From Pipeline Thinking to Understanding Pathways: Findings from the Academic Pathways Study

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Overview of Paper

- Provides a broad summary of CAEE work from multiple methods through 2007
- Today’s presentation focuses on a few aspects of the students’ development of engineering knowledge and skills
Undergraduate engineering education

1. science
2. engineering
3. analysis
4. capstone
design

real life
Findings from the Paper

Large variation in student pathways...

• Reasons for choosing engineering
• Choosing to stay or go
• Navigation through curriculum
• Experience by gender
• Acquisition of engineering knowledge and skills
• Preparation for the “real world”
Today focusing on …..

*Large variation in student pathways…*

- Reasons for choosing engineering
- Choosing to stay or go
- Navigation through curriculum
- Experience by gender

➡️ Acquisition of engineering knowledge and skills

- Preparation for the “real world”
Acquisition of Engineering Knowledge and Skills

• Question: Are students learning to engineer?

• Describing
  ➔ Conceptions of design

• “What counts” as engineering knowledge
Conceptions of Design$^{1,2,3}$
Atman, Kilgore, Morozov, Yasuhara

*Of the twenty-three design activities below, please put a check mark next to the SIX MOST IMPORTANT...*

- Survey question administered in Years 1 and 4
- All four institutions
**Toward Engineering Design Expertise**

**Most important design activities, Year 1 vs. Year 4, all APS**

(*p < 0.05, **p < 0.01; McNemar, two-sided*)

- Understanding the problem
- Communicating*
- Planning**
- Brainstorming
- Testing
- Goal Setting
- Using creativity
- Making decisions
- Visualizing**
- Seeking Information
- Evaluating
- Building
- Identifying Constraints**
- Generating alternatives
- Imagining
- Modeling
- Prototyping
- Abstracting
- Making trade-offs
- Synthesizing
- Decomposing
- Iterating**
- Sketching

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**Year 4 (n=89)**

**Year 1 (n=89)**

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ASEE 2008
Most Important Design Activities

Changes from Year 1 to 4, all APS

- Identifying constraints
- Modeling
- Iterating
- Evaluating
- Prototyping
- Building
- Using creativity
- Communicating
- Planning
- Visualizing

difference in % from Year 1 to 4

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Most Important Design Activities by Gender
Year 4, all APS (*p<0.05, **p<.01, Fisher's Exact, 2-sided)

Understanding the problem
Communicating
Planning
Brainstorming
Testing*
Goal Setting**
Using creativity
Making decisions
Visualizing
Seeking Information
Evaluating
Building**
Identifying Constraints
Generating alternatives
Imagining
Modeling
Prototyping
Abstracting
Making trade-offs
Synthesizing
Decomposing
Iterating
Sketching

Women (n=39)
Men (n=64)
Acquisition of Engineering Knowledge and Skills

• Question: Are students learning to engineer?

• Describing
  • Conceptions of design
  ➔ “What counts” as engineering knowledge
“What Counts” as Engineering Knowledge
Stevens, Amos, Garrison, Jocuns

- Ethnographic observations and interviews in Years 1 - 4
- At Large Public University
“What Counts” Changes Over Time

During students’ first two years:
- Technical subject matter prerequisites (mathematics, physics, chemistry) outside of engineering
- Little exposure to engineering coursework
- Lecture-based teaching, individual-based problem sets (except labs)

During final two years:
- Coursework is in students’ respective engineering majors.
- Problems shift to open-ended problems.
- Students’ relationship to data changes from mathematical “puzzle solvers” to data collectors and users.
- Biggest changes observable in Capstone project courses
Examples of changes in “What Counts”

Two students navigating these changes at Large Public University:

• Adam struggled to adjust as problem-set based mathematics (school math) was displaced by group work and open-ended problems.

• Simon came into his element with the capstone project.
  – Drew on his experience as a student leader in stress testing lab
  – Demonstrated expertise in some of the tests (even in relation to the professors/instructors)
Today focusing on …..

Large variation in student pathways...
• Reasons for choosing engineering
• Choosing to stay or go
• Navigation through curriculum
• Experience by gender

• Acquisition of engineering knowledge and skills

⇒ Preparation for the “real world”
Preparation for the “Real World”\textsuperscript{1,2,3}
Atman, Kilgore, Lund, Morozov, Yasuhara

Please rate how well prepared you are to incorporate each of the following items while practicing as an engineer...

- List of 20 engineering skill/knowledge items based on...
  - ABET outcomes
  - Engineer of 2020 (National Academy of Engr.)

- Survey question administered in Year 4

- All four institutions
What Are We Finding?

• Data on student learning from surveys and a more in depth look at a smaller number of students

• Good news: students are learning, becoming more expert-like

• But some gaps remain
  – Not all students shift easily to new “what counts”
  – Low importance of global/societal context
Summary of Findings

Large variation in student pathways...

• Reasons for choosing engineering
• Choosing to stay or go
• Navigation through curriculum
• Experience by gender
• Acquisition of engineering knowledge & skills
• Preparation for the “real world”
• Details on more findings in remaining papers of session #1531 and #2531 tomorrow....
Stay tuned—The stories continue to unfold...
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For further information see the CAEE Web site at http://www.engr.washington.edu/caee or contact Cindy Atman at caee@engr.washington.edu
Citations


