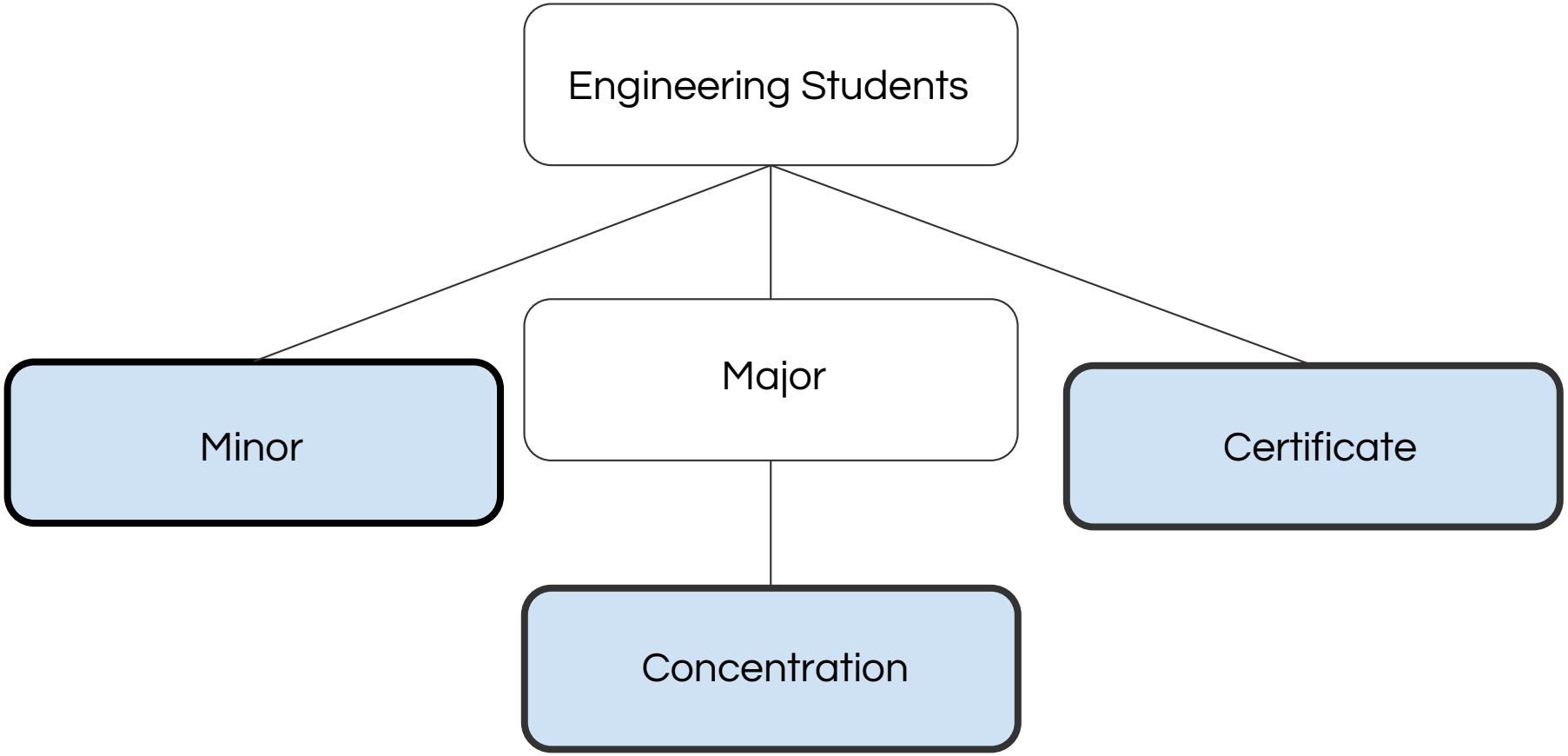
Business Program Participation and Engineering Innovation:

