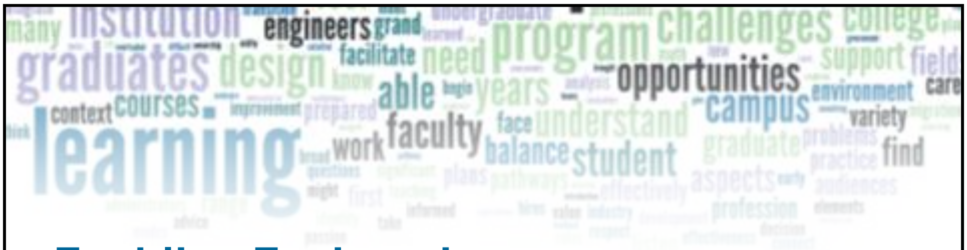

Enabling Engineering Student Success

Using Research to Inform Engineering Education Decisions

Cynthia J. Atman and Jennifer Turns

Center for the Advancement of Engineering Education
Center for Engineering Learning & Teaching, University of Washington

Wednesday, October 27, 2010, 11:00 am
National Science Foundation

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CENTER FOR THE ADVANCEMENT OF ENGINEERING EDUCATION

Center for the Advancement of Engineering Education

- Academic Pathways Study
- Studies of Engineering Educator Decisions
- Engineering Teaching Portfolio Program
- Institute for Scholarship on Engineering Education

- 7-year grant
- 100+ researchers at 16 institutions

CAEE Leadership team: Robin Adams, Cynthia Atman, Sheri Sheppard, Lorraine Fleming, Larry Leifer, Ronald Miller, Barbara Olds, Karl Smith, Reed Stevens, Ruth Streveler, Jennifer Turns

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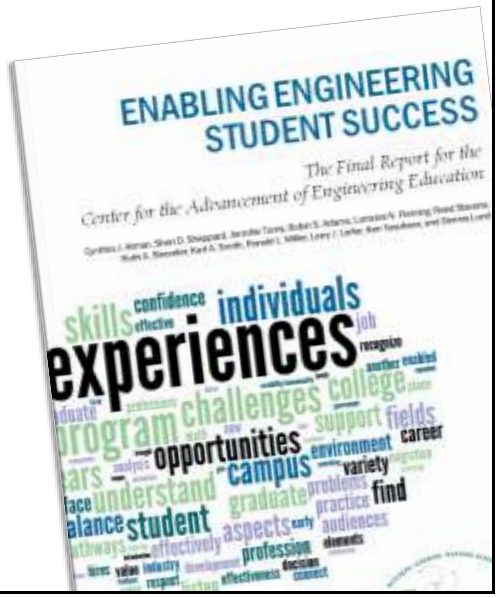
CAEE Final Report

- Available at
  www.engr.uw.edu/caee



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Talk overview

1. FACULTY

Studies of Engineering Educator Decisions (SEED)

2. STUDENTS

Academic Pathways Study (APS)

3. INFORMING TEACHING DECISIONS

Talk overview

1. FACULTY

Studies of Engineering Educator Decisions (SEED)

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3. INFORMING TEACHING DECISIONS

Teaching decisions

DECISION

- Decision as a commitment to action
- Outline
  - What and why
  - Our Study
  - Findings

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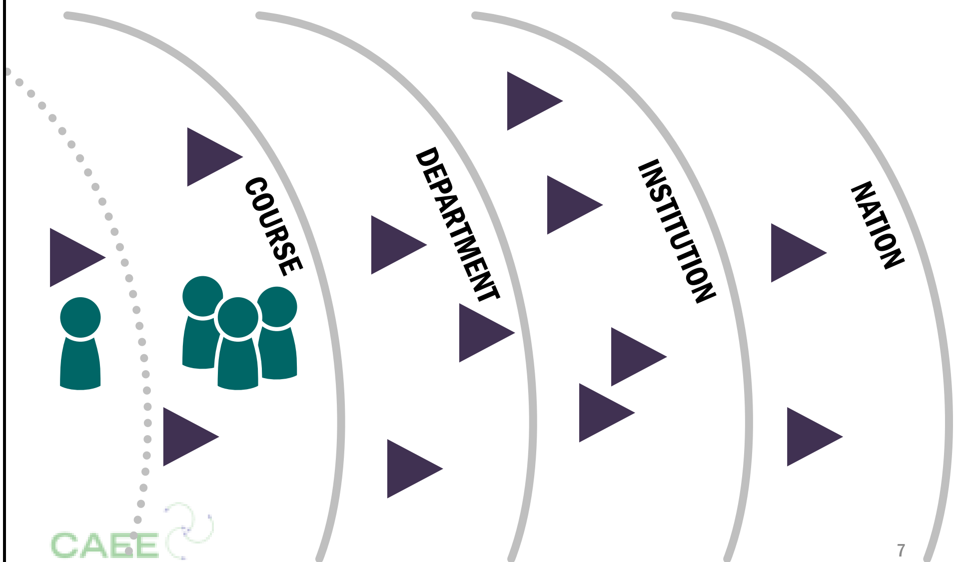
1. FACULTY

