Chapter 4
Designing Expansive Science and Engineering Learning for Heterogeneity, Justice, and More Sustainable Futures

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ABSTRACT

As the science and engineering disciplines push toward more culturally sustaining and justice-centered approaches, there is a growing need to support educators in designing more expansive learning experiences. In this chapter, we provide a Justice-Centered Design Matrix to support formal and informal science and engineering (SE) educators in (re)designing their curriculum and pedagogy to weave in the sociopolitical and sociocultural contexts of SE with the edges of disciplinary knowledge and practices toward expansive learning experiences. Through an overview of the design matrix and illustrative examples of how the matrix was used to design learning experiences for a pre-service teacher SE content course and in-service professional learning course, we describe how this framework can be used to design culturally sustaining and justice-centered SE learning experiences. In creating a framework for educators to critically reflect on their design and practices, we propose a model for how to make culturally responsive and sustaining pedagogies and curriculum in SE more accessible.

INTRODUCTION

Formal science education learning spaces have not typically functioned in ways that cultivate the natural curiosity of students. More specifically, these learning spaces do not support students in seeing the value of science through consequential learning that captures the heterogeneity of human learning, and that is grounded in diverse ways of knowing, being and doing. Science learning is often structured to indoctrinate students into settled science (Bang et al., 2013) - one that is heteronormative, narrow, and has bounded understandings of disciplinary knowledge that ignore the multiple ways individuals engage in and understand the field. However, recent work in science and engineering (SE) education has begun to push toward more culturally sustaining and justice-centered learning experiences for students that attend to cultural and linguistic variation in learning, as well as develop students' critical thinking and consciousness, abilities to question and critique, and lens to discern how science can be used as a tool for societal change.

Despite these advancements, historically and contemporarily, SE fields continue to neglect the role of social sciences in our conceptions of the discipline, and consequently, SE learning. More specifically, the disciplines fail to address the systemic and institutionalized racist, sexist, and power-laden nature of SE, the scientific enterprise, and science-backed policies (McGee, 2020), as well as their disproportionate impacts on Black, Indigenous, Latinx and other people of color (Johnson-Agbakwu, 2020). As such, we can no longer continue to ignore the nu-