Divergent Paths to Teaching Innovation: How Three Engineering Professors Engaged with Communities of Practice

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Background

The role of communities of practice (CoPs) in improving teaching has been widely documented in engineering education literature. Faculty CoPs have been shown to promote the integration of Evidence-Based Instructional Practices (EBIPs) in STEM courses, enhancing student learning outcomes and fostering collaborative teaching cultures [1], [2]. CoPs allow faculty to share ideas, support each other, and work together to make teaching better and improve students' learning experiences.

Previous studies have shown that faculty communities play critical roles in promoting and sustaining instructional change for improving teaching practices in undergraduate STEM education [3], [4]. They are particularly helpful in encouraging faculty to make lasting changes to their teaching practices. CoPs enable STEM faculty to pursue shared goals and receive institutional support to overcome challenges to teaching innovation [5]. Through CoPs, faculty can work toward shared goals and find the support they need to try new teaching methods, even when there are challenges.

However, engineering faculty often face systemic challenges in prioritizing teaching innovation. Traditional academic reward structures frequently emphasize research outputs over teaching contribution [6], [7]. When universities reward research more than teaching, faculty members feel less motivated to invest their time and effort in improving their teaching. This research-over-teaching system discourages faculty from investing in teaching innovation, despite its important impact to enhance student learning.

Previous studies have highlighted the role of mentoring and collaboration in fostering faculty development and institutional change [8]. Mentorship and collaboration play critical roles in helping faculty grow and make changes that benefit students and institutions. These studies reveal that CoPs not only support the adoption of evidence-based teaching practices but also help faculty overcome barriers in the university that give teaching less recognition. This study builds on prior work by examining how faculty take divergent paths during their participation in CoPs to solve problems and innovate in teaching and learning in their courses.

In research-intensive universities, where faculty often navigate tensions between research and teaching priorities, CoPs provide a space for fostering teaching innovation. This study explores the divergent paths three senior engineering professors took as they engaged with teaching-focused CoPs, highlighting how they navigated innovation, collaboration, and resilience within the context of institutional challenges.

The faculty members' participation in CoPs was supported by an internal grant program, referred to as the Teaching Innovation Program (TIP) for confidentiality purposes. The TIP aims to support CoPs by providing annual funding to teams of faculty who share a commitment to improving teaching practices in engineering education. Over the past decade, the program has funded between 7 and 17 faculty teams annually, fostering collaboration, knowledge exchange, and the adoption of evidence-based teaching practices.

As engineering education researchers, we are interested in how Communities of Practice (CoPs) influence faculty members' professional growth and teaching practices in environments where research is prioritized. We focus on how personal, departmental, and institutional factors affect faculty engagement in teaching innovation and how they navigate tenure systems that prioritize research. To explore this, we asked the following research question:

> How do individual faculty members' choices and pathways influence their engagement with teaching-focused communities of practice and their efforts to advance teaching innovation within a research-intensive university?

We choose Communities of Practice (CoPs) as the theoretical framework for this study [9]. CoPs are groups of individuals who engage in collective learning through shared practices and collaboration toward shared goals. In the context of faculty teaching innovation, CoPs offer a structured but flexible environment for members to construct knowledge, navigate challenges, and evolve their teaching roles through collaboration. This framework guided our selection of participants who had been involved in Cops for many years and informed our narrative analysis approach. Understanding CoPs as social learning systems allowed us to examine how shared values and collaborative practices influenced each professor's engagement with and impact on teaching innovation.

As communities of practice have supported faculty in teaching and learning innovation, recent conversations in engineering education have begun to focus on the potential of developing an entrepreneurial mindset (EM) for undergraduate engineering education. EM involves fostering curiosity, creating connections, and generating value, skills that align with innovation and adaptability in the classroom. Although not a central focus of this study, several participants demonstrated behaviors aligned with EM through their proactive, collaborative, and student-centered approaches to teaching reform. These emerging patterns raise new possibilities for exploring how CoPs might support EM in future faculty development initiatives.