Teaching decisions



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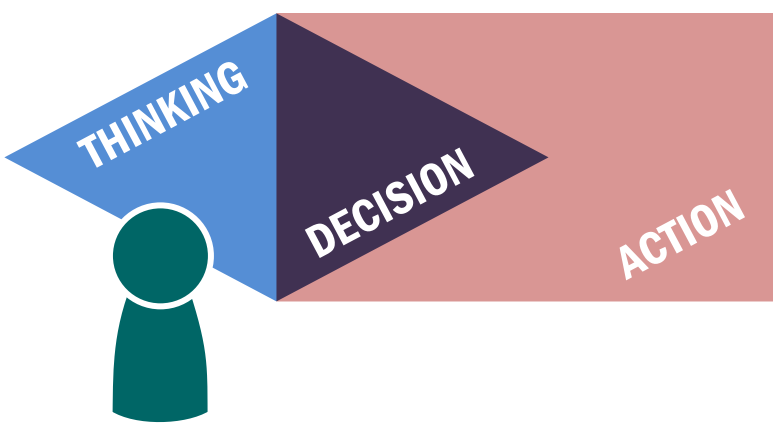
1. FACULTY

Why teaching decisions?



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Studies of Engineering Educator Decisions (SEED)

- Approach
  - Critical decision method interview: A planning and an interactive decision; also demographics, teaching history, process for making decisions
  - 31 participants, all ranks, 9 of 10 departments, volunteer
  - One-hour interviews

General findings

- All but one educator responded by talking about decisions.
- References to time were pervasive.
- Few information sources were mentioned.
- Faculty talked about engaging in *some* teaching practices that are theoretically linked to motivation.

How do the educators take learners into account in their teaching decisions?

- Why: Being "learner-centered" is a best practice, yet has divergent meanings
  - From *How People Learn:* Effective learning environments are learner-centered…
  - From research on teaching conceptions: More effective teachers have "learner-centered" rather than "instructor-centered" conceptions.
- Can we explore learner-centeredness with our data?

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Differentiating based on learner characteristics

- Knowledge (18 of 31)
- Behavior (29 of 31)
- Educational classifications (22 of 31)
- Social classifications (14 of 31)

⟹ Faculty in this sample ***were*** taking learners into account. How can we help with a next step?…

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1. FACTURLY

Challenges in learner-centered decision-making

- Learner information is only one type of information.
- Limited time to get to know students
- …
- What can faculty know about students?

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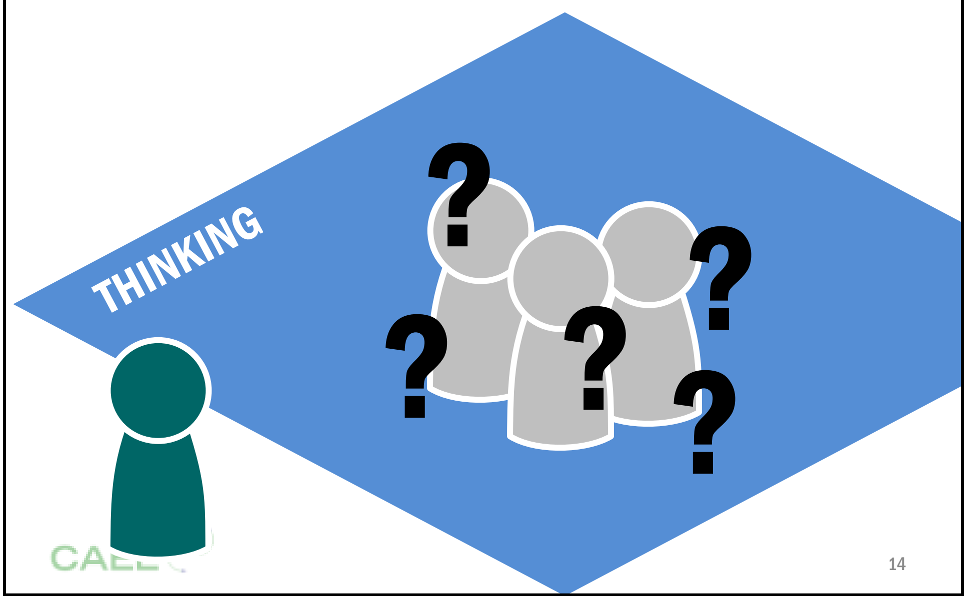
1. FACULTY 2. STUDENTS

What can we know about students?



