UNDERGRADUATE RESEARCH EXPERIENCES IN ENGINEERING: THE STUDENT PERSPECTIVE

Presentation to the National Academies Board on Science Education

November 19, 2015, Washington, DC

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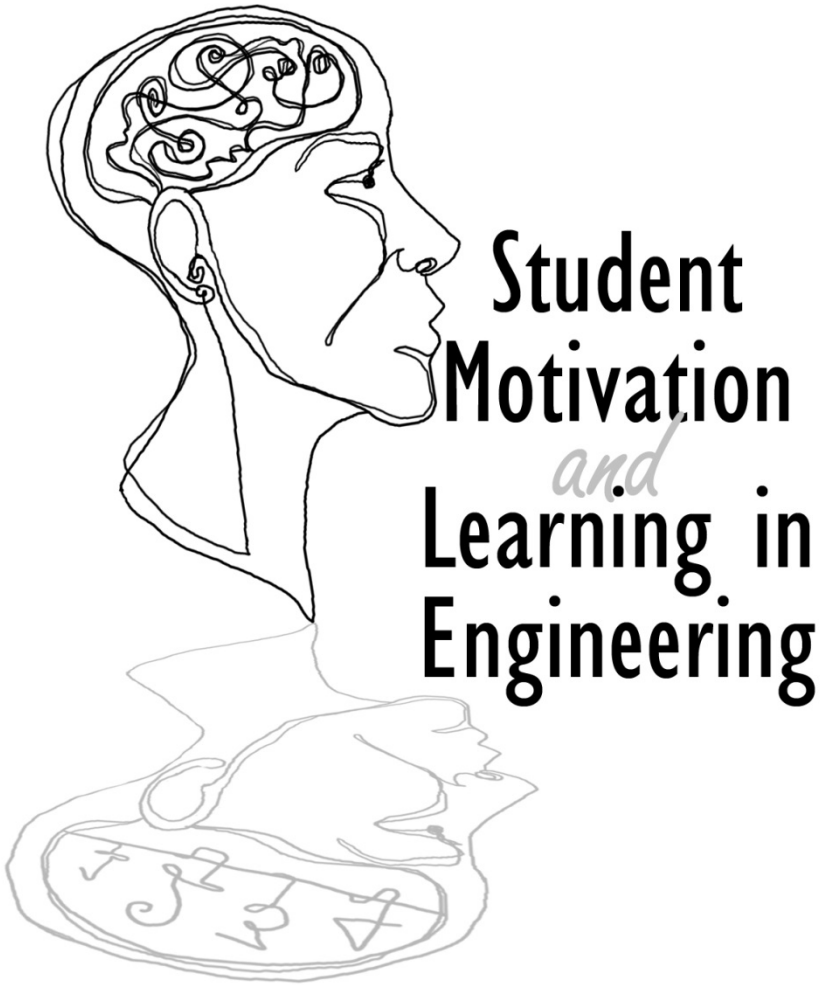
ENGINEERING AND SCIENCE EDUCATION

Lisa C. Benson
Associate Professor, Clemson University

About my research



- Preparing a diverse new generation of engineers and scientists
- Creating self-directed learners
  - Understanding motives behind why students are here
  - Examining interactions between motivation and learning
- Providing empirical evidence to support education initiatives that empower students

My URE research emerged from differences in student motivation and problem solving practices in different learning environments.

"Yeah, I feel like I am willing to be more creative, like when it comes to our [research] or something like that, but in class, I just know there's a right answer. And you could get an A if you know how to do it. So it's a little more frustrating in the school setting if you are given a problem that doesn't have a specific answer."

- Researcher identity and epistemic cognition: perceptions and attributes of undergraduate researchers do not necessarily translate to classroom practices.[1]

Images courtesy of:
http://www.rose-hulman.edu/news/on-campus/2012/siemens-features-rose-hulman-design-project.aspx
http://www.stke.k12.nf.ca/9-4%20Career%20List/Mechanical%20Engineer.html

[1]Faber, C. and L. Benson, "Undergraduate Engineering Students' Development of a Researcher Identity," 2015 AERA Conference, Chicago, IL

Research skills align with important aspects of engineering practice and ways of knowing engineering concepts.

