profession and ethics
  - Diversity
  - Critical Thinking
  - Engineering Departments
- Survey results support
  - Measuring some course outcomes
  - Informing course improvements

Student Retention by Major



Revision to First Year Curriculum

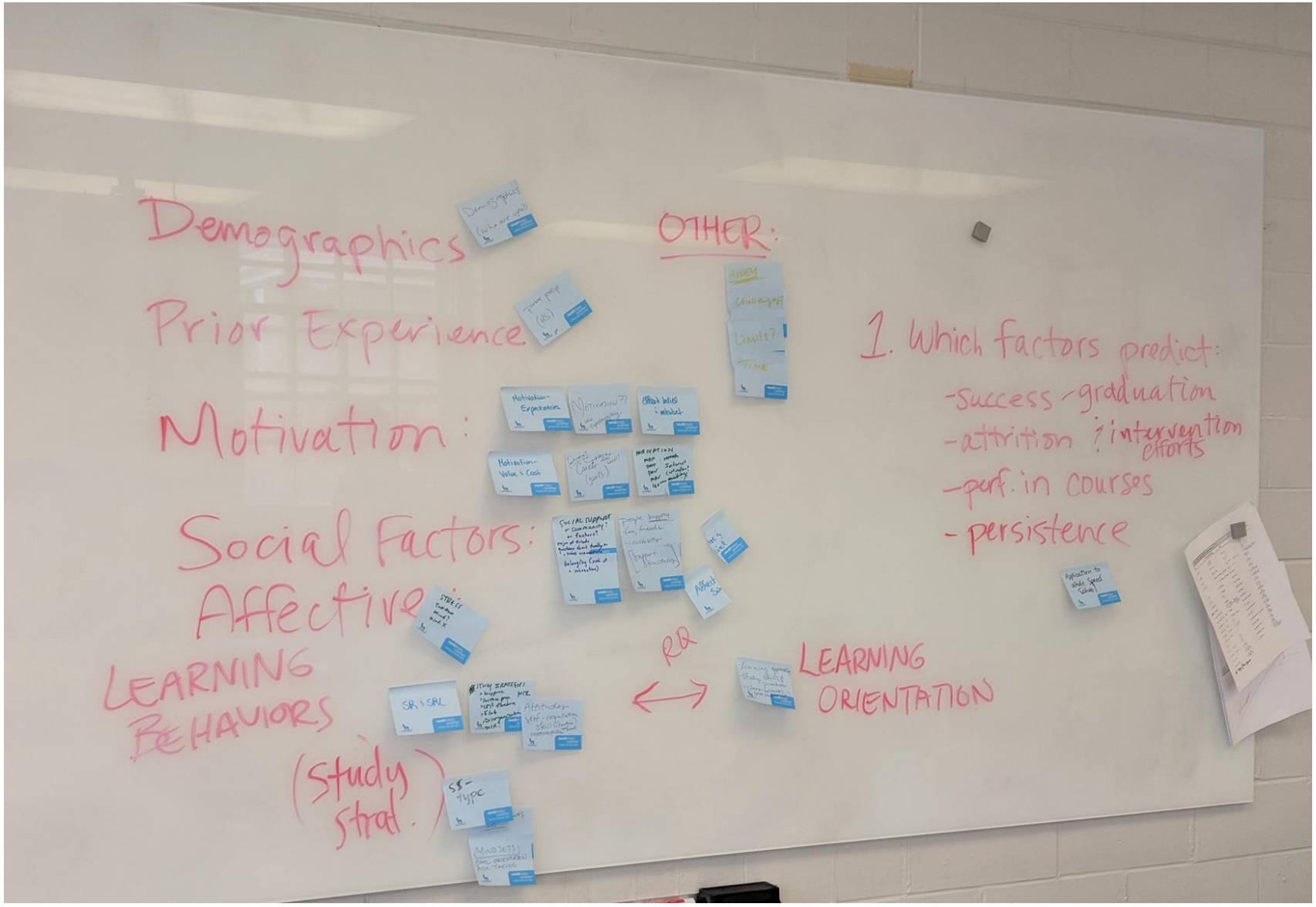
- Common first year (almost)
- Two new courses to replace Introduction to Engineering
  - Engineering Tools, Methods and Practices I & II

Update to Demographic Data

- Each year need:
  - Current Unit, Current Academic Plan
  - Current GPA, Current hours
  - Degree (started in 2014)

- 2017-2018
  - Worked with IR to implement a semester update model with low overhead.
  - Added new items including grade in specific courses.

Factor Reduction



Core Factors

1. Motivation
2. Prior Experience
3. Demographics (Self-reported)
4. Test Anxiety
5. Study Strategies
6. Outcomes (Post-survey Only)

Future Directions

- Retrospective studies
  - Is psychological cost a predictor of performance/retention in Cohorts F13 and F14?
  - Did PLTW experience predict anything F16, F17?
  - Is psychological cost a predictor of performance/retention in Cohorts F13 and F14?
- Use Data Science to analyze combinations of surveys and demographic data
  - Currently building a Data Model

Thanks you

QUESTIONS