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Talk overview

1. FACULTY

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2. STUDENTS

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3. INFORMING TEACHING DECISIONS

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2. STUDENTS

Academic Pathways Study (APS)

- **APS lead:** Sheri Sheppard
- **APS team:** Cynthia Atman, Lorraine Fleming, Ronald Miller, Karl Smith, Reed Stevens, Ruth Streveler

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APS research methods & samples

- N NSSE national sample (2002, 2006–2007)
  - National Survey of Student Engagement
  - *N* = 11,819; matched pairs (first-year and senior) from 247 institutions
- L Longitudinal cohort (2003–2007)
  - Surveys, structured interviews, ethnographic interviews and observations, engineering design tasks
  - *N* ≈ 160,* from four campuses
- B Broad national sample (Spring 2008)
  - APPLES2 survey
  - *N* = 4,266,* cross-sectional sample from 21 engineering colleges
- W Workplace cohort (2007–2008)
  - Interviews
  - *N* = 101, early-career engineers at a range of private and public organizations

*Oversampled for underrepresented groups

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SELECTED APS FINDINGS

Successful engineering students

- Learning skills and language of engineering, e.g., teamwork, communication
- Becoming more confident with design
- Developing identity as engineers
- Better understanding what engineers do, e.g., through co-ops, internships
- Good persistence rates, but little in-migration

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SELECTED APS FINDINGS

Challenges

- Heavy workload, competitive culture
- Disconnect between early math/science courses and "real engineering"
- Difficult transition from individual work on "textbook" problems to teaming on open-ended problems
- Gendered experiences, confidence

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Which three are the most important?

Contemporary issues	Life-long learning
Societal context	Data analysis
Global context	Math
Conducting experiments	Creativity
Professionalism	Design
Management skills	Ethics
Science	Engineering analysis
Business knowledge	Teamwork
Leadership	Communication
Engineering tools	Problem solving

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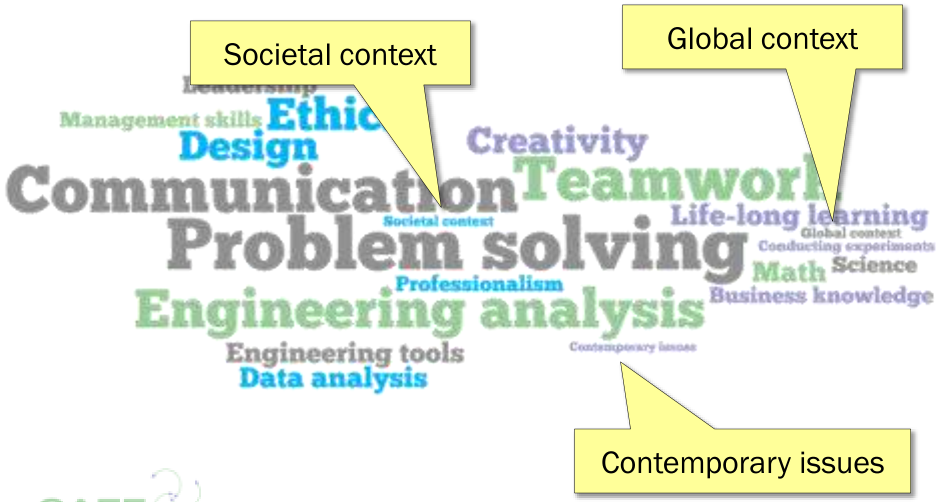
2. STUDENTS

Importance (seniors)



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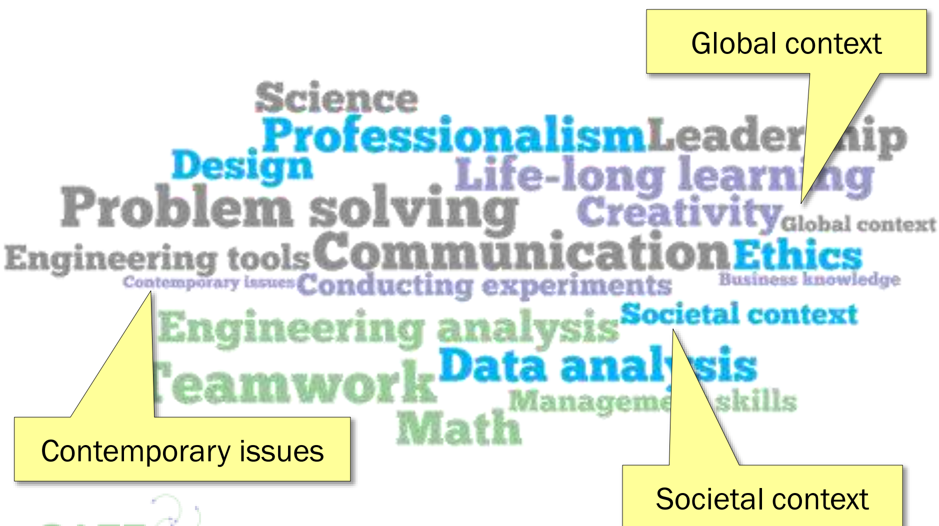
2. STUDENTS

Preparedness (seniors, self-report)



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2. STUDENTS

The well-rounded engineer

- Understanding engineering as discipline and profession
- Life-long learning

  "…the engineer of 2020 will learn continuously throughout his or her career, not just about engineering but also about history, politics, business, and so forth."
- Consideration of broader context

  "Successful engineers in 2020 will, as they always have, recognize the broader contexts that are intertwined in technology and its application in society."

