

Understanding Ambiguity in Engineering Problem Solving

PROJECT SUMMARY

Overview:

What is ambiguity? That is the central question driving this proposal. Ambiguity has been approached in multiple ways, depending on the field of study: in terms of personal tolerance to ambiguity, multiple meanings, complexity, and indeterminacy. Surprisingly, within the field of problem solving itself ambiguity remains largely undefined, even though it is a key aspect of understanding and successfully solving engineering problems. The lack of a clear definition hampers efforts to better understand approaches to ill-structured problem solving.

Based on our literature review, we anticipate that there are multiple ways engineers can experience ambiguity and that there will be fundamental, qualitative differences in the way novices and experts experience it. Therefore, the goal of this project is to develop new knowledge about how novice and expert problem solvers (i.e., students and practicing engineers) experience ambiguity, and to develop a taxonomy of ambiguity. This taxonomy will provide researchers an opportunity to delve more deeply into how ambiguity is manifested in engineering, the processes problem solvers use to deal with ambiguity, and how to design educational approaches to teach students how to handle ambiguity. The research question guiding this study is: What are the qualitatively different ways that novice and expert civil engineers experience ambiguity?

We will use phenomenography in combination with artifact elicitation interviews to develop separate outcome spaces for novices (students) and experts (practicing engineers) in civil engineering. The result will be a description of the different ways ambiguity is experienced by these two groups when they have been engaged in solving engineering problems.

Keywords: expert-novice, phenomenography, problem solving

Intellectual Merit:

The primary intellectual merit of this project is the understanding of how ambiguity is experienced during engineering problem solving and the resulting taxonomy of ambiguity. This taxonomy will have important intellectual merit in helping to advance our understanding of problem solving generally. From a research perspective, a taxonomy will allow future research investigations that examine different and specific aspects of ambiguity. For example, we can use the taxonomy to develop a richer range of ambiguity problems experiences (e.g., multiple correct solution paths vs. an underspecified solution path), which can then be used to probe the relationships between ambiguity and other constructs (domain knowledge, working memory, epistemological beliefs, etc.). We will also provide a methodological contribution by showing how artifact elicitation can be combined with phenomenography.

Broader Impacts:

Because this project is designed to develop an initial framework and taxonomy of ambiguity, its broader impacts are primarily for the research community. Long-term we expect this thread of research to have important impact on the practice of engineering education, and we will conduct initial activities towards this goal. There will be two primary broader impacts activities for this project. First, we will conduct a workshop to bring together researchers in problem solving. At this workshop we will solicit feedback on the taxonomy and facilitate establishing new research projects and collaborations on problem solving. As an initial demonstration of the utility of the taxonomy for educational practice, it will be used to develop problems as part of a curriculum redesign that is ongoing in the co-PI's department, Environmental Engineering Sciences.