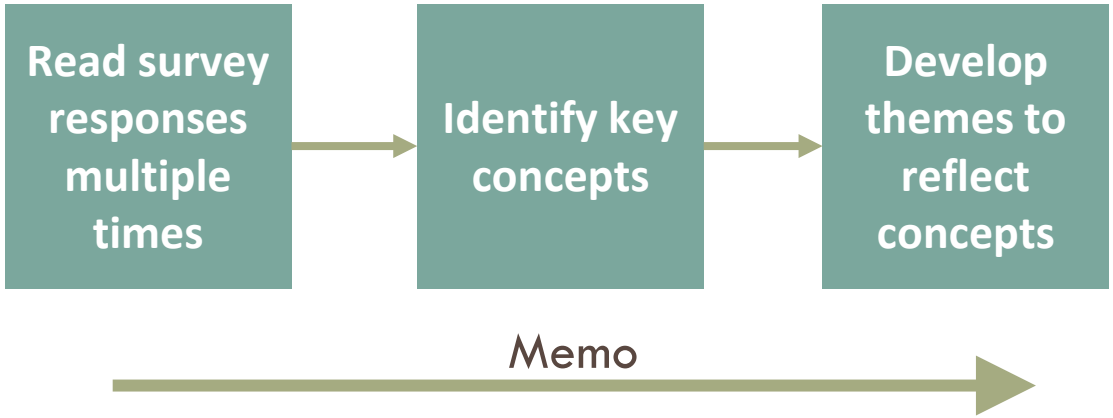
- Our research questions:
  - How do undergraduate engineering students develop their identities as researchers and their ways of knowing engineering through UREs?
  - How do UREs affect students' views of research and being researchers?
- Our methods:
  - Sixteen engineering students who had participated in research completed three open-ended surveys focused on researcher identity
  - Six BME students interviewed, focused on epistemic cognition (aims and processes) during research experiences

How do undergraduates in engineering see themselves as researchers?

- Set of 3 open-ended surveys developed iteratively
- Sought to understand students' beliefs about research, views of themselves as a researcher, and experiences with research
- Example questions:
  - **Why did you start doing research?**
  - **In your words, what is research?**
  - **What is the purpose of research?**
  - **Do you feel like you are a researcher?**
    - **[If yes…] Describe three ways in which you see yourself as a researcher.**

Conventional qualitative content analysis was used to analyze students' responses.[1]