An Exploration of Engineering Students' Minors, Certificates, and Concentrations

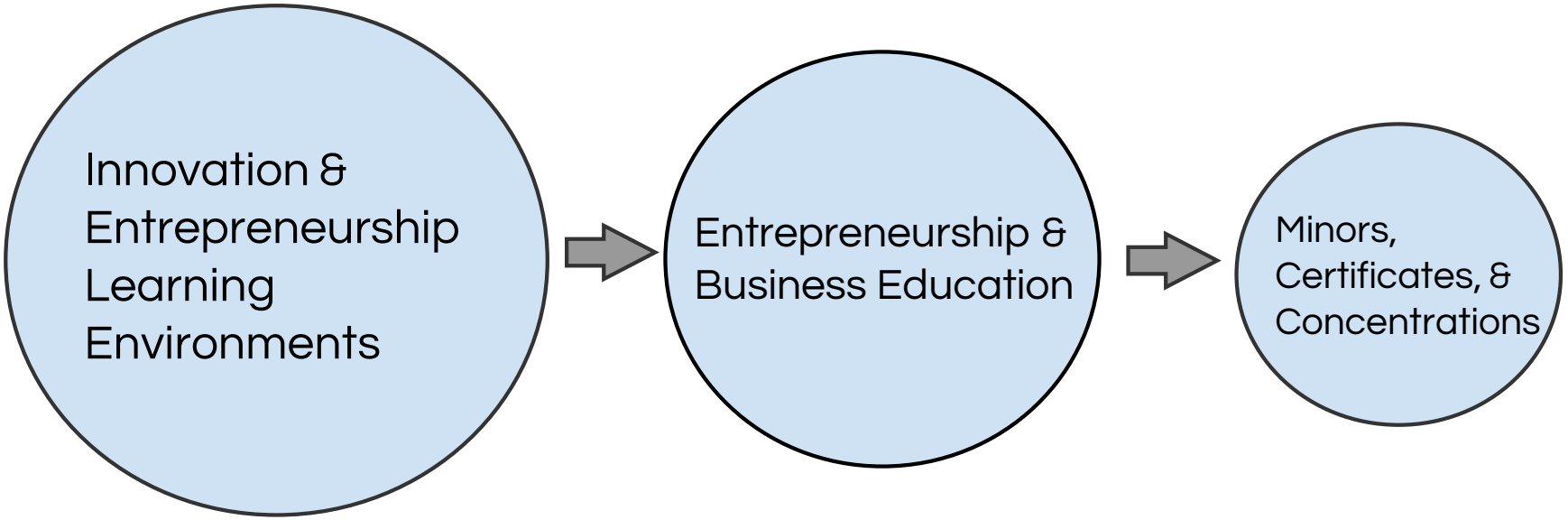
Entrepreneurship & Engineering Innovation Division Technical Session 6

Research Team:
Emily Cao, Shannon Gilmartin, Qu Jin, Carolin Dungs, Sheri Sheppard
Stanford University

We start with a more detailed look into engineering students' academic program participation (within and around their major).



Many engineering schools are introducing entrepreneurship and business education into coursework.



To understand the role and effectiveness of Innovation and Entrepreneurship (I&E) learning environments in engineering programs—specifically, those formal business programs offered through dedicated minors, certificates, and concentrations—it is valuable to assess the characteristics and career goals of engineering students who pursue these types of opportunities.

Primary research questions:

1. What are characteristics of engineering students who are pursuing business-related minors, concentrations, and certificates?

2. Are these students more likely to be involved in entrepreneurship-related and other extra and co-curricular activities?

3. Do these students have higher (or lower) innovation self-efficacy than do other engineering students?

4. Is there a difference in innovation-related career goals between these students and their peers?

Data Collection: The Engineering Majors Survey (EMS)

Designed to measure a range of undergraduate learning experiences that may influence students' beliefs about their ability to innovate

When: February-March 2015

Distributed to: Over 30,000 engineering juniors and seniors at 27 colleges and universities in the U.S.

Respondents: 7,197 engineering students

EMS Questions

[]5b. Are you pursuing a concentration or topical track within this major? *

Please choose **only one** of the following:

- ○ No
- ○ Yes
- ○ I prefer not to answer

[]What is the concentration or topical track in which you are enrolled? (Please enter the name of your concentration or topical track area in the space provided.)

