Board 224: Characterizing Design Activity Engagement: A Summary of Insights from Year Two

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Abstract

In this paper, we aim to summarize our efforts to understand how the identities of civil and mechanical engineering students engaged in capstone projects relate to their engagement in design activity. Building upon our previous introductory study, we share insights from the content analysis of interviews with civil and mechanical engineering students engaged in capstone design courses and report initial findings related to how students' self-perception as engineers impacts their role within the capstone team.

Introduction

In this paper, we summarize the initial results from a wider study funded through the NSF RFE (awards No. 2138019 and No. 2138106) program exploring engineering students' engagement and motivation in capstone design activities.

Capstone design courses are designed to expose engineering students to open-ended design problems and require students to collaborate with peers while using a variety of engineering skills gained over the course of their studies. Such courses are an integral part of future engineers' training as these experiences expose undergraduate engineering students to real-world design scenarios and encourage them to apply a variety of technical skills and conceptual knowledge toward solving complex engineering design problems.

Understanding and improving student engagement in design activity within the context of capstone courses could help students develop and solidify stronger design skills, and better prepare them to assume the role of professional engineers. Design activity engagement within the social context of capstone courses can be influenced by a student's identity, but little research has been done on understanding this influence.

Our investigation in the overarching study is informed by the concepts of situated cognition [1] and engagement within engineering practice [2], both accounting holistically for the context within which design activities are performed. Additionally, we account for frameworks defining personal engagement as a state in which "people employ and express themselves physically, cognitively, emotionally, and mentally during role performances" [3, p. 694] to better understand student engagement through a specific role within a capstone team.

In this paper, we provide a better understanding of the connections between a student's identity as engineer and their engagement in the design process within the context of capstone activities.

Our findings will contribute to our larger investigation and provide the foundation upon which a model of design activity engagement and identity motives of students can be built.

Summary of Project Objectives and Research Methods

This study contributes to a larger study aiming to develop a model of design activity engagement and identity motives in students and professionals, using the inductive approach of Constructivist Grounded Theory (CGT) [4] to conduct data analysis. The aim of this intermediate study is to collect and analyze descriptions of how Civil and Mechanical engineering students perceive their roles within their capstone teams, and how these roles relate to their personal identity.

The specific research-focused aims of this project are to:
Objective 1: Develop a model of design activity engagement and identity motives of students and professionals.
Objective 2: Expand our model to account for the resistance and synergies, alignment, and tension, between academic and workplace settings and across disciplines.

In this paper, we discuss our ongoing efforts toward objective 1 by examining the patterns between a student's personal identity and their roles within a capstone design team.

Summary of Data Collection:

Our findings in this study rely on data collected in the form of 14 semi-structured interviews with 8 students (4 Mechanical Engineering and 4 Civil Engineering students). All participants were selected through convenience sampling from 2 engineering capstone courses at a large research-intensive university. The first author conducted each interview between week 6 and 15 of a 20-week capstone course. A semi-structured interview protocol was developed with all co-investigators and used to elicit rich descriptions of student's engagement within their capstone design team. Probing questions were also employed by the first author to clarify and deepen participant's accounts of their roles within their team. The initial and focused coding of these interviews provided initial insights into our topics of interest.

Focused codes:

We present in this study the results of emerging focus codes [4] obtained through analysis of interviews described previously. After analyzing the content of each interview through initial coding, we created focus codes where recurring patterns appeared among initial codes. For example, Pablo explained that his choice of capstone project was made to fit what future engineering career he intended on pursuing after graduation, where Isabella saw the choice of her capstone project and role to gain insights into the tasks she would perform as an engineer. These

patterns seemed to suggest that these students related their project and roles within the project to their future self as engineers. Table 1 illustrates our process going from initial to focus coding.

Another notable pattern was the tendency for students to adapt their contribution within the capstone project to their competency or personal interests. Hunter described his interest in working with his hands and operating machinery and explained that he chose the role of manufacturing engineer in the project for this reason. Isabella mentioned choosing to take on her role within the team because it best fit the themes of the recent course she had taken.

Lastly, students' personal identities seemed to affect their identity as engineers and impact the way they engaged within the capstone team. While Cory's interest in solving multi-faceted problems led him to engage more readily in the design project, Ana's aversion to identity labels made her experience her defined role within her team as restrictive, hence affecting her engagement in design.

Participant	Initial Code	Focus Code
Pablo	Seeing project as fitting for future career	Relating Capstone to future self
Isabella	Using Capstone to gain insights on career role	
Amelia	Using capstone to showcase and confirm skills	
Hunter	Choosing role from hands-on interest	Adapting team contribution to competency and interest
Isabella	Matching role choice with current expertise	
Pablo	Matching project duties to personal interest	
Cory	Enjoying solving multi-faceted problems	Personal identity conflicting/reinforcing identity as engineer
Ana	Considering engineering label restrictive	
Hunter	Feeling motivated by solving complex problems	

Table 1 - Initial and Focus Codes

Future Work:

These emerging patterns observed during early stages of initial and focus coding will be studied more in depth through the subsequent data collection and analysis of our CGT study. Expanding the number of participants across both Mechanical and Civil capstone design courses will

provide further data and contribute to the credibility of our future findings. By continuing our ongoing study, we hope to gain a better understanding of patterns between students' identity and their engagement within capstone design and improve student's experiences within capstone design courses.

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