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BOARD # 334: CAREER: An Integrated Framework for Examining Contextual Influences on Faculty Pedagogical Decision Making and Student Learning in Design Education

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Introduction

Recently, the ways that emerging technologies, such as generative AI, social media algorithms, and predictive analytics, reflect, propagate, and exacerbate systems of inequality has made the impact of engineering decisions on people and society an issue of national importance [1-2]. As a result, scholars have called on engineering educators to facilitate learning experiences that challenge engineering as a technocentric discipline towards pedagogical practices that foster students' repertoires for understanding and integrating the social, technical, and contextual aspects of engineering judgements and decision making [3-4]. Since then, the push to implement so-called "sociotechnical" engineering education learning experiences have garnered immense institutional and federal resources, precipitating a proliferation of new and yet unproven approaches to designing and implementing sociotechnical engineering education activities [5].

Still, while sociotechnical engineering education has been valorized for its goal of producing more socially conscious, justice-oriented engineers, critiques abound. Scholars have raised concerns about the lack of clarity in how sociotechnical education is defined, noting that some engineering educators conflate sociotechnical engineering education with ethics education. Others have challenged the nature of sociotechnical learning activities, such as service-learning and community-based design projects, for their tendency to fail to engage with the ways power dynamics shape interactions between faculty, students, and community members [8-12]. These critiques elevate the need for clarity around defining sociotechnical design education.

Other criticisms have come from local, state, and national legislative actors who have advanced efforts to curtail or ban the teaching of the "divisive issues" in primary, secondary, and postsecondary education [13-14]. However, the form and function of these legislative attacks differs across sociopolitical contexts in the United States. That is, the teaching practices and learning activities allowed, even encouraged, in one sociopolitical context may be altogether banned in another, shaping the types of learning activities students have access to across contexts. However, little is known about the ways these sociopolitical factors are manifested in engineering classrooms, or the impacts of these issues on student learning.

Taken collectively, there is a need to understand the ways contextual factors influence how faculty define and implement sociotechnical design education. Thus, the purpose of this research is to (a) research the influences that support or constrain sociotechnical design pedagogies across contexts, (b) study how these contextual influences shape faculty pedagogies, and by extension, student learning, and (c) research strategies for addressing student resistance to sociotechnical engineering education. This research is guided by the following research questions:

1. How do contextual influences, such as sociopolitical restrictions, shape the pedagogical strategies engineering design faculty adopt to teach students about addressing social inequalities in engineering design processes?
2. What educational activities catalyze students' sociotechnical design repertoires in engineering design contexts?

3. How is student resistance to sociotechnical engineering design manifested in engineering design education, and what context-specific strategies can faculty adopt to mitigate student resistance?

Conceptual Framework

This research draws on the Academic Plan Model (APM) which "makes explicit the many factors that influence the development of academic plans in colleges and universities" [15, p. 5]. Additionally, the APM considers the influences of local, national, and societal sociocultural and historical factors that shape the development and implementation of academic plans. For example, Lattuca and Stark [15] note how internal (e.g., to the institution) influences, such as the institutional mission, financial resources, the characteristics of students, and faculty governance structures are important factors shaping curricular decision making.

Indeed, decades of research has connected institutional missions to prescribed programs of study, as well as the learning experiences embedded in those programs [e.g., 16]. Faculty teaching at land-grant institutions, whose missions entail "solving the practical problems faced by residents of their state" [17, p. 1] might encounter different resources and sociopolitical supports and barriers than those at small, private research institutions. Other internal influences, such as the the makeup of the student body of an institution, have also been shown to influence faculty pedagogical decision making [18]. For example, Cardella colleagues described the need to "consider how we recognize and value assets students bring to undergraduate engineering design experiences" across contexts when developing design coursework [18, p. 20333].

Similarly, the APM points to external influences, such as accrediting agencies (e.g., ABET) and local, state, and national governments, as factors exerting influence on academic plans. For example, new local, state, and national legislation designed to curtail the teaching of "divisive" sociopolitical issues in higher education may result in a "chilling effect" for faculty pursuing educational reforms [14, 19] that may lead some educators to avoid topics altogether. However, little is known about how faculty have responded to local, state, and national legislation in their pedagogical practices and learning activities in design education.

According to Lattuca and Stark [15], the APM is suitable for understanding all levels of the curriculum, from a single lesson to a course, to the integrated curricular and co-curricular learning experience that constitutes a student's academic career in higher education. We apply the APM to studying the ways that faculty implement sociotechnical design education in specific courses across academic (i.e., institutional) and geopolitical contexts, focusing specifically on the conditions under which various influences shape faculty pedagogical decision making.