Only answer this question if the following conditions are met:
Answer was 'Yes' at [S1Q5b]' (5b. Are you pursuing a concentration or topical track within this major?)

Please write your answer(s) here:

Name of concentration/topical track: _____

EMS Questions

[]7. In addition to your major(s), are you pursuing a minor or certificate for academic credit? *

Please choose **all** that apply:

- ☐ No
- ☐ Yes, a minor
- ☐ Yes, a certificate
- ☐ I prefer not to answer

[]What is the minor program in which you are enrolled?

Only answer this question if the following conditions are met:
Answer was 'Yes, a minor' at
[S1Q7]' (7. In addition to your major(s), are you pursuing a minor or certificate for academic credit?)

Please write your answer(s) here:

Name of program:

[]What is the certificate program in which you are enrolled?

Only answer this question if the following conditions are met:
Answer was 'Yes, a certificate' at [S1Q7]' (7. In addition to your major(s), are you pursuing a minor or certificate for academic credit?)

Please write your answer(s) here:

Name of program: ____

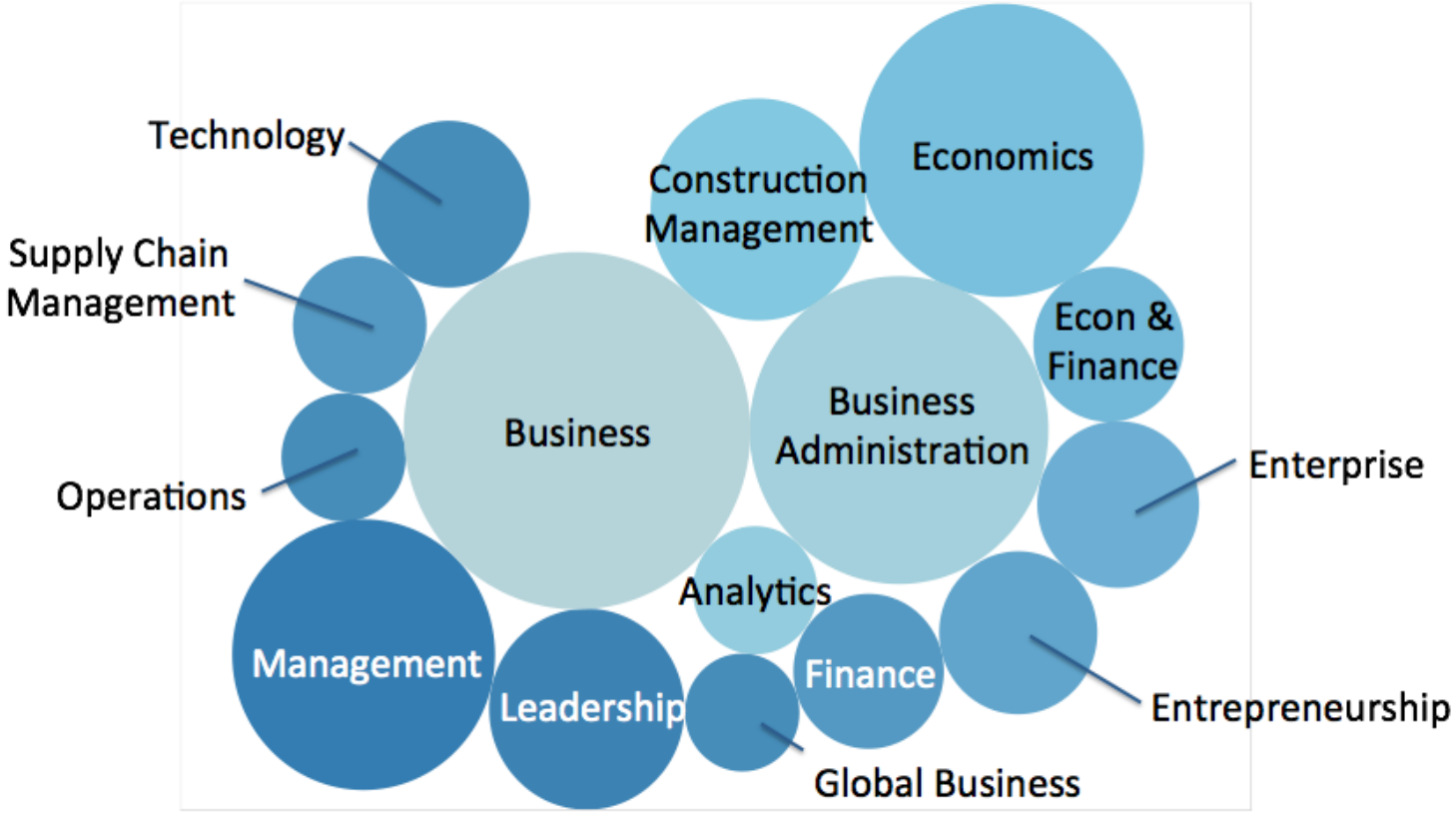
Respondents

7,197 respondents marked one of 39 engineering majors:

36% indicated pursuing a concentration within their major
27% pursuing a minor
5% pursuing a certificate

7% of respondents indicated pursuing a business-related concentration, minor, or certificate

