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How Implicit Assumptions About Engineering Impacted Teaching and Learning During COVID-19

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ABSTRACT

The COVID-19 crisis has challenged engineering educators with unplanned moves to remote delivery, providing an opportunity to examine the implicit beliefs that drive pedagogical practices in engineering. Drawing on Godfrey's (2015) framework for engineering education culture, core beliefs about engineering as a way of doing emerged, including fear of cheating, valuing of hardness, and views on flexibility. Concerns around cheating and hardness raise critical questions about the beliefs driving engineering pedagogy. In contrast, practices that prioritize flexibility such as providing recordings of lectures and slides and holding virtual office hours and review sessions allowed students more easily to participate.

Key words: Diversity Concerns, Undergraduate, Engineering Curriculum

INTRODUCTION

COVID-19 challenged engineering educators with unplanned moves to remote delivery across programs globally, exacerbating difficulties around inclusion, engagement, and inequality. Instructors had to make rapid, high-stakes decisions and develop teaching practices that also mitigated concerns about equity and access. These decisions and practices provide a unique opportunity to examine implicit beliefs about engineering teaching. Examining teaching practices and underlying beliefs can drive a re-evaluation of our pedagogy as the pandemic endures and faculty continue to make high-stakes, time-sensitive decisions. Understanding underlying assumptions, we argue, is essential to developing inclusive, learning-centered pedagogies.

FRAMEWORK

We use Godfrey's framework describing the culture of engineering education as a lens for examining implicit beliefs that drive pedagogical practices (Godfrey, 2015). The framework's key dimensions address engineering ways of thinking, doing, and being, as well as beliefs around difference, around the nature of student-faculty relationships, and around the relationship to the institutional environment. In this paper, drawing on interview data, we examine the "engineering way of doing" that impacted the students' classroom experience. We note the ways in which our findings are and are not consistent with Godfrey's findings.

An engineering way of doing refers to shared beliefs and assumptions about how teaching and learning should be done within engineering (Godfrey, 2015; Godfrey & Parker, 2010). One such belief that permeates the design of engineering curriculum is what Godfrey refers to as "hardness" – engineering education should be hard, and the workload should be heavy. This dimension also includes various beliefs about engineering curricula and teaching, including curriculum design, teaching methods, assessment methods, plagiarism, and time management (Godfrey, 2015).

METHODS

This analysis is based on semi-structured interviews with eight mechanical engineering students and three mechanical engineering faculty at two U.S. institutions: a small technical university in the western mountains and a large land-grant university in the mid-Atlantic. Participants were invited to participate via email, screened for the level of difficulty (a four-point scale, ranging from "It wasn't ideal, but I did fine" to "Honestly, it was pretty rough all around") they perceived in the spring semester, and selected for variation across perceived difficulty levels.

Hour-long interviews were conducted via Zoom in May and June 2020. Student and faculty participants were invited to discuss a course that went particularly well and a course that did not go well during the remote portion of the Spring 2020 semester. Participants were asked to describe the decisions they made about each course, including how courses were structured and how they responded.

RESULTS

Three core beliefs about engineering as a way of doing emerged as participants discussed their decisions in the remote course experiences: fear of cheating, valuing of hardness, and views on flexibility. Fear of cheating and valuing of hardness are consistent with Godfrey & Parker's (2010) definition of

an engineering way of doing, while flexibility represents a new component. Here we focus on student beliefs and observations, with relevant descriptions of how faculty participants agree or disagree.

Students repeatedly perceived that a fear of cheating motivated their instructors' decisions around assessments, which the interviewed faculty confirmed. Most student participants experienced at least one instructor who changed the assessments to discourage cheating. Students described instructors recognizing that students would take exams in their homes with access to the internet and course materials. As a result, students reported multiple strategies instructors employed to prevent students from using these resources, including using lockdown browsers, requiring attendance at Zoom meetings during exams, or restricting time so students could not finish the test on time if they used outside resources. However, as one faculty member mentioned, lockdown browsers and mandatory Zoom meetings raise privacy concerns: "I am very anti me sitting here watching someone take a test in their bedroom … I don't feel that's right." Moreover, restricting time doesn't account for the additional barriers students face with remote learning (e.g., time zones, family commitments, internet bandwidth).

Alternatively, students described instructors who allowed them to use course material and provided additional time, but took precautions by making their exams harder and "un-Google-able." This approach simultaneously recognized concerns about time constraints and cheating. While student participants generally understood instructors' desire to prevent cheating, they preferred an approach of "trust" rather than a presumption of guilt. A third-year engineering student commented: "Most people understand that you can't cheat your way through school and then go out in the real world and be successful." Students were particularly frustrated by exams that did not offer partial credit, especially when questions built on one another.

Practices that participants appreciated ran counter to the "engineering way of doing" described by Godfrey. Godfrey's framework positions "hardness" as a guiding belief, while "flexibility" is rarely associated with engineering courses. However, our student participants most frequently reported flexibility and student-centered teaching as successful practices within an engineering way of doing. Flexibility encompassed course requirements (e.g., removing a week of material, removing an assignment, making the final exam optional), timelines (e.g., flexible deadlines, extra time for exams), and students' circumstances (e.g., internet access, time zones, family obligations, illness). Importantly, the content in courses where instructors were flexible still challenged participants. They did not perceive flexibility as an impediment to educational quality.

IMPLICATIONS

The findings from these interviews point to two important implications for faculty in structuring courses under the pandemic and beyond. First, the prominence of concerns about making courses

"hard" and preventing cheating raises significant questions about the beliefs driving engineering pedagogy, particularly since we do not have evidence that this focus reinforced learning for students. Second, flexible practices that prioritize accessibility, including providing recordings of lectures and slides and holding virtual office hours and review sessions, allow students who face barriers traveling to campus to more easily participate. Even in in-person contexts, disabilities, family or work obligations, access to transportation, and more can create such barriers; flexible practices, that is, can make both remote and in-person teaching more inclusive. Going forward, this data suggests that instructors should continue to be adaptable to student needs and the way students are learning.

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