Methods

The Teaching Innovation Program (TIP) is an annual initiative designed to foster teaching innovation in undergraduate engineering classrooms at a large research-intensive Midwestern U.S. university (referred to as Midwestern Tech). Funded by the College of Engineering for over a decade, TIP encourages engineering faculty to collaborate in study teams to develop and implement innovative teaching practices. Faculty teams submit proposals for teaching innovation projects, and selected teams receive funding and support to conduct their studies over the academic year. These projects often focus on enhancing student engagement, integrating new technologies, and addressing discipline-specific teaching challenges. By creating an organized

opportunity for faculty to collaborate and experiment, TIP has been a supporting structure for teaching innovation.

We used a qualitative case study to explore how three senior tenured engineering professors participated in teaching-focused communities of practice (CoPs) at a large research-intensive public university in a Midwestern U.S. over a decade. We chose a case study approach because we focus on providing in-depth understanding of individual participants' unique experience within their real-life contexts [10]. This approach allowed us to deeply examine how these professors navigated and overcame teaching challenges. The participating engineering faculty brought diverse perspectives on addressing systemic challenges while engaging in innovative practices. Moreover, qualitative case studies enable researchers to focus on bounded systems, such as the institutional context, to provide rich descriptions of participants' experiences [11].

We chose three white men engineering professors. Each professor has over 15 years of teaching experience, and sustained engagement in the Teaching Innovation Program (TIP) for 7 to 10 years. These tenured full professors who represented distinct engineering disciplines, offered rich insights into teaching-focused communities of practice (CoPs). In addition to teaching, some held administrative or curricular leadership roles within their departments. All professors showed a strong commitment to addressing systemic challenges related to the research-over-teaching culture of their institution and to participating in CoPs to address critical problems they identified in the courses they taught. Their varied yet overlapping identities and career paths provided a nuanced view of how CoPs can foster innovation, mentorship, and professional development in research-intensive contexts.

We collected data from multiple sources for this study: semi-structured interviews via an online video (8–10 pages transcripts) used as the primary data source and artifacts related to their TIP participation. Semi-structured interviews gave us detailed accounts of their teaching journeys, including their strategies and challenges. Individual interviews, a primary research method in qualitative research, allowed us to explore participants' perspectives on their experiences in depth [11]. Collecting artifacts was included to examine the participants' engagement with CoPs and their broader perceptions of collaborative teaching practices in their contexts. Document analysis of institutional records, TIP project documents and artifacts, and project proposals provided further insights into institutional contexts around participants. The importance of multiple data sources is well aligned with case study research [10] by triangulating data and enhancing the credibility of the findings.

We used narrative analysis to examine the data, organizing participants' stories around predetermined themes, such as motivation, lived experience, impact on teaching and career, and barriers and challenges. This approach focused on preserving participants' individual stories while organizing their narratives within the themes we focused. To establish trustworthiness of data analysis, we conducted multiple close reading of interview transcripts and documents to construct coherent narratives for each participant. By maintaining the sequence and context of their experiences, the analysis captured their engagement with CoPs. Themes were used to frame the narratives, ensuring consistency across participants to allow their unique voices to be heard.

Findings

The Resilient Innovator

The Resilient Innovator's story emphasizes the power of collaboration in transforming teaching cultures, even in the face of institutional resistance. Reflecting on his initial motivation, he shared, “I think a part of a big motivation for me initially…was that I wanted to work with other people to do this.” His aim was to go beyond isolated efforts and create systemic improvements. “I didn’t just want to work on my class alone…I wanted to do something that was going to involve multiple classes and multiple instructors,” he explained. This aspiration drove him early engagement with teaching-focused communities.

His lived experience underscored the power of collaboration in reshaping departmental culture. “This working with other faculty was really key to my whole experience,” he reflected. Through collective efforts, he observed significant cultural shifts. “There’s now a community that works with each other and talks to each other…It used to be isolated people,” he explained. The CoP fostered cross-departmental connections, enabling faculty to exchange ideas and strategies. As he noted, “You can achieve things you wouldn’t achieve otherwise and…change the way the department culture or the teaching culture really works.

