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CAREER: It's not Sorcery, It's Skill: Shedding Light on How Professional and Personal Experiences Shape the Use of Intuition in Engineering Practice

Dr. Elif Miskioglu, Bucknell University

Dr. Elif Miskioglu is a mid-career engineering education scholar and educator. She holds a B.S. in Chemical Engineering (with Genetics minor) from Iowa State University, and an M.S. and Ph.D. in Chemical Engineering from Ohio State University. Her early Ph.D. work focused on the development of bacterial biosensors capable of screening pesticides for specifically targeting the malaria vector mosquito, Anopheles gambiae. As a result, her diverse background also includes experience in infectious disease and epidemiology, providing crucial exposure to the broader context of engineering problems and their subsequent solutions. These diverse experiences and a growing passion for improving engineering education prompted Dr. Miskioglu to change her career path and become a scholar of engineering education. As an educator, she is committed to challenging her students to uncover new perspectives and dig deeper into the context of the societal problems engineering is intended to solve. As a scholar, she seeks to not only contribute original theoretical research to the field, but work to bridge the theory-to-practice gap in engineering education by serving as an ambassador for empirically driven educational practices.

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Abstract

This CAREER project seeks to further our understanding of the experience-intuition-expertise relationship and apply that knowledge to develop practice-informed educational initiatives that support the professional formation of engineers by promoting discussion of intuition. Intuition is a critical skill of experts that has been studied in nursing, business management, and law. A previously funded NSF Research in the Formation of Engineers (RIEF) project extended the study of discipline-specific intuition to engineering, resulting in a definition of engineering intuition and framework situating intuition in engineering practice. This previous work describes how experience builds the skill of intuition, but neglects to address the positive or negative feedback loops created by experience that can influence intuition use leading to the first research aim of this CAREER project: *Characterize the ways in which engineering practitioners understand experience to influence intuition development and use.* Aim 1 will be achieved through a phenomenography that seeks to capture the outcome space of experiences as they relate to development and use of intuition, followed by narrative analysis that returns focus to individual or composite narratives. Outcomes of Aim 1 will directly inform the first goal of the *Education Plan*: developing and piloting a student-facing *Practitioner Voices Series* that highlights different experiential pathways through practitioner narratives. Currently in year one, this paper reports largely on the methods development of Aim 1 as we kick off the research efforts.

Introduction & Background

Engineering intuition is an expert problem-solving skill used by practitioners to navigate constraints that is detailed in the recently published Leveraging Intuition Towards Engineering Solutions (LITES) framework [1] (Figure 1). LITES specifically characterizes intuition as a subconscious coordination among problem-solving approaches. Intuition often manifests as a Physiological response that is rooted in the expert's prior Experience and supported by Data-Based Approaches (prior knowledge, experience in running similar data), Holistic Prediction (big picture perspective that comes from familiarity with the context), and Sensibility Check (is this approach or solution reasonable, or ridiculous?). LITES also acknowledges that whether an individual problem solver moves forward with their intuition or not depends on what is referred to as Internal Factors. Internal Factors are personal characteristics or context that act as a gatekeeper to the ultimate use of intuition once triggered. For example, individuals who are not in the majority group within an organization may come to expect greater questioning on their approaches and subsequently feel compelled to have more explicit evidence to support their decision-making than intuition offers. Internal Factors are influenced by experience, but in a different way from the aforementioned Experience that builds the skill of intuition.