Frequency of Business Programs

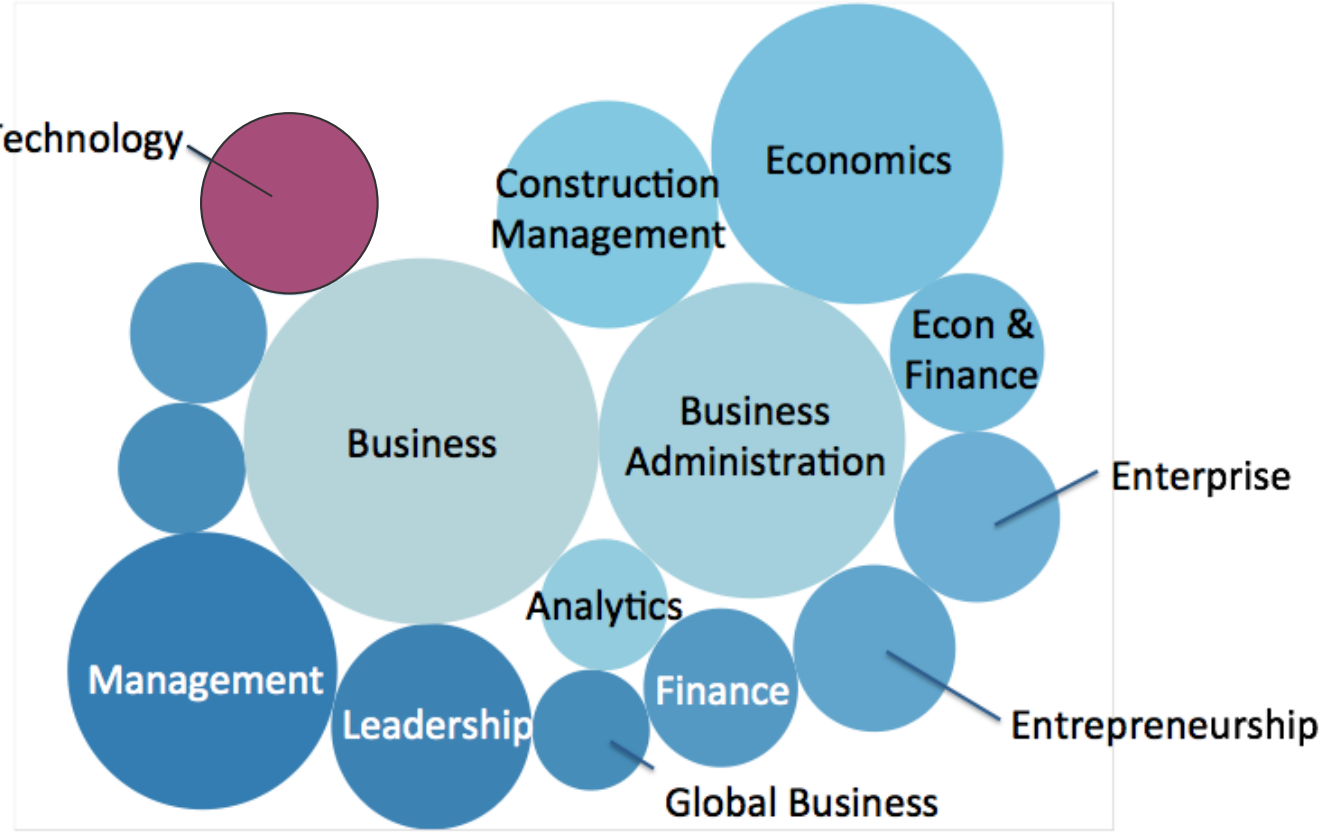


