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BOARD # 336: CAREER: Engineering Identity in a Makerspace Supported Multi-disciplinary Course

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CAREER: Advancing Engineering Identity Development Through Multidisciplinary Courses and Makerspace Integration

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Abstract

This study examines how undergraduate students develop an engineering identity within a multidisciplinary course incorporating an academic makerspace. Survey data were collected at the beginning and end of the Fall 2023 semester, supplemented by observational field notes and student-created artifacts. Findings indicate a statistically significant positive shift in engineering identity dimensions, particularly in performance/competence beliefs and recognition. This research highlights the potential of academic makerspaces to foster engineering identity beyond traditional curricula and suggests that multidisciplinary, experiential learning environments can democratize access to engineering pathways. Implications for future course design and broader educational policy are discussed.

Introduction

Engineering identity development is a critical predictor of persistence and success within engineering education (Stevens et al., 2008). Traditionally nurtured through disciplinary coursework and engineering-focused extracurriculars, the pathways to developing a robust engineering identity are evolving alongside the rise of multidisciplinary learning environments. Academic makerspaces, characterized by open-ended, collaborative, and experiential learning opportunities, present promising contexts for identity formation across diverse student populations (Forest et al., 2014).

This study investigates how participation in a multidisciplinary course with embedded makerspace activities influences undergraduate students' engineering identity over one semester. It builds on prior frameworks of professional identity development (Carlone & Johnson, 2007; Tonso, 2006), offering insights into the mechanisms through which hands-on, interdisciplinary learning experiences contribute to students' self-concept as engineers. Through a mixed-methods approach, this study explores the following research question: *How does participation in a multidisciplinary course with makerspace activities impact students' engineering identity?*

Literature Review

Understanding Engineering Identity

Engineering identity is a multidimensional construct encompassing self-recognition of competence and performance, internalized interest, and external recognition by others (Godwin, 2016). These dimensions significantly affect students' persistence, engagement, and career trajectories (Patrick et al., 2018). Carlone and Johnson (2007) emphasized the interplay between competence, performance, and recognition, while Hazari et al. (2010) extended this framework to include interest as a critical factor in physics and engineering identity development.

Identity evolves through interaction with environments that offer "identity resources" (Wenger, 1998; Stevens et al., 2008). These environments provide critical opportunities for performance and recognition that shape self-perceptions. Research has shown that supportive environments that foster frequent, authentic engagement in disciplinary practices enhance identity development and persistence in STEM fields (Hazari et al., 2010; Godwin, 2016).

The Role of Makerspaces in Engineering Identity Formation

Academic makerspaces provide unique opportunities for hands-on engagement, prototyping, and collaborative problem-solving, activities directly linked to the competence and performance facets of engineering identity (Usinski et al., 2024; Andrews et al., 2021). Makerspaces also facilitate peer recognition and the formation of supportive learning communities, critical to strengthening engineering identity (Forest et al., 2014). Studies such as those by Litchfield and Javernick-Will (2021) have demonstrated that makerspaces build social capital and foster a sense of belonging, particularly for underrepresented groups. Additionally, Slaton (2010) argues that inclusive design and accessibility in educational spaces like makerspaces are essential to broadening participation in engineering. Recent investigations highlight that participation in makerspaces correlates with improved innovation self-efficacy and greater academic and professional confidence (Andrews et al., 2021). However, most prior research has focused on engineering students already committed to the field. There is a gap in understanding how multidisciplinary makerspace experiences shape identity trajectories among students with varying levels of prior exposure to engineering.

Although the link between makerspaces and skill development is established (Forest et al., 2014; Wilczynski, 2015), more research is needed on how multidisciplinary makerspace courses shape engineering identity dimensions holistically, particularly regarding recognition and belonging across diverse student populations (Stevens et al., 2008; Tonso, 2006).

Methods

Course Context and Design

The study was conducted in a multidisciplinary undergraduate course offered in Fall 2023 at a large public institution in the southern United States. The course featured collaborative, project-based learning centered around real-world challenges, with substantial engagement in an academic makerspace for prototyping, fabrication, and testing.

Data Collection and Analysis

The study employed a mixed-methods approach. Pre- and post-course surveys measured engineering identity dimensions using a modified version of a validated instrument. The survey included twelve Likert-scale items measuring performance/competence, recognition, and interest. Open-ended survey responses, field notes from observations, and student artifact documentation were also collected. Twelve students completed both pre- and post-surveys, and all participation was voluntary and anonymized.