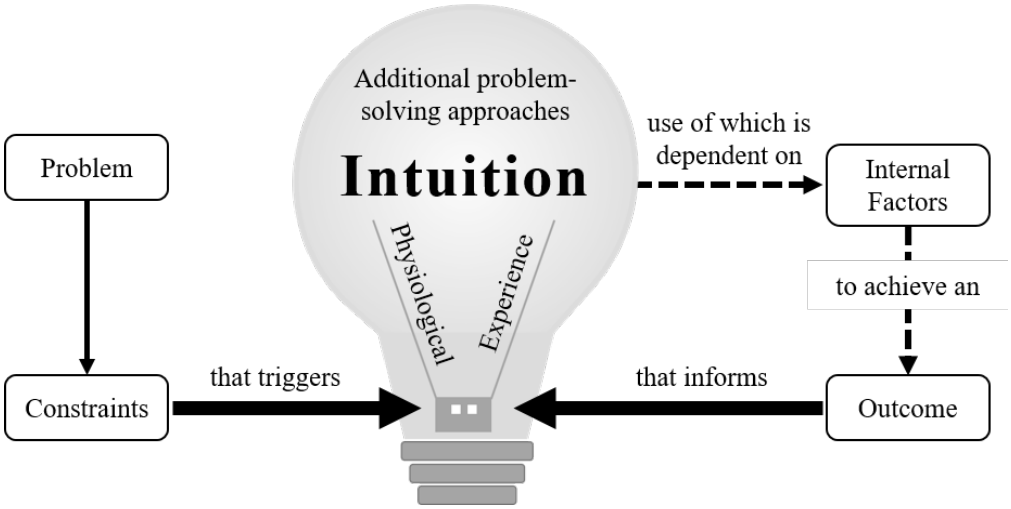

Figure 1. Simplified LITES Framework modified from [1].

The LITES framework does not explicitly acknowledge the role of what might be called personally formative experiences in shaping Internal Factors and ultimately influencing the use of intuition, nor does it consider how personally formative experiences may confound the opportunity for problem-solving experiences that build the skill of intuition directly. Aim 1 of this CAREER project and the embedded research questions seek to address this gap by shedding light on the varying roles of experience in developing problem-solving skills broadly and intuition specifically through a phenomenography and giving voice to these varying roles of experience through a narrative analysis.

Aim 1**:** *Characterize the ways in which engineering practitioners understand experience to influence intuition development and use.*

RQ 1**:** How do practitioners understand the role of experience in their development of engineering problem-solving skills, particularly the skill of engineering intuition?

RQ 2: How do personally formative experiences facilitate or inhibit an individual's perceived agency in using intuition as a problem-solving approach?

RQ 3**:** How do aspects of identity and self-perception interplay with experience to affect an individual's development and use of intuition?

Methods

Phenomenography is chosen as the primary approach towards answering RQ 1 for its methodological focus on seeking to capture the extent of variation in how a phenomenon is understood [2], in this case the experience-intuition relationship. Narrative analysis subsequently returns the focus of the work to the individual and their stories [3], answering RQs 2 and 3 and feeding directly into the Educational Plan's *Practitioner Voices Series*.

Participants, Recruitment, and Sampling: Participants will be engineering practitioners recruited through purposive sampling [4]. Purposive sampling is chosen specifically to support recruitment of a broad dataset that includes individuals with various years of professional experience, academic background and experience, industry, demographics, and self-efficacy experiences. In particular, years of experience and self-efficacy experiences have direct ties to expertise development [1, 5 – 7] and are subsequently important to represent broadly in the sample. Recruitment strategies will leverage institutional and professional networks. Prior to full study recruitment, we will be recruiting pilot phase participants through convenience

sampling to test the protocol and ensure our data collection and analysis efforts answer the posed research questions.

Data Collection: Qualitative data will be collected through semi-structured phenomenographic interviews informed by elements of critical incident technique [8]. The main portion of the interview will focus on eliciting participant experiences that influenced the development of their problem-solving skills, as well as their use of such skills. We will explicitly discuss intuition only at the end of the interview to ensure that this lens does not influence earlier responses. The protocol is currently under development, and will be tested in Spring 2026.