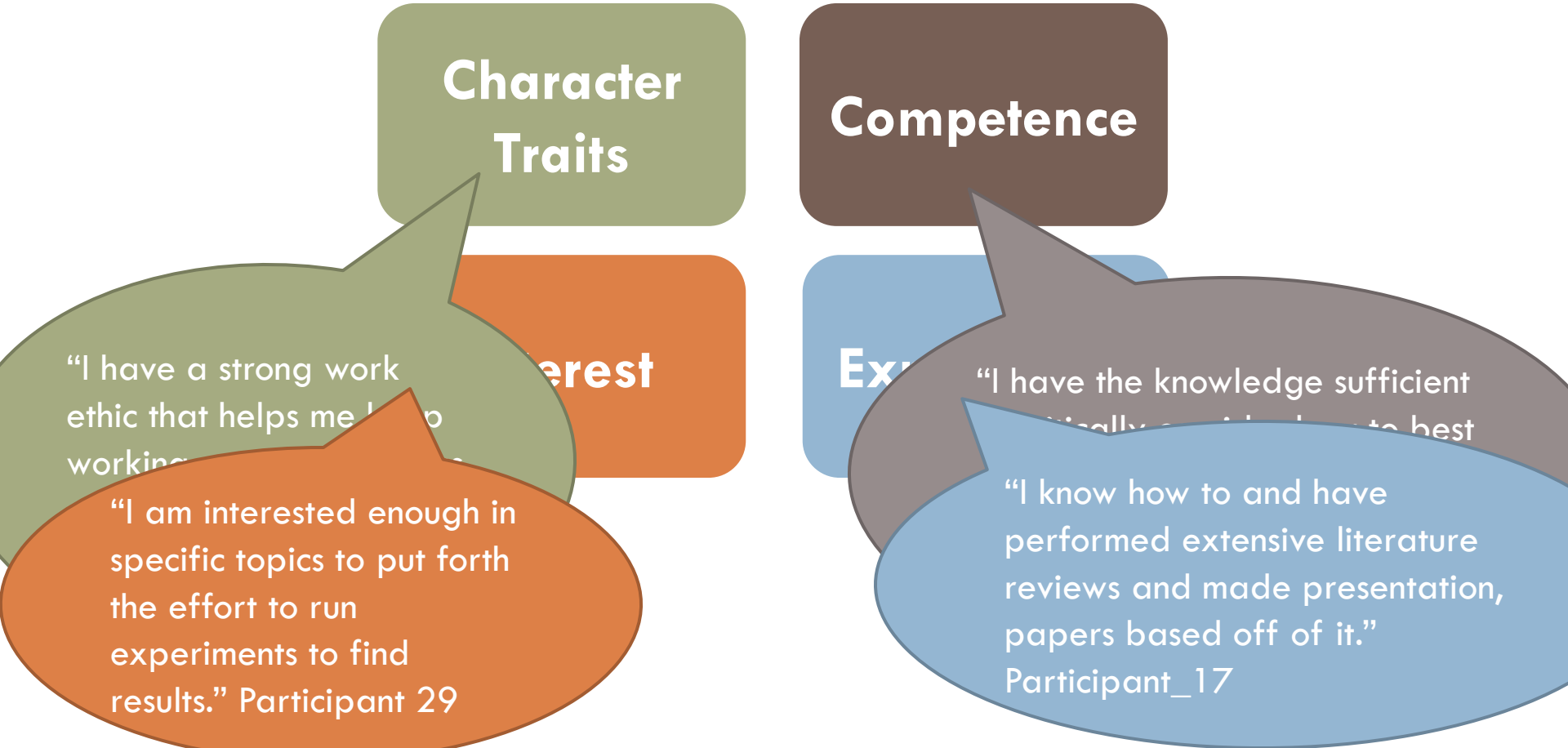
- Avoids using predefined categories
- Allows for ideas to emerge from the data



1) Hsieh, H. & Shannon, S.E. (2005) Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*, 15(9), 1277-1288.

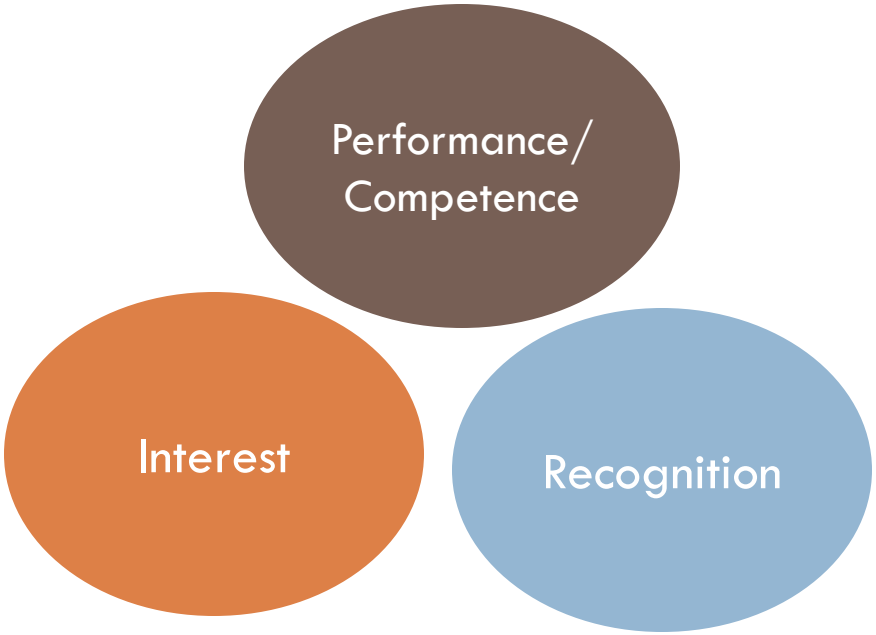
All of the students in the study identified themselves as researchers.