Quantitative data were analyzed using paired-sample t-tests to examine statistically significant changes in engineering identity dimensions. Qualitative data were analyzed through thematic analysis using open and axial coding to identify patterns related to students' engagement, recognition experiences, and identity shifts. Exploratory analyses were performed by gender, prior engineering experience, and makerspace participation frequency.

Results

Survey results revealed statistically significant positive shifts in two key dimensions of engineering identity: performance/competence beliefs and recognition. The paired-sample t-tests indicated that students' self-assessment of their engineering skills and their perceived acknowledgment from peers and instructors improved meaningfully over the course of the semester ($p = 0.01$ and $p = 0.03$, respectively). Interest levels remained consistently high,

suggesting that students entered the course with strong enthusiasm for engineering-related activities, and this enthusiasm was maintained throughout the semester.

Students without prior engineering coursework demonstrated the most substantial gains in performance/competence beliefs. This finding suggests that the makerspace environment may be particularly impactful for students who do not initially identify strongly with engineering. Female students reported higher increases in external recognition compared to their male peers, underscoring the importance of inclusive and supportive learning environments in fostering identity development among underrepresented groups.

Qualitative data from open-ended survey responses, classroom observations, and analysis of student artifacts provided additional insights. Students frequently described the makerspace as "empowering" and "transformative," with many citing the opportunity to see tangible outcomes of their ideas as critical to building their confidence as engineers. Observational data revealed that students who engaged more frequently with makerspace resources, both during and outside of scheduled class time, developed deeper collaborative networks and demonstrated increased agency in project leadership roles.

Analysis of student artifacts, including project prototypes and final presentations, further corroborated survey findings. Students who reported greater shifts in identity also produced more complex and technically sophisticated projects, indicating a link between self-perception of competence and actual performance outputs. Additionally, students noted that peer collaboration and informal mentorship relationships formed in the makerspace significantly contributed to their sense of belonging and external recognition. Taken together, the quantitative and qualitative findings provide compelling evidence that multidisciplinary makerspace experiences can positively influence multiple dimensions of engineering identity, particularly performance/competence and recognition, even within a single semester timeframe.

Discussion

The findings corroborate prior research that makerspaces function as rich "identity resources" by providing authentic engineering experiences. Hands-on engagement supported the development of performance and competence, while collaborative activities fostered recognition and belonging. Makerspaces serve not only as spaces for technical skill development but also as environments where students negotiate and affirm their identities as engineers through peer interaction and project-based success.

The limited growth in exam-related confidence suggests that practical makerspace skills may not directly translate to traditional assessment formats. This disconnect highlights the need for educational strategies that better integrate experiential learning with academic evaluation. Future course designs should consider embedding exam-aligned makerspace activities or developing reflective practices that bridge the practical and theoretical aspects of engineering education.

This study extends existing models of engineering identity development by demonstrating that multidisciplinary makerspace activities can enhance identity dimensions even outside traditional disciplinary boundaries. By situating engineering identity development within a multidisciplinary context, this research underscores the importance of inclusive, hands-on learning environments in broadening participation in engineering pathways.

Educational institutions should consider embedding makerspace opportunities across diverse disciplines to foster broader engineering identity development. Furthermore, the design of makerspaces and their programming must be intentional in promoting inclusivity to support

underrepresented students' persistence in STEM fields. Attention to mentorship structures, recognition practices, and community-building activities within makerspaces can further amplify their impact on identity development.

The small sample size of this study limits the generalizability of the findings. Future research should incorporate longitudinal designs to explore the durability of identity shifts over time and examine how social networks within makerspaces influence professional identity formation. Investigating the intersections of makerspace participation, disciplinary identity, and career outcomes across diverse populations will provide richer insights into the transformative potential of these spaces in engineering education.

Conclusion

Multidisciplinary courses that integrate academic makerspaces offer powerful opportunities for fostering engineering identity. This study demonstrates that such experiences promote performance/competence beliefs and external recognition, key predictors of persistence in engineering fields. As makerspaces become more central to higher education, understanding their role in shaping diverse pathways into engineering is critical for building a more inclusive and innovative future workforce.

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