Data Analysis: Interview data will be analyzed first through phenomenography then narrative analysis. In the first phase of analysis, we intend to use a blended phenomenography approach to balance the strengths and shortcomings of individual approaches [9]. Each member of the interview team will produce a reflective memo immediately following the interview to capture initial ideas. Then, the research team will engage in a collaborative analysis that starts with independent open-coding of utterances that relate to how the participants understand the role of experience in their problem-solving skill development. Utterances will enter a de-identified pool and assessed for relevance by the full team. Once a consensus pool of utterances is produced, we will begin to extract meaning by categorizing these utterances into related groups. We will check for saturation before moving on to developing the outcome space that describes relationships between categories.

Narrative analysis will then be applied to the same dataset. Transcripts will be first reviewed to identify narrative versus non-narrative elements and subsequently deductively coded using the emergent categories from the phenomenographic analysis. Attribute coding will also be applied to provide context to each transcript. Each coder will produce a brief analytic memo for each interview before meeting across the team to reach consensus. Specific transcripts will be selected for narrative construction, and proposed for the *Practitioner Voices Series*. Composite narratives may also be candidates for the *Series*, if the analysis suggests trends across any groups.

Preliminary Results and Future Work

The primary result to date is the pilot phase interview protocol. This protocol takes a four-part approach to: 1) build rapport with the participant, 2) probe their approaches to problem solving and how these developed, 3) identify their perception and definition of intuition, and 4) probe their use and development of intuition in particular. The decision to talk about problem solving broadly prior to discussing intuition specifically is intended to better ensure that both elements are captured in the data, and reduce the impact of any negative stigma around the word intuition on the collected data. This is motivated by our prior experience suggesting that intuition can be a polarizing topic in engineering, whereas problem solving skills (of which intuition is one) are viewed favorably overall.

Ongoing work to pilot the interview protocol points to some of the challenges in capturing the intended data. We are actively exploring productive avenues to build out the first part of the interview focused on building rapport. We aim to create an interview space where participants feel comfortable talking about a vast variety of both professional and personal experiences without the invisible pressure of the field of engineering (similar to the "market-reflected gaze" that describes the market trends and standards that drive homeowners' renovation decisions [10]) on them. To this end, we're developing a version of the protocol that asks participants to discuss domains (outside of the workplace) in which they perceive themselves to be experts in their element, and using that to transition to discussing their problem solving in engineering.

Immediate future work will subsequently focus on recruitment and data collection for Aim 1 (year two) before shifting focus to Aim 2 in year three of the project. Aim 2 is to characterize the perceptions of intuition and its role in engineering practice held by engineering faculty and industry recruiters, and poses the fourth and fifth research question of this work.

RQ 4: How do engineering faculty and industry recruiters understand engineering problem solving, particularly the role of intuition?

RQ 5**:** What does the discourse around intuition across different groups reveal about sociocultural influences on the construct and the potential challenges of any intuition-related initiatives?

Aim 2 will employ a phenomenography (RQ 4) followed by discourse analysis (RQ 5). The outcomes will provide understanding of the target audiences for Education Plan Goal 2: developing and piloting materials, including short courses, that introduce intuition to engineering faculty, practitioners, and industry recruiters.

Broader Impact

The outcomes of this CAREER project will be broadly disseminated to positively impact: (1) scholars interested in the study of experience, expertise, and intuition, (2) educators seeking to build their students' workforce preparation, (3) students' and (4) practitioners' professional development, and (5) industry recruiters. Generating and applying new knowledge of the experience-intuition-expertise relationship to workforce preparation can: (1) better prepare the engineering workforce to take on upcoming challenges by leveraging the already widely-used problem-solving skill of intuition, (2) increase the capacity of the engineering workforce to develop new expertise through improved knowledge transfer, and (3) increase access to careers in engineering by embedding experience-based skills development into curricula to reduce the opportunity gap created by limited access to extra and co-curricular activities and expanding our understanding of experiences that support translatable problem-solving skill. These efforts have the potential to revolutionize engineering by facilitating a stronger workforce poised to more efficiently and accurately leverage their past experience to address arising problems.

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