His most notable contributions came through the adaptive course learning system and digital testing system projects, which transformed assessment practices and student learning experiences. “The adaptive course learning system and digital testing system projects clearly had tremendous impact…so many classes radically altered and the student experience about learning,” he shared. These initiatives demonstrated how faculty collaboration can lead to teaching change across multiple classes. “Having the support from the college and the financial support was helpful, but financial support…wasn’t the main thing. The main thing is just that you have a group of people that you meet with regularly,” he emphasized.

Participation in these projects also influenced his career trajectory. “I started messing around with what became Adaptive course learning system in my own class, but it never would have gone anywhere if it was just for my one class,” he explained. His efforts to scale these projects across multiple courses showcased the impact of collective action on teaching innovation.

Despite his achievements, systemic barriers posed significant challenges. “It caused lots of problems…my department had never promoted somebody who did education research, and they didn’t know how to evaluate my promotion case,” he revealed. This lack of acknowledgement from the university highlighted the undervaluing of teaching-focused contributions in academia. However, he found fulfillment in his dual focus on research and education. “I basically switched about half of my research effort towards education…these have both been really fulfilling to me,” he noted. His experience underscores the resilience required to pursue teaching innovation in environments that prioritize research over pedagogy.

The Resilient Innovator’s story highlights the transformative potential of communities of practice in supporting faculty collaboration and driving systemic change, even in the face of institutional resistance.

The Writing Integration Champion

The Writing Integration Champion's journey began with a shared frustration over students' poor technical writing skills. Reflecting on initial discussions with colleagues, he recalled, "We were saying, 'The students had poor technical writing and they're not getting better. What can we do?'" These conversations revealed a lack of understanding about teaching technical writing effectively. He explained, "We realized we don't really understand how to teach technical writing and that we need to learn to do that." His efforts highlight how shared goals can lead to significant educational improvements, despite initial challenges in group dynamics.
The discovery of SIIP funding was pivotal in moving from conversation to action. "SIIP gave us the incentive to push a student forward and take responsibility to actually do something," he noted. This funding provided not only financial resources but also a sense of accountability that drove his team to take meaningful steps toward addressing the issue.

His lived experience in the CoP was transformative but not without challenges. "Communication was kind of hard…we were arguing and disagreeing," he admitted about the initial stages of collaboration. However, the group eventually overcame these difficulties. "When we overcame that…it became a really good group. Lots of different people contributed, and it wasn't one person doing everything," he shared, highlighting the collective effort and mutual respect that defined their work.

The project evolved gradually, starting with modest goals such as surveying best practices and culminating in workshops and training programs. "We reached a certain level where we thought, 'This is pretty good,'" he recounted. The success of these efforts inspired the team to pursue larger initiatives, leading to a funded NSF proposal. "That was a great success story, and I was very proud of that," he added, reflecting on the impact of their work.

Participation in the CoP profoundly influenced his teaching philosophy. "I think I'm teaching with more care for the student, like considering the student more," he observed. Early in his career, his approach was more rigid: "'This is it…so I'm teaching it, and too bad.'" Over time, he began to prioritize empathy and adaptability, balancing rigor with care. "You can be challenging… but you're always there, listening, watching, caring," he explained. This introspective approach extended beyond his own classroom. "I'm always looking to like, 'Hey, how can we make this better?'" he said, emphasizing his commitment to continuous improvement. His work in the CoP reinforced his belief in collaboration and the value of interdisciplinary learning. "We created a culture where writing is seen as integral to engineering education, not an add-on," he concluded.

Despite his achievements, institutional barriers remained a persistent challenge. "I won the teaching award from the college, and I thought they'd be happy," he recalled. Instead, senior colleagues reacted negatively, urging him to prioritize research. "They said, 'Focus on research.' I said, 'Who said I'm not focusing on research? I am!'" This lack of institutional support highlighted the ongoing tension between teaching and research priorities.

