

# Students' Attitudes and Threshold Concepts Towards Engineering as an Environmental Career: Research by Participatory Design of an Educational Game

---

**Johannes Strobel<sup>1,2,4</sup>, Inez Hua<sup>3,4</sup>, Constance Harris<sup>2</sup> & Jun Fang<sup>2</sup>**

<sup>1</sup> School of Engineering Education; <sup>2</sup> Department of Curriculum & Instruction  
(Educational Technology); <sup>3</sup> School of Civil Engineering;  
<sup>4</sup> Division of Environmental and Ecological Engineering  
Purdue University

Harvey Mudd Workshop VII, May 29 2009



# Sustaining sustainable design

---

From an engineering education perspective:

1. Capacity building (faculty, students, industry)
2. “Sustainable teaching” (teaching using sustainable principles)
3. Educational Research as integral component



# Why this study? Context

---

- Green Industry and green jobs
- Environmental Literacy
- Adult population
  - “confused public that performs poorly on basic environmental literacy questionnaires”
  - “95% of this public supports environmental education in our schools” (NEETF/Roper)
- Engineering students (earlier study):
  - unsatisfactory knowledge and
  - a general belief that environmental issues are very important
- Resistance to change (hybrid cars)
- Global (grand) challenges
- Re-discovering what engineering is



# Research Questions

---

- What is the knowledge level of first year engineering students in regards to environmental and ecological issues, in particular environmental engineering?
- What are threshold or gatekeeper concepts, which help students to transform existing knowledge into deeper conceptual understanding?
- What is the baseline conceptual understanding of ecological and environmental engineering and life cycle assessment?

How to embed the questions into a teaching/research setting based on sustainability principles



# Theoretical Framework

---

- Socio-cognitive career theory
  - Outcome expectancy (meaning of work)
- Threshold concepts:
  - Gatekeeper concepts for change of deep structures
- Participatory design
  - Students as co-designers of their own learning



# Research Methodology

---

- Survey – baseline testing (1400 students)
  - Environmental knowledge (Impact; Policy; Technologies; Sustainability)
  - Resistance to change
- Knowledge elicitation via collaborative game design (24 students: six teams)
  - Design artifacts
  - Discussion protocols
  - End of project interviews
- Engineering context: LCA

# Results

# Quant

1/3

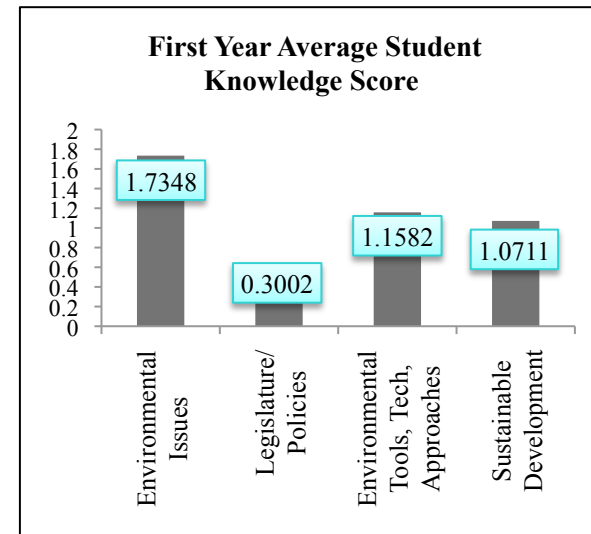
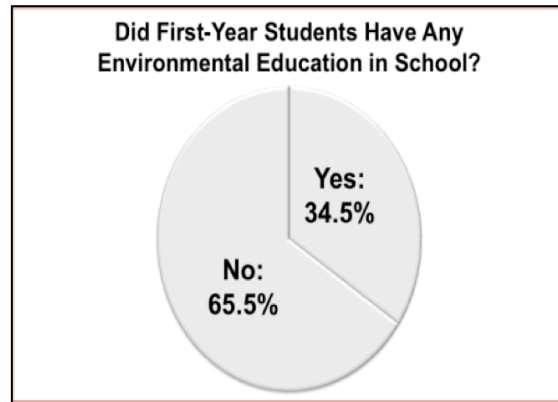


Table 1  
*The Correlation Between High School Environmental Education and Student Knowledge of Environmental Engineering Issues (N=1360)*

	1	2	3	4	5
1. Prior Environmental Education	--				
2. Environmental Issues	.272**	--			
3. Legislative Policy	.196**	.466**	--		
4. Environmental Tools, Technologies, Approaches	.096**	.601**	.471**	--	
5. Sustainable Development	.161**	.595**	.497**	.715**	--

\*\* Correlation is significant at the 0.01 level (2-tailed).

# Results

# Quant


2/4

Table 2  
*The Correlation Between High School Math and Science Education and Student Knowledge of Environmental Engineering Issues (N=1360)*

	Semesters of High School Math Taken	Semesters of High School Science Taken	1	2	3	4
Semesters of High School Math Taken	--					
Semesters of High School Science Taken	.268**	--				
1. Effect of Environment	-.101**	.180**	--			
2. Legislative Policy	-.069*	.123**	.466**	--		
3. Environmental Tools, Technologies, Approaches	-.028	.103**	.601**	.471**	--	
4. Sustainable Development	-.070**	.155**	.595**	.497**	.715**	--

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).



Resistance to Change	--
Environmental Issues	-.071 **
Legislative Policy	.006
Environmental Tools, Technologies, and Approaches	-.078 **
Sustainable Development	-.079 **

\*\* . Correlation is significant at the 0.01 level (2-tailed).

- Results of LCAs: surprising and ‘troublesome’
- Compromising functionality for environmental concerns
  - “functionality is made secondary”
  - “only think of the environment”
  - contradiction to their understanding of engineering.
- ‘Just information’ – no roadmap
- Intertwined process – Uncertainty and less-optimal-data-environments – no single component alone



---

Questions?