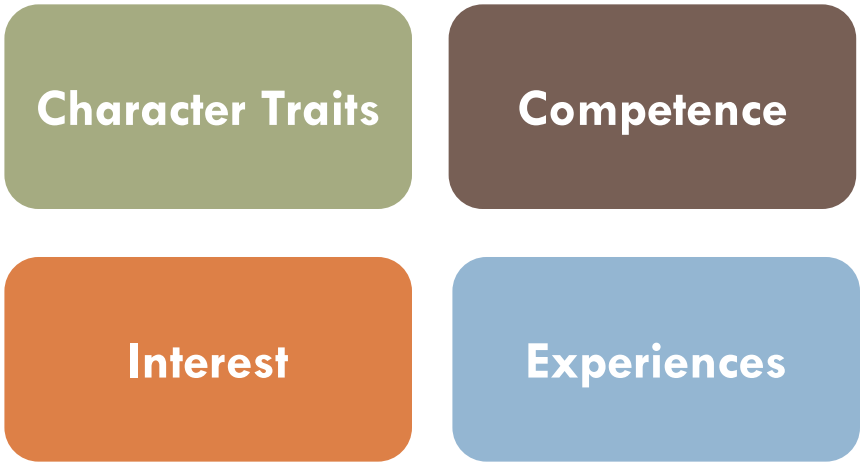
- Four themes emerged to describe why they felt like researchers.



This work is the first step in establishing a framework to assess students' development of a researcher identity.

- Themes are similar to those in a discipline-based identity framework[1, 2]

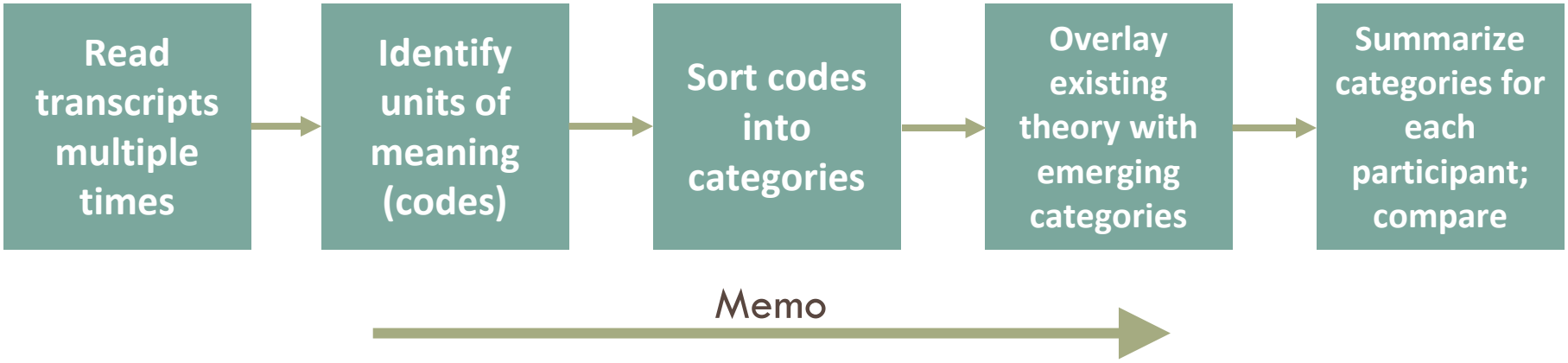




1) Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M.-C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching*, *47*(8). 2) Godwin, A., Potvin, G. & Hazari, Z. (2013). The Development of Critical Engineering Agency, Identity, and the Impact on Engineering Career Choices. *Proceedings of the ASEE Annual Conference*, Atlanta, GA.

How do undergraduate engineering students develop their ways of knowing engineering through UREs?

- Six biomedical engineering undergraduate students interviewed about their UREs, focusing on epistemic cognition
- Sample interview questions:
  - Tell me about your research experiences.
  - How do you evaluate the success of your research?
  - What do you hope to gain from research?
  - When starting a new study, how do you decide what methods to use?



What students get out of a URE is not necessarily related to why they seek research experiences.

- Research project choice based on interest
- Both epistemic and non-epistemic goals
- Students' research decision-making processes not related to goals; more related to their research group
  - More autonomy → Clearer research outcomes and relevance, contributions to research group discussions
  - Less autonomy → Difficulty describing research outcomes and relevance; did not develop research skills to the same extent
  - Struggles with their project or the structure of their research experience → Lack of adopting research community's epistemic processes (how knowledge is made)
- Students new to research are more likely to rely on mentors than on peer-reviewed resources to confirm research decisions

Research findings can inform design and implementation of effective UREs in engineering.