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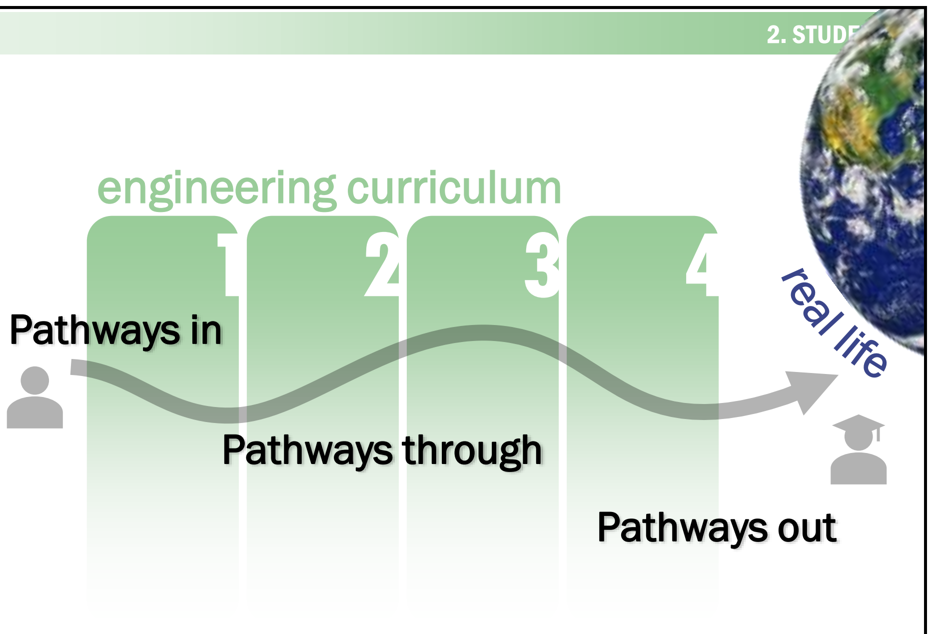
2. STUDENTS