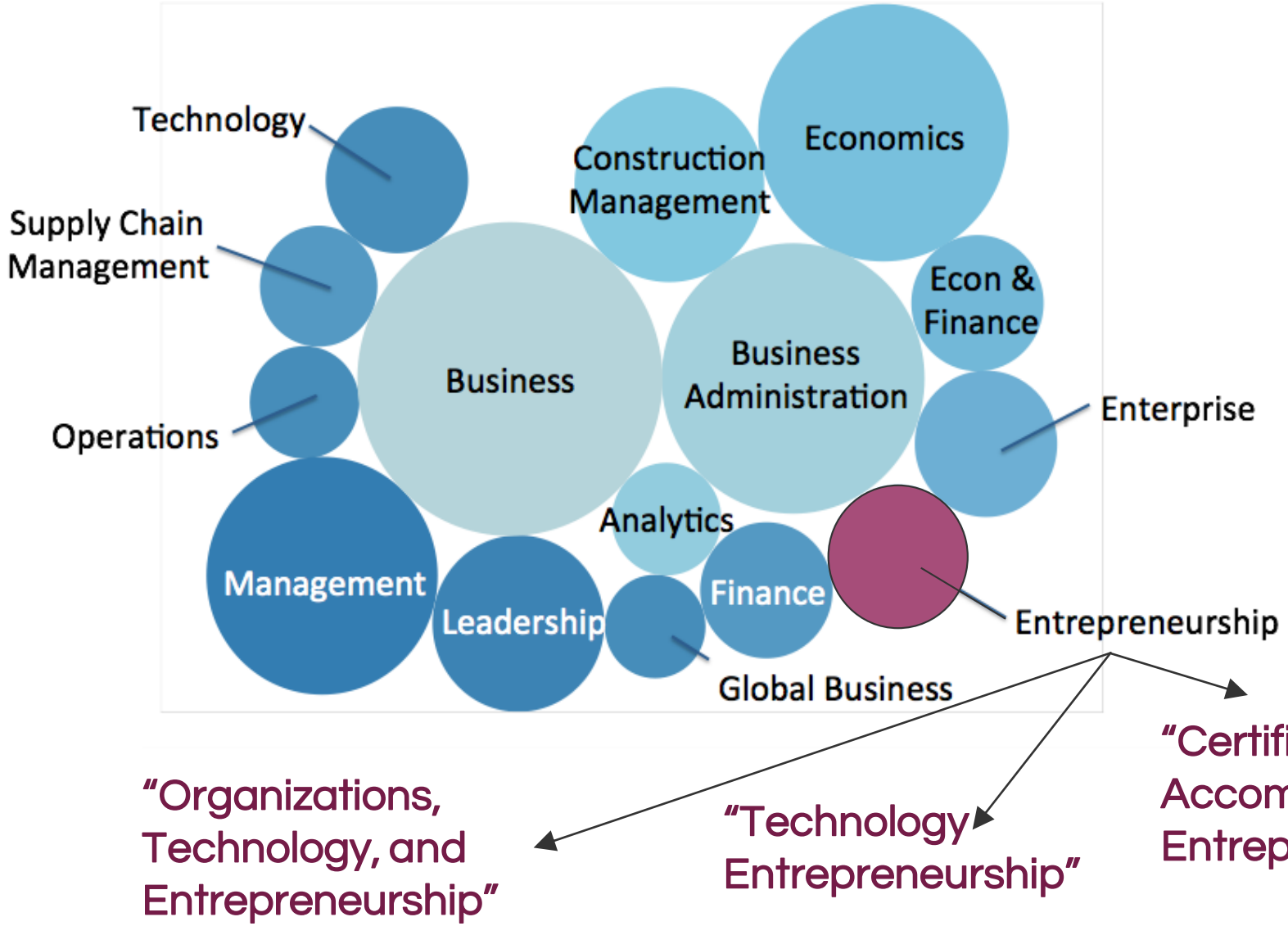
Examples of Write-In Responses

"Technology Commercialization"