Finally, we extend the APM to study an additional internal factor shaping the implementation of sociotechnical design education–student resistance. To do so, we draw on the Weimer Framework for Student Resistance [20], which describes types and manifestations of student resistance. Weimer described three broad categories of student resistance, such as (a) passive, nonverbal resistance, (b) partial compliance, and (c) open resistance. We draw on this framework to understand student resistance to sociotechnical engineering design education across sociopolitical contexts, as well as mechanisms by which faculty address resistance.

Methodological Framework

Drawing on the APM, our research plan entails comparing the influences on faculty pedagogical decision making across contexts and over time. As such, we draw on the comparative case study (CCS) methodological framework for data collection and analysis procedures. The CCS methodology was recently applied to the study of faculty pedagogical decision making related to diversity, equity, inclusion, and justice in engineering education (see: [21]). According to Carrero [22], the CCS methodology extends case study methods by helping researchers understand engineering faculty decision making not as static, bounded cases but as evolving, dynamic, context-sensitive decisions that reflect "an evolving sense-making process shaped by historical, socio-political, and power-laden forces" [22, p. 4]. While Carrero's work, which similarly draws on the APM, focuses on engineering educators', broadly defined, integration of DEIJ topics into their pedagogies, the present research focuses on engineering design education.

The CCS methodological framework "attends simultaneously to macro, meso, and micro dimensions of case-based research" [22] by allowing for comparison across three axes. First, the horizontal axis, which allows for examining faculty pedagogical decisions across cases, will examine how faculty pedagogical decisions, such as the types of learning activities they design and their assessment strategies, differ across sociopolitical contexts. Second, the vertical axis, which examines cases across various levels. In this, we presuppose that influences on faculty pedagogical decision making differ at the unit/departmental-, institutional-, local-, state-, and national levels, and have designed data collection procedures to interrogate the various influences at each level. Finally, the transverse axis allows for comparison over time [22]. For example, the implementation of new local, state, and national legislation, as well as the advent of new or evolving sociopolitical influences may shape faculty motivations and implementations of sociotechnical design education.

Research Methods

Drawing on the APM [15] and Weimer Framework [20], this research will entail two data collection strands–one *faculty strand* examining influences on faculty pedagogies and one *student strand* examining the impact of faculty pedagogical decisions on student learning in engineering. Data collection in the faculty strand, which will begin in the Spring of 2025, is guided by the integrated methodological framework that combines two data collection strategies. First, we will begin with one-on-one interviews with engineering design faculty who teach team-based, project-based engineering design courses. We will begin first locally and then move to institutions across sociopolitical contexts in Massachusetts, Florida, Texas, California, and Michigan.

The one-on-one interviews will entail four broad topics guided by the theoretical framework and, where appropriate, research on sociotechnical design education: (a) motivations for implementing sociotechnical design education, including how positionality informs their pedagogies, (b) contextual influences on pedagogical decisions, (c) assessments of learning in sociotechnical design education, and (d) goals for learning about sociotechnical design education. Example interview questions are presented in Table 1 below.

Second, to build a community of practice amongst scholars implementing sociotechnical design pedagogies, we plan a set of "group pedagogical reviews" that position faculty to interact with faculty members across sociopolitical contexts. The goal of these group pedagogical reviews is to position faculty to compare their activities, as well as facilitate pedagogical ideation and innovation. The group pedagogical reviews will happen across three meetings that combine faculty across sociopolitical contexts. In Meeting 1, the groups will discuss how faculty develop projects that facilitate the development of students' sociotechnical design repertoires, including whether and how faculty develop relationships with local community partners. In Meeting 2, the groups will discuss learning activities for fostering students' sociotechnical design repertoires. Finally in Meeting 3, the groups will discuss assessments of learning in sociotechnical design.

Data collection in the student strand will consist of an ethnographic study of student learning across sociopolitical contexts in Massachusetts, Florida, Texas, California, and Michigan. The study will consist of ethnographic observations, survey data collection, and interviews with students enrolled in sociotechnical engineering design courses. The goal is to understand how the varying sociopolitical influences on faculty pedagogies are manifested in students' learning experiences and, by extension, learning outcomes.

Discussion and Conclusion

This research seeks both to understand contextual factors that shape faculty pedagogical decision making as well as build community for faculty implementing sociotechnical design education. Our recent interactions with engineering design faculty make clear that faculty face challenges while implementing sociotechnical design education. However, as Costanza-Chock [11] notes, "that wherever people face challenges, they are always already working to deal with those challenges" (p. 20). We believe this project represents an opportunity to learn from faculty already attempting to address contextual challenges that undermine sociotechnical design pedagogies and learning outcomes.

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