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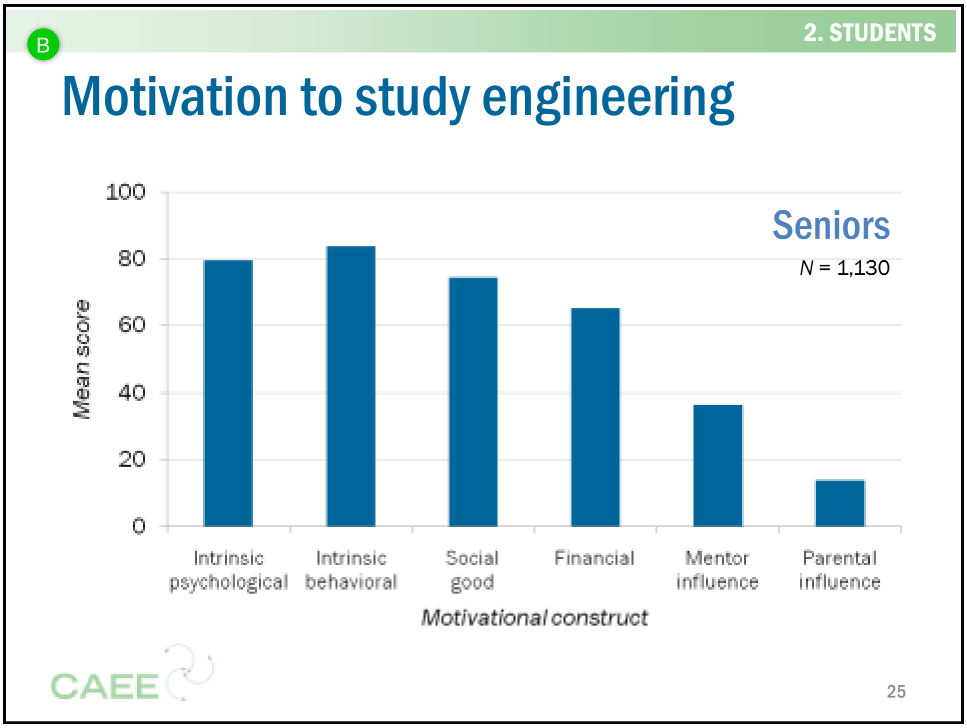
B
2. STUDENTS
Motivation to study engineering
Seniors
N = 1,130
100
80
60
40
20
0
Mean score
Intrinsic psychological
Intrinsic behavioral
Social good
Financial
Mentor influence
Parental influence
Motivational construct
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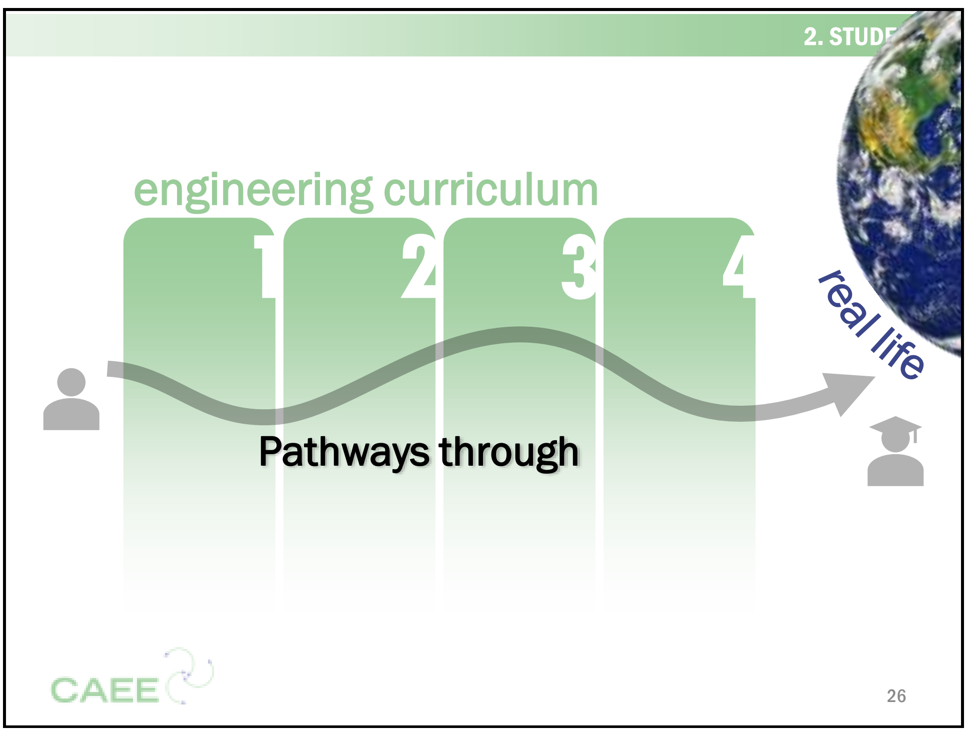
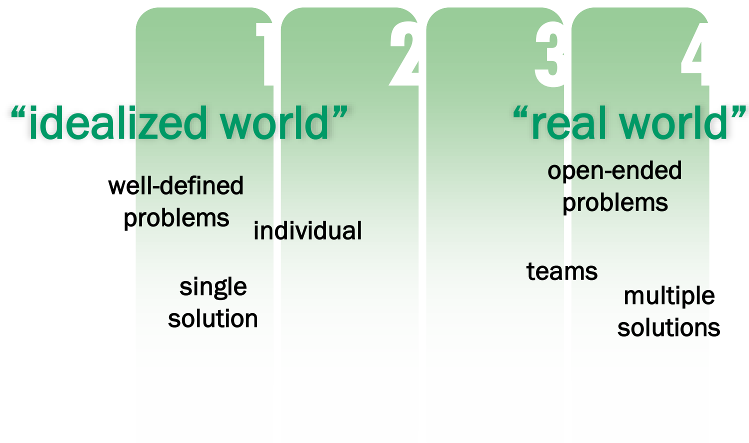

2. STUDE
engineering curriculum
1
2
3
4
real life
Pathways through
CAEE
26

2. STUDENTS

L

What counts as engineering?



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2. STUDENTS

N

ENGINEERING COMPARED WITH OTHER MAJORS

Engagement and outcomes scales

HIGH	LOW
First-year higher order thinking practices	First-year gains, general education
First-year gains, practical competence	Senior gains, personal & social development
Senior gains, practical competence	Senior integrative learning practices
	Senior reflective learning practices

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Important design activities, changes

down in Year 4	*up in Year 4*
Visualizing***	Identifying constraints***
Planning*	Iterating**
Communicating*	Modeling
Using creativity	Evaluating
Building	Prototyping
…	…

**p* < 0.05, ***p* < 0.01, ****p* < 0.001; *N* = 89

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Alternating design tasks

1. Midwest floods
2. Street crossing
3. Midwest floods
4. Street crossing

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L

Midwest floods design task

10-minute, paper-and-pencil design task

“Over the summer the Midwest experienced massive flooding of the Mississippi River. What factors would you take into account in designing a retaining wall system for the Mississippi?”