Despite the lack of support, he remained committed to his value, "After that, my attitude was, I'm going to do what I believe is the right thing," he stated. His experience underscores the

resilience required to pursue teaching innovation in environments that often undervalue such efforts. By remaining steadfast in his vision, he demonstrated how CoPs can empower faculty to navigate systemic challenges while driving meaningful change.

The Balanced Strategist

The Balanced Strategist entered his career committed to excelling in both research and teaching. “I always believed that you shouldn’t have to choose between being a good researcher and a good teacher,” he explained. His work underscores the value of ongoing improvements to teaching supported by CoPs. His motivation for joining the project was rooted in a desire to scale his work to benefit more students. “I wanted to hire a team of people to help develop and write this code...serving several hundred, now almost a couple thousand, students this semester,” he shared. For him, teaching became more central over time. “I really get more out of teaching personally than I get out of research. Teaching is really where I live, I guess,” he admitted. This evolving perspective highlighted his long-term goal of contributing meaningfully to engineering education.

The Balanced Strategist’s lived experience in the classroom revealed important challenges. “I’ve noticed an increase in the level of anxiety among students in my class, even before the pandemic,” he observed. This realization led him to focus on scaffolding exercises designed to alleviate student anxiety. “The scaffolding exercises are designed to directly address anxiety and give people a gentler vehicle to build up expertise and confidence,” he explained.

Feedback from students reinforced the value of this approach. “We’ve been surveying the students and now have some evidence that, at least from their perspective, this approach is helping,” he noted. These efforts underscored the importance of tailoring teaching practices to meet students’ needs. Participation in the CoP fundamentally reshaped his teaching practices. “One thing that became clear was that there were problems in the class where I didn’t actually have a design process,” he acknowledged. This insight led to significant changes in his approach. “I reorganized the lectures and homework to focus on a clearer process,” he shared, adding, “It’s still ongoing, but as my picture of the process gets clearer, I can better emphasize what’s important as I teach.”

This continuous process exemplified the influence of CoPs in refining teaching strategies. By applying what he learned, he not only improved student outcomes but also clarified his own teaching approach.

Despite his successes, barriers persisted. “Honestly, I think time was the biggest barrier. Between teaching, research, and administrative duties, there was just no time,” he admitted. The culture within computer science also posed challenges. “In computer science, teaching is often seen as a service obligation rather than a personal passion,” he observed. This perception often devalued teaching-focused efforts, making it difficult to prioritize them. “There’s a perception that focusing on teaching means you’re not serious about research, which is frustrating,” he noted. Yet, through his engagement with the CoP, he found the support and validation needed to persist. This experience highlighted the systemic challenges faculty face when balancing teaching innovation with research demands.

Discussion

The findings illustrate how Communities of Practice (CoPs) serve as effective structures for fostering collaboration, driving innovation, and addressing systemic challenges in research-intensive universities. Across the three cases, the Resilient Innovator, the Writing Integration Champion, and the Balanced Strategist, several key themes emerge.
CoPs played a critical role in influencing faculty identities and practices by fostering a collaborative environment for innovation. Participants found a sense of belonging that validated their teaching- focused aspirations. The Resilient Innovator emphasized the shift from isolated efforts to a department-wide culture of collaboration, while the Writing Integration Champion highlighted how shared frustrations led to actionable solutions. The Balanced Strategist demonstrated how CoPs supported iterative improvements in teaching methodologies, underscoring the role of collaboration in fostering continuous growth.

The cases highlight systemic challenges that hinder faculty efforts to innovate teaching. Institutional norms often prioritize research over teaching, devaluing contributions to pedagogy. For instance, The Resilient Innovator faced challenges in promotion evaluations due to his focus on teaching innovation, while The Writing Integration Champion encountered negative reactions to his teaching accolades. These experiences highlight the resilience faculty need to overcome an institutional culