Board 130: Engineering Education Collaborations: Exploring "Ways of Thinking" Using a Mixed Methods Approach

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Engineering Education Collaborations: Exploring 'Ways of Thinking' through Mixed Methods

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Background

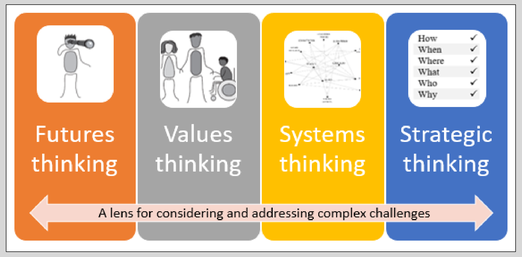
Motivation

- Calls to transform engineering education by adopting new 'ways of thinking'.
- NSF promoting interdisciplinary collaborations to develop "outlooks, perspectives, ways of thinking, knowing, and doing" (NSF, 2017, p.3).

Goals

- Appreciation for novel ways of thinking conceptualized in the sustainability education research
- Experimental evidence of ways of thinking perspectives within authentic projects
- Groundwork to initiate a ways of thinking framework

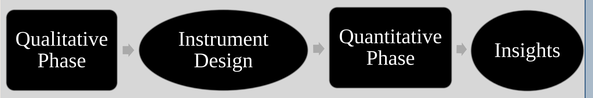
Guiding Framework (Warren, Archambault, & Foley, 2014)



Research Questions

1. What do futures, values, systems, and strategic thinking mean in the context of engineering education research undertaken by an interdisciplinary research team?
2. What are the underlying dimensions of the futures, values, systems, and strategic thinking for engineering education research?

Research Design



Qualitative Methods

- Maximum variation purposeful sampling
- 18 PI/Co-PI participants
- Dyadic interviews
- 6 meeting observations
- Thematic Analysis (Miles, Huberman & Saldana, 2014)

Instrument Design and Validation

- Mixed methods joint display (Creswell, 2015)
- Item development (DeVellis, 2003)
- 3 Expert reviews
- 4 Think aloud sessions

Quantitative Methods

- Participants - NSF awardees of two interdisciplinary programs
- Sample size (n=310)
- Dillman's (2014) Tailored Design deployment methodology
- Exploratory Factor Analysis

Qualitative Results: Conceptualizations

Futures Thinking

"We have to look at what 10, 15, 20 years down the line, what is education going to look like?"

Imagining | Future Workforce | Incremental Improvement

Content Changes | Impact | Stakeholder Support | Pedagogical Changes

"… the innovations developed and put in place will wither after the funding is exhausted. In the immediate future I think is, how are we going to keep this stuff going when funding is over."

Values Thinking

"Unless we reach down to elementary school level and get kids, with a diverse group of people, interested in what we do, we are not going to have a diverse workforce."

Diversity and Inclusion | Design Values | Personal Values | Pedagogical Values

Societal Values | Collaboration Values | Research Values

"We are thinking like the fit of a priority scheme, that when I work with people who share my priorities and how will I go about something, why I want go about those things? It works."

Systems Thinking

"What are our inputs, what are our goals, what are our activities, who are the participants, what are short-term, medium-term, and long-term outcomes? Making those connections."

Weaving a Tapestry | Bigger Picture | Sub-systems and Interactions

"You can tell the students to do stuff, you can look at what the curriculum is, but very few universities go tell the faculty member 'You need to change how you teach'. If you are thinking this is the system, that is an important piece."

Strategic Thinking

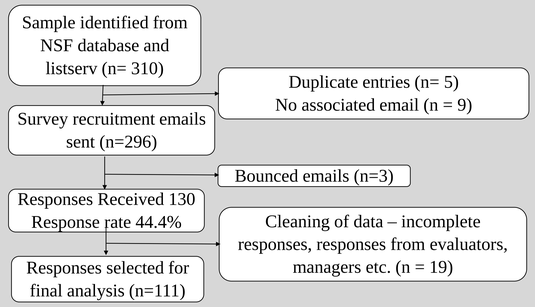
"There's a real framing difference when you collaborate and the kinds of questions you ask are really, really different. The outcomes are really different."

Collaboration | Evaluation | Developmental planning

Personal Growth | Problem Solving | Consensus Building

"I have always found that is really comfortable when you talk with the engineers, if you say design, develop and test. They do that anyway."

Quantitative Results: Underlying Dimensions



Participant Profile

Demographic	Response count	Response %
Rank		
Professor	32	28.8
Associate Professor	34	30.6
Assistant Professor	18	16.2
Research Professor	20	18.1
Unspecified	7	6.3
Discipline		
Engineering	28	25.2
Social sciences	20	18.0
Both/Engineering education	47	42.4
Unspecified	16	14.4
Role on the project		
PI	36	32.4
Co-PI	55	49.5
Unspecified	20	18.1

Results: Exploratory Factor Analysis

Futures Thinking (Cronbach's α = .869)

Measure	EER	EE
Preparing students as future professionals		**0.954**
Preparing students as future citizens		**0.651**
Curricular changes		**0.520**
Pedagogical changes	**0.508**	
Research with long lasting impact	**0.449**	
Research to drive transformational changes	**0.533**	
Administrative support	**0.779**	
Translation of research to practice	**0.912**	
Short-term thinking (1-2 years)	**0.596**	
Engaging in scenario-building activities	**0.548**	

Note. Results based on *N*=111, EER = Engineering Education Research, EE = Engineering Education

Systems Thinking (Cronbach's α = .910)

Measure	Sub-systems
Existence of problem at different scales	**0.688**
Synergy across all components	**0.685**
Implications on all stakeholders	**0.614**
Interdependence of EES components	**0.827**
Interactions of elements in EES	**0.780**
Dynamic nature of the education system	**0.848**
Cascading effects of a solution	**0.788**

Note. Results based on *N*=111.

Values Thinking (Cronbach's α = .807)

Measure	Personal	D&I
Valuing diversity in the profession		**0.931**
Valuing inclusion in the profession		**0.877**
Considering heterogeneity of users in design		**0.551**
Aligning personal values with EER	**0.890**	
Societal values with EER	**0.475**	
Reconciling personal values with collaborators	**0.575**	
Improving engineering teaching		
Context-driven research methodologies		
Creating new knowledge		

Note. Results based on *N*=111, D&I = Diversity and Inclusion

Strategic Thinking (Cronbach's α = .885)

Measure	Research	Personal
Positioning research within larger dept. goals	**0.637**	
Conveying importance of research	**0.831**	
Planning of project	**0.666**	
Strategic courses of action for execution	**0.905**	
Creative approaches of problem-solving	**0.605**	
Evaluation strategies to capture impact	**0.532**	
Improving based on lessons learned	**0.625**	
Collaboration strategies		**0.914**
Personal strategies for career growth		**0.820**

Note. Results based on *N*=111.

Discussion and Implications

"Our collaboration would have been more effective if we had this framework."

"This framework represents things that collectively an interdisciplinary team should strive to achieve or brainstorm under."

- How do you see this research informing future research collaborations?
- How do you see this research informing the future direction of grant funded proposal calls?
- How do you see this research building capacity for larger impact?

Future Plans

- Refinement of survey items
- Confirmatory factor analysis
- Expansion to other sites and projects
- Deeper exploration of values thinking
- Applicability for Engineering Research Centers
- Framework with concrete abilities of ways of thinking

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