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L

Year 3 floods task responses

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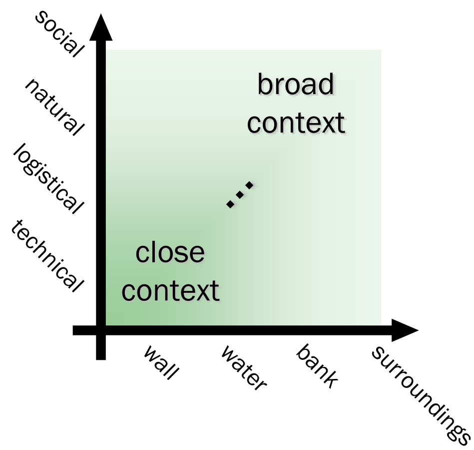
L

2. STUDENTS

Floods coding scheme



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2. STUDENTS

Close/broad contextual factors

- **Broad context** factors: social, natural, riverbank, surroundings, *etc.*
  - "aesthetic appeal – is it going to draw local complaint?"
  - "the surrounding habitat – make sure little or no damage is done to the environment"
  - "would wall impact use of the river by industry?"
- **Close context** factors: technical, wall, logistical, water, *etc.*
  - "cost of materials"
  - "check the budget available for the operation"
  - "how to contain the river water that has flooded out"

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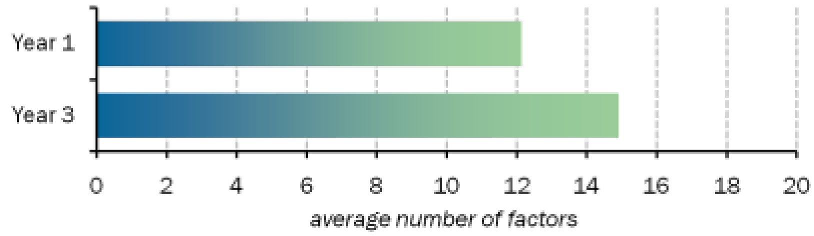
2. STUDENTS

More factors in Year 3



N = 69 (longitudinal sample)
p < 0.001 (total factors)

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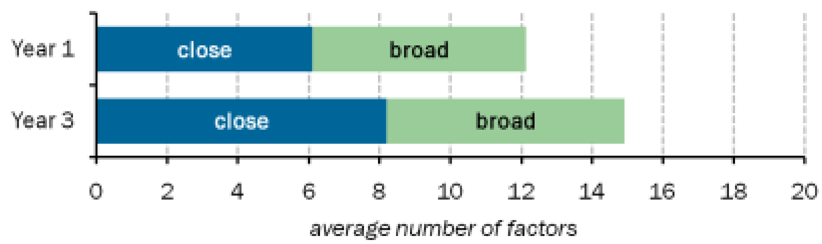
2. STUDENTS

More close context in Year 3



N = 69 (longitudinal sample)
p < 0.001 (total factors and close context factors)

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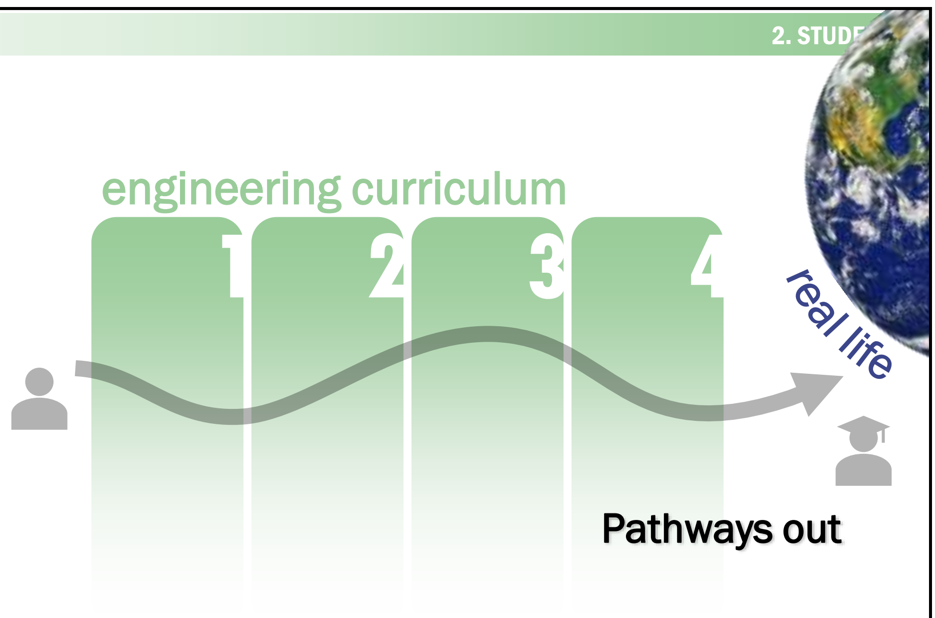
Gender differences

- Important design activities
  - Women were less likely to select *Building*, more likely to select *Seeking information* and *Goal setting*.
- Midwest floods
  - Women cited more factors than men.
  - Specifically, women cited more *broad context* factors than men.