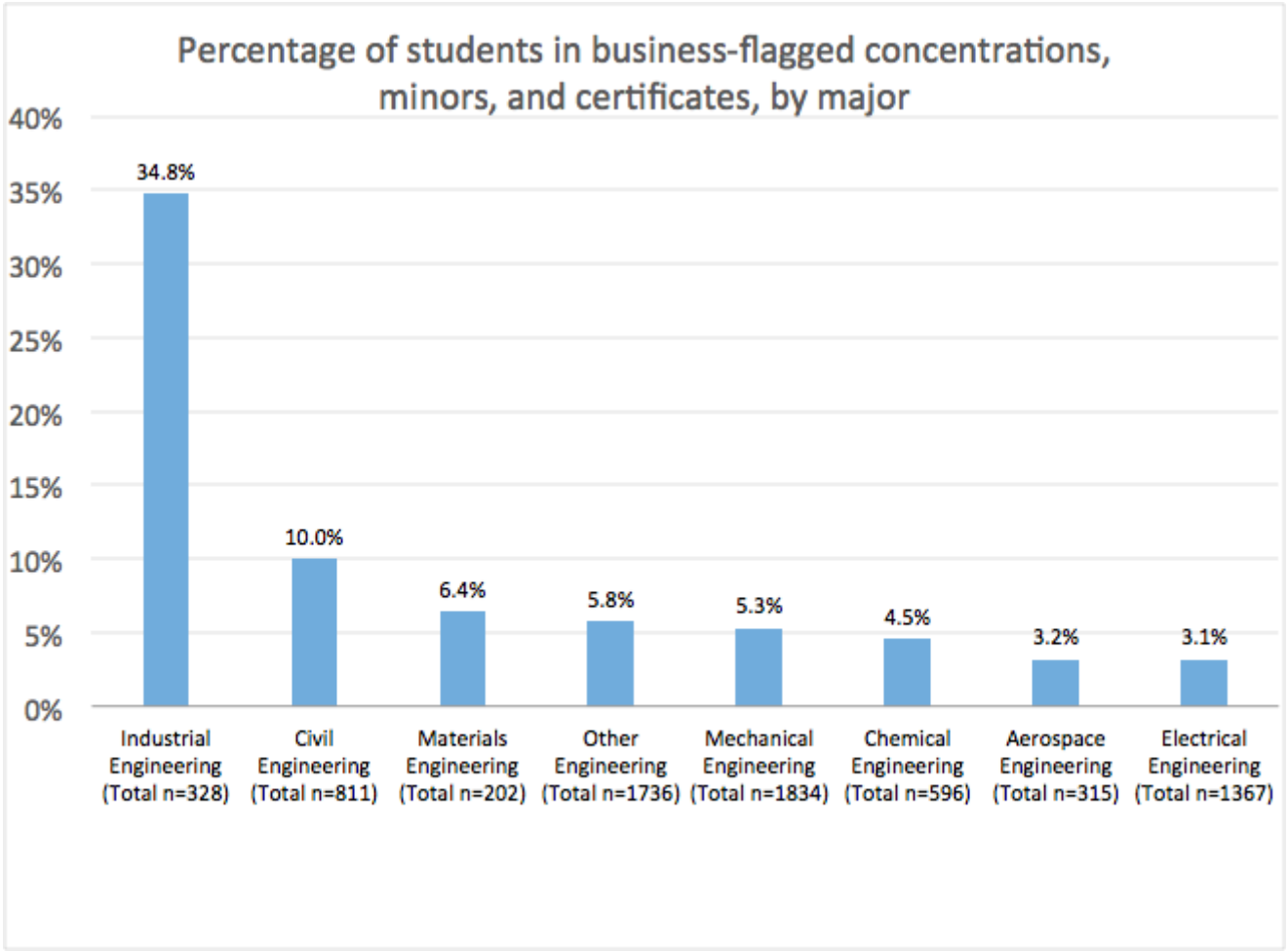
"Technology & Management"

"Manufacturing Technology & Management"




Technology
Supply Chain Management
Operations
Management
Leadership
Global Business
Finance
Analytics
Business
Business Administration
Construction Management
Economics
Econ & Finance
Enterprise
Entrepreneurship
"Organizations, Technology, and Entrepreneurship"
"Technology Entrepreneurship"
"Certificate of Accomplishment in Entrepreneurship"

1. Characteristics of engineering students pursuing business programs



2. Are these students more likely to be involved in entrepreneurship related activities?

Leadership Involvement

Have you:	Business Flagged %	Not Flagged %	P-value
Led a student organization	36.9%	25.1%	< .001
Started or co-founded a student club or other student group on campus	12.1%	8.4%	0.008
Started or co-founded your own for-profit or non-profit organization	5.8%	2.3%	< .001

Participation in Clubs & Organizations

Have you:	Business Flagged %	Not Flagged %	P-value
Participated in a business or entrepreneurship club	19.2%	6.6%	< .001
Participated in a community service-based club	29.4%	23.6%	0.006
Participated in other student clubs or groups in engineering	49.7%	43.4%	0.01
Participated in other student clubs or groups outside of engineering	51.4%	43.1%	0.001

Among the extra- and co-curricular activities we tested, we **did not** find any difference between flagged and non-flagged students in the following items:

Design:

- Participation in a design club
- Participation in a design or invention competition
- Usage of a maker space/design or inventors studio/prototyping lab

Robotics:

- Participation in a robotics club

Career:

- Attendance of a career related event or meeting (e.g., a college career fair, a one-on-one meeting with a career counselor)

Social:

- Participation in a social entrepreneurship/social innovation competition

3. Do these students have higher (or lower) innovation self-efficacy than do other engineering students?

4. Is there a difference in innovation-related career goals between these students and their peers?

Innovation Self-Efficacy (ISE)

Innovation Self-Efficacy is measured using a scale with six items asking respondents how confident they are in doing the following tasks:

1. Ask a lot of questions
2. Generate new ideas by observing the world
3. Experiment as a way to understand how things work
4. Actively search for new ideas through experimenting
5. Build a large network of contacts with whom you can interact to get new ideas for new products or services
6. Connect concepts that appear, at first glance, to be unconnected

Career Goals: Innovative Work (CGIW)

The Career Goals-Innovative Work scale asks respondents to report the importance they ascribe to being involved in the following activities in the first five years after graduation:

1. Searching out new technologies, processes, techniques, and/or product ideas
2. Generating creative ideas
3. Promoting and championing ideas to others
4. Investigating and securing resources needed to implement new ideas
5. Developing plans and schedules for the implementation of new ideas
6. Selling a product or service in the marketplace

Differences are significant but small…
(average score on 0-4 scale)

	Business Flagged Mean	Not Flagged Mean	P-value
Innovation Self-Efficacy (ISE)	2.7	2.3	< .001
Career Goals-Innovation Work (CGIW)	2.7	2.5	0.001

Summary of Findings

- 7% of all engineering students are in business-related minor, certificate, and concentration programs- with the highest participation rate among industrial engineering majors
- They tend to have greater involvement in entrepreneurship- and leadership-related activities on campus – but not in design activities and career development activities
- Their ISE and CGIW scores are statistically, but maybe not practically, different from scores among other students

Limitations and Implications

These business program participants are likely a self-selected group of students, assumed to already have an interest in business, leadership, management, or entrepreneurship. Future research might explore the "net" effect of participation vis-à-vis a longitudinal design with comparison groups.

Other outcomes besides innovation self-concept and goals should be explored. Limitation: Wide variation in program goals and missions.

Future research could examine what common innovation and entrepreneurship learning objectives are found in existing business programs. Integrating these learning objectives into "core" engineering coursework would provide a more comprehensive look at the effects of I&E on engineering students.

Acknowledgements

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