



Stepping Stones: Capacity Building in Engineering Education

Arnold Pears, Uppsala University, Sweden
Mats Daniels, Uppsala University, Sweden



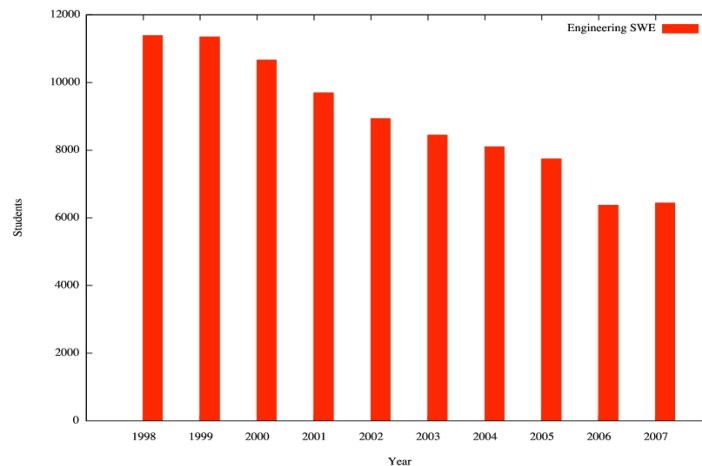
Presentation Outline

- 1) Stepping Stones motivation and objectives
- 2) Overview of Stepping Stones Study
- 3) Key results
- 4) Discussion



Engineering in decline

Cumulative first preference applications for all engineering programs
[source SCB]



Objectives

- Build community
- Enhance awareness of factors affecting student motivation and image of Eng. Education in Sweden
- Enhance awareness of research methods in disciplinary education research by conducting a joint project on a National scale



Participation

- Full data was collected from a range of engineering programs at 8 Swedish Universities
- Partial data was collected at a further 3 sites.
- Analysis was conducted by participants from the 8 major sites.



Collection Instruments

- Survey, adapted from PiE
- Concept Map of engineering terms
- Critical Incident Interview
- Photo Elicitation Exercise



Data Demographics

Site	Surveys	Concept Maps	Interviews	Interview Types and Totals				Concept Maps Types and Totals			
				F	G	A	E	F	G	A	E
B	60	14	14	6	5		3	6	5		3
C	121	22	22	9	10	1	4	7	10	1	4
D	50	13	13	5	6		2	5	6		2
E	26	10	10	4	4		2	4	4		2
F	83	12	12	5	5		2	5	5		2
K	9	7	7	4	2		1	4	2		1
H	99	24	24	9	11		4	9	11		4
I	52	13	13	6	5		2	6	5		2
Other	21	0	0								
	521	115	115	46	48	1	20	46	48	1	20



Survey

- Adapted from Persistence in Engineering survey (Academic Pathways Survey)
- Original instrument extensively validated
- **Source** <http://www.engr.washington.edu/caee/>



Concept Map

- Arrange and relate engineering terms to one another
- Captured as “explanograms” to preserve the sequence of development



Critical Incident

Q1 In a few words, what would you say real engineering is?

Q2 Can you give me some examples of engineering in the world? (If the participant asks “what is in the world” encourage them to interpret it as they see fit.)

ELICITING CRITICAL INCIDENT

Q3 Can you think of an engineering experience you have had that you particularly enjoyed? Or an experience that you felt represented your ideas of engineering? We are interested in something that actually happened to you.

- a. Can you give a brief overview of the experience?
- b. What did that experience involve? (Questions i-v are optional prompts)
 - i) Scale: was it a big thing? Or a more private, “aha” moment?
 - ii) Setting: where did this happen? Was it at home, or in school, or somewhere else?
 - iii) Circumstances: was this one in a sequence of things, or a one-off? Were they doing something normal, or unusual?
 - iv) Client: was it when you were involved in an engineering experience yourself? If so, whom were you working for?
 - v) Groups involved: were you working with others at the time? Were you in a team? Were you working with other teams?
- c. What is it about that experience that summarises “engineering”?
- d. Why do you think this particular experience came to mind? Why was it important?



Photo Elicitation

- Collected reactions to three images
 - Association of image with eng.
 - After discussing image “what is eng.?”
 - Have perceptions changed over time?
 - Specific time/issue that challenged view of eng.



Image A

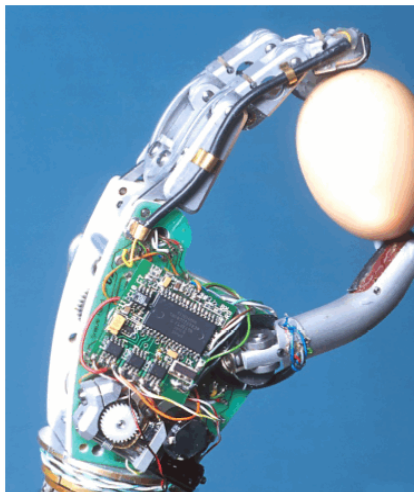




Image B



Image C





Studies conducted

Study	Unit of Analysis	Data Source			
		Survey	Concept Map	Critical Incident Interview	Photo Elicitation Interview
Study A	Institution Discipline	Subset of constructs			
Study B	Participant (experience, gender)		Map & Explanogram		
Study C	Participant (experience, gender)	Subset of questions		Subset of questions	Subset of questions
Study D	Participant (experience, gender)				Subset of questions
Study E	Participant (gender)	Subset of questions	Debrief		



Stepping Stones Results

Students' experience of engineering in terms of:

- education, characteristics and goals
- motivations
- perceptions

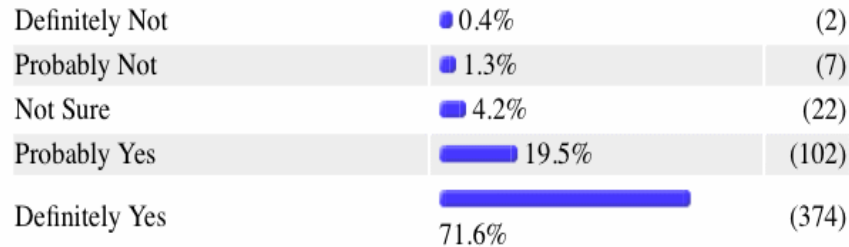
and much more in the report

<http://www.it.uu.se/research/publications/reports/2007-018/2007-018.pdf>



Attitude to persistence

7. Do you intend to complete your engineering degree?



Self assessment of competence

12. Rate yourself on each of the following traits as compared to your classmates. We want the most accurate estimate of how you see yourself. (Mark one in each row.)





Exposure to Engineering

30. Do you have family members who are working engineers?



31. Do you have close friends who are working engineers?

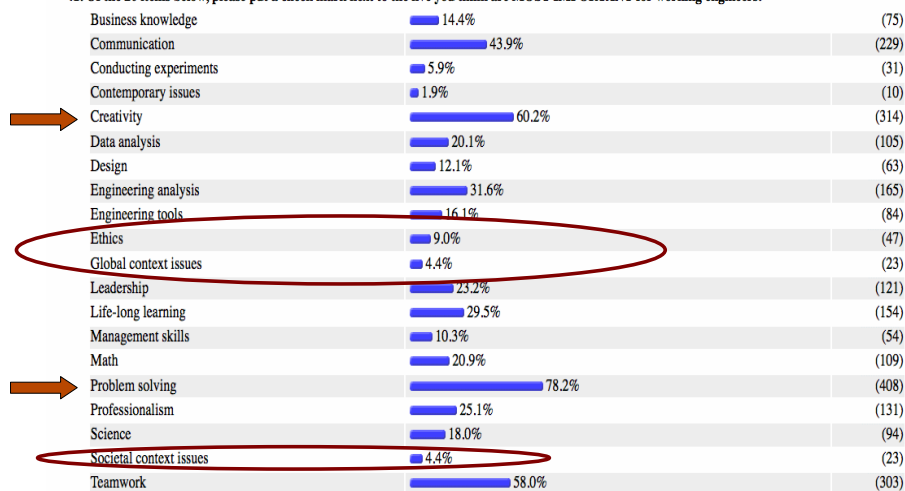


32. How much exposure have you had to a professional engineering environment as a visitor, intern (praktikant), or employee?



Perceptions of skill desirability

41. Of the 20 items below, please put a check mark next to the five you think are MOST IMPORTANT for working engineers.





What is engineering about?

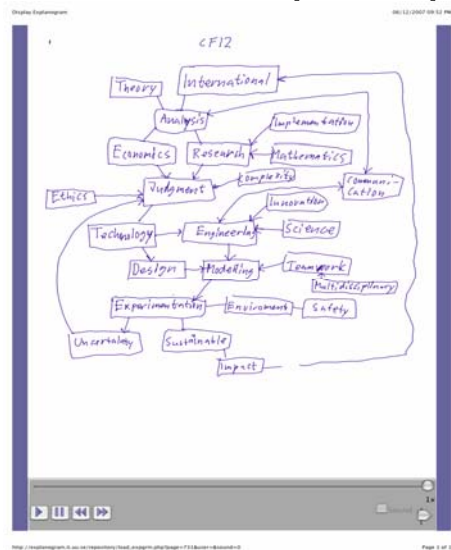
Code	Description	Examples
NEW	contributing with something qualitatively new	innovation, new ideas, thinking for the future, something not built before
CRE	being creative and explorative	create, design, discover, explore, put things together
DEV	improving something that already exists	develop, improve, optimize
CON	realizing concrete products	construct, implement, building, realizing, physical things, hands-on
SOLVE	solve problems	solve problems
THINK	intellectual activities	thinking, curious, understanding, challenges
KNOW	static knowledge connected to engineering	knowledge, mathematics, technology, natural science, physics
SOC	social impact of engineering activities	changing society, ease everyday life, impact on human beings
TEAM	teamwork	teamwork, working together, collaborate
COMP	engineering is diverse or complex	complexity, many things



What do engineers do?

Code	Description	Examples
BRIDGE	fairly large and concrete objects	bridges, tunnels, roads, infrastructure, buildings, houses, pyramids, aqueducts, Eiffel tower, Turning Torso, airport in Japan
TRANS	ways of transporting people or goods	cars, trains, buses, airplanes, bikes, boats, vehicles
TOOLS	everyday tools mostly for personal use	TV, mobile phones, coffee machine, digital pen, saxophone, chair, radio equipment, wrench key, DVD player
ENER	energy, natural resources and environment	energy, nuclear power, electricity, cleaning technology
HUM	impacts on basic human life	health care, medical machines, harvesters, food factories
MECH	mechanics, mostly for professional use	mechanical devices, robots
SYS	large abstract systems	systems, networks
SOFT	software	software, computer programs
COMP	computers	computer
SUBJ	different subjects related to engineering	physics, chemistry, mathematics, electronics
ALL	engineering is everywhere	everything, everywhere, a lot

A Concept Map



Concept Map Analysis

Central concept	Frequency count
Engineering	86
Science	11
Society	7
Research	6
Design	4
Technology	4
Economics	3
Environment	3
Implementation	3
Innovation	3
Modelling	3
Multidisciplinary	3
Theory	3
Analysis	2



Gender differences?

- N= 521, Male=383, Female=108
- Females identify parental expectations and job prospects as strong motivators.
- Males rate importance of good communication skills slightly more highly than females.
- No significant difference on statement
 - "Technology plays an important role in society"



Conclusions

- Student experiences of engineering are quite uniform across Swedish Universities
- Students expect to learn **problem solving** and be **creative** during their time at University.
- Poor appreciation of the value some important aspects of Engineering practice.
 - especially ethics and global/social context
- Females more often identify parental expectations and job prospects as strong motivators
- Full report available at
 - http://www.it.uu.se/research/publications/reports/2007_018



Contrast with APS Results (USA)

Four major issues led to students leaving engineering

- lack of faculty guidance/advisement***
- lack of community engagement***
- scholarship/financial dilemmas***
- course difficulty in the area of calculus***

“This finding is disturbing because we see students choosing a major, not based on interest or aptitude, but based on minimizing the risk of losing their financial support.”