2. STUDENTS

Early career engineers

- Perception of not doing a lot of “real engineering”

  “I don’t feel like I’ve had to actually do engineering”
- Problems highly uncertain, ambiguous, complex

  “In the real world, it’s a lot more difficult to model things…There’s a lot more variables involved…”
- More practical, hands-on work

  “There’s no mathematical formula you could use, like you would in school…”

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2. STUDENTS

The well-rounded engineer

- Understanding engineering as discipline and profession
- Life-long learning

  “…the engineer of 2020 will learn continuously throughout his or her career, not just about engineering but also about history, politics, business, and so forth.”
- Consideration of broader context

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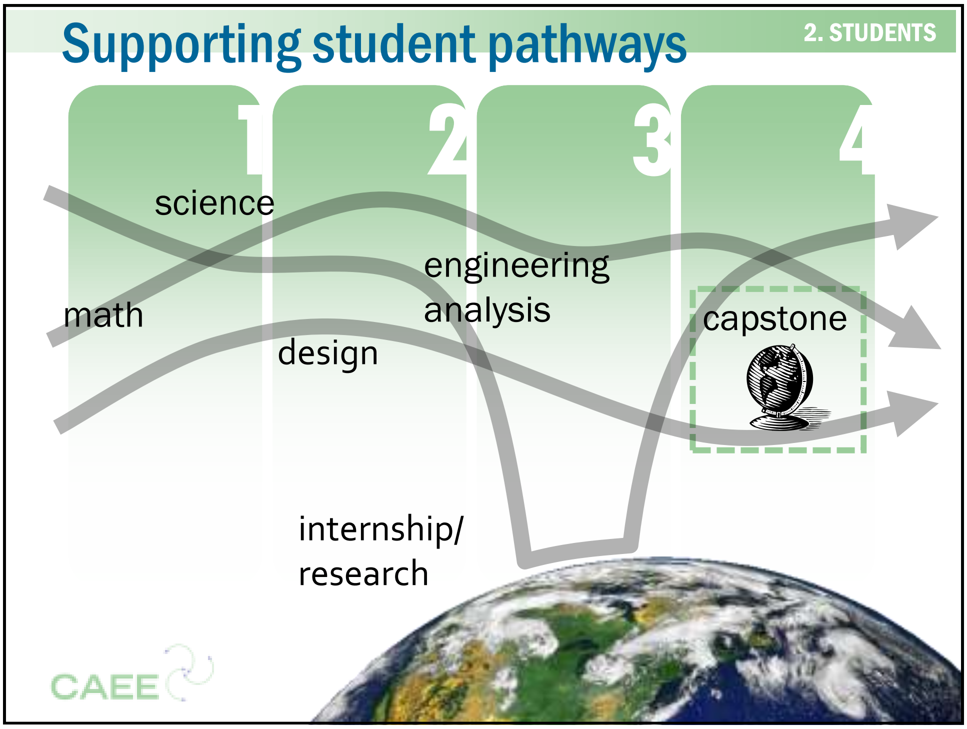
Supporting student pathways
2. STUDENTS
1
2
3
4
science
math
engineering
analysis
design
capstone
internship/
research
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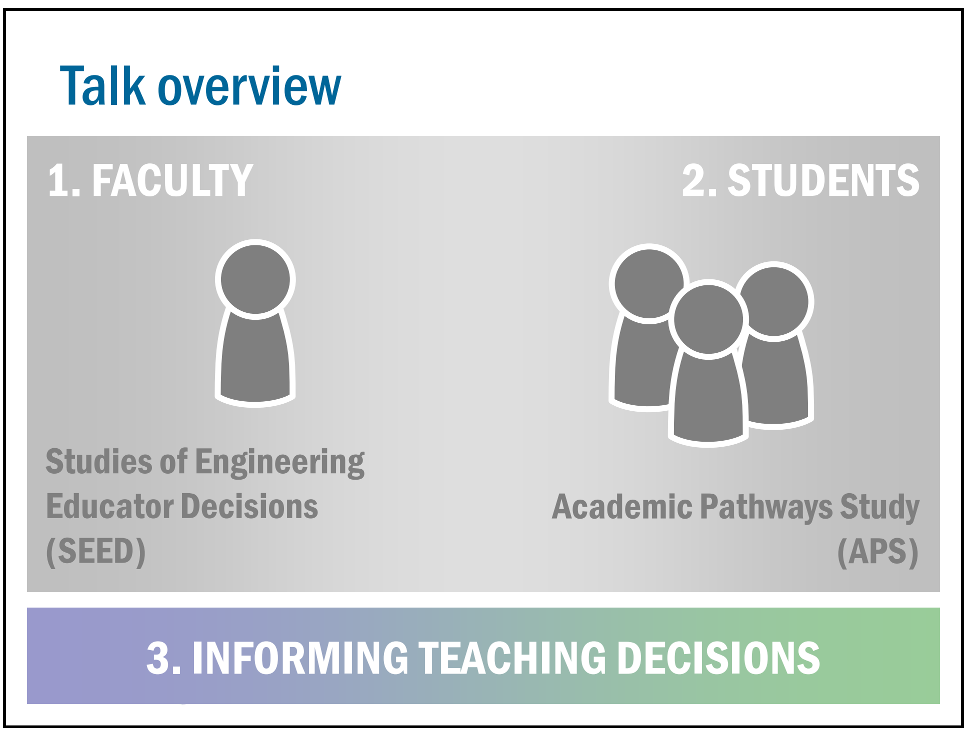
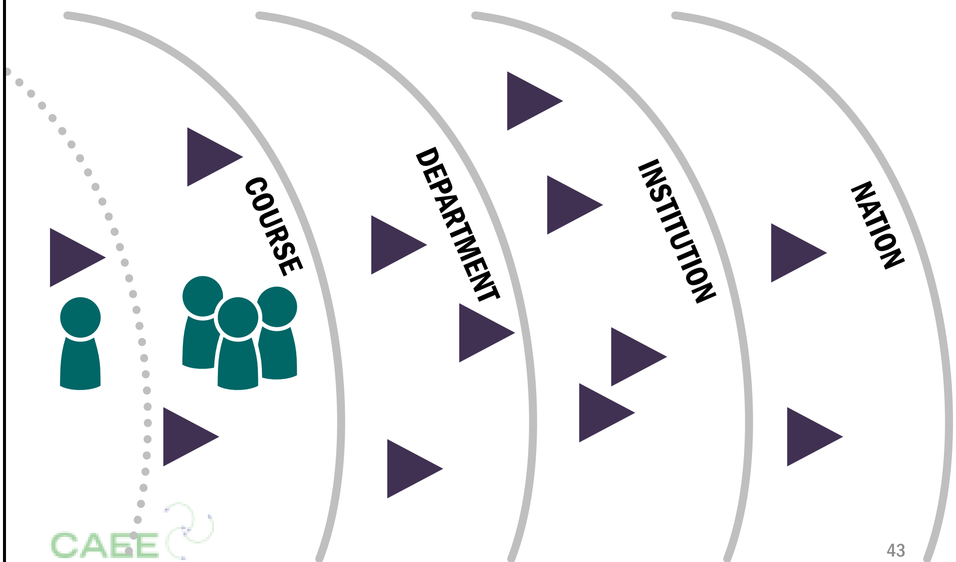