- Give students the chance to experience authentic research activities
  - Literature reviews
  - Design experiments
  - Analyze results
  - Write reports
  - Present work
  - Work with others
- Scaffold experiences to help students develop competencies
- Facilitate student involvement in research that interests them

Directions for future research on UREs: The student's perspective & long term outcomes

- Broaden study population to create comprehensive descriptions of UREs from students' perspectives
  - How undergraduates conceptualize research
  - How/if they view themselves as researchers
  - How they understand the nature of knowledge and knowing in their fields
- Study the impact of research group culture and structure on students' epistemic cognition when making research decisions and on development as a researcher
- NSF Award EEC-1531607: Student Perspectives on Researcher Identity and Transformative Epistemologies (SPRITE)

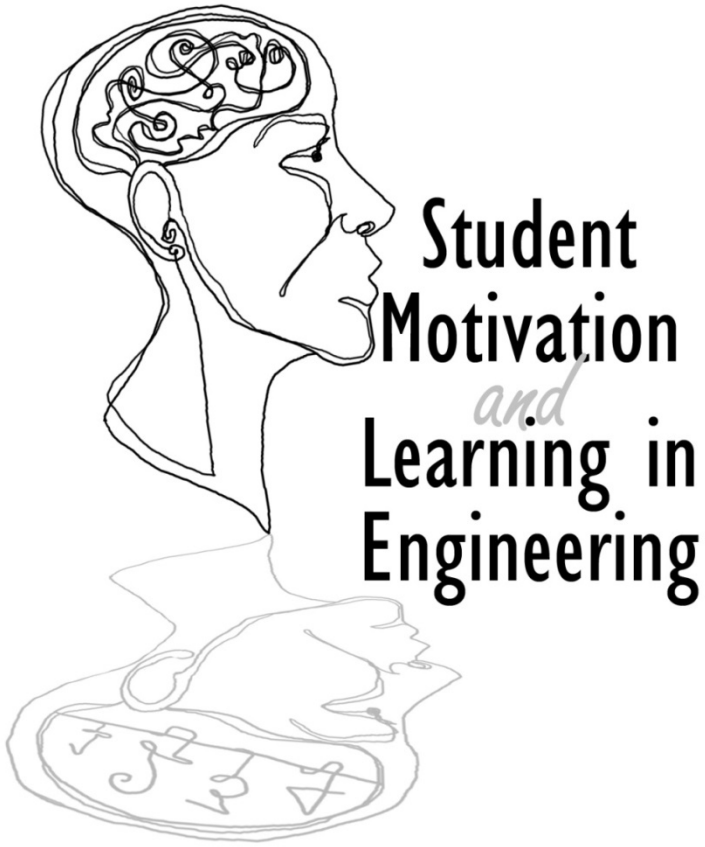
SPRITE will start with a multi-institution quantitative study on researcher identity and epistemic beliefs.

	Engineering Epistemic Beliefs Items
1	Theories in engineering cannot be argued or changed
2	Classroom engineering problems have only one right numerical answer.
3	Engineering problems outside the classroom have only one right answer.
4	Engineering knowledge cannot be subject to change with new observations by individuals.
	Engineering knowledge cannot be subject to change with new

	Need for Cognitive Closure
1	Even after I've made up my mind about something, I am always eager to consider a different opinion.
2	I don't like situations that are uncertain.
3	I dislike questions which could e answered in many different ways.
4	I feel uncomfortable when I don't understand the reason why an event occurred in my life.

	Classroom Need for Closure
16	I carfully plan my study time for [ENG] class.
17	I think that having a detailed and complete syllabus in my [ENG] class is necesssary for me to be successful.
18	I like to go into [ENG] class knowing what I can expect for the day.
19	I hate it when I have to change my study plan for [ENG] class.

Thank you!



Acknowledgements:

The Benson Research Group

The SPRITE Research Group:
Courtney Faber, The College of NJ
Rachel Kajfez, The Ohio State University
Marian Kennedy, Clemson University
Penelope Vargas, Clemson University

NSF Support: GRFP; CAREER Award
EEC-1055950, and EEC-1531607