Talk overview
1. FACULTY
2. STUDENTS
Studies of Engineering
Educator Decisions
(SEED)
Academic Pathways Study
(APS)
3. INFORMING TEACHING DECISIONS

3. INFORMING TEACHING DECISIONS

Teaching decisions



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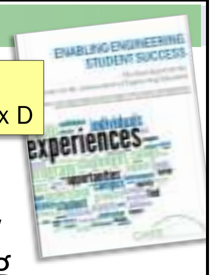
3. INFORMING TEACHING DECISIONS

Local Inquiry Questions

See Appendix D



- **Awareness of engineering careers:** Are there courses/programs that show students the wide range of engineering careers?
- How well do you understand **similarity and variability** in your students' motivation, background, interests, learning challenges, confidence, and future plans?
- How many areas **beyond math, science, and analysis** would students list as important components of engineering?

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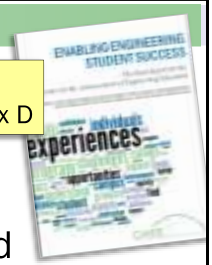
Local Inquiry Questions



See Appendix D

- Do your students consider global, environmental, societal, economic, and cultural **context in engineering design**?
- When and where do your students develop the skills required to be **self-directed learners**?
- Do you help your students **reflect** on their industry (*e.g.*, internship) and research experiences and **integrate** them into their understanding of the engineering profession?

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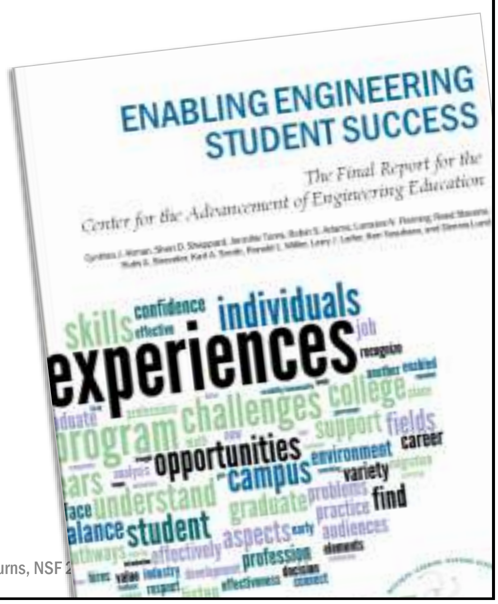
CAEE Final Report

- Available at **www.engr.uw.edu/caee**



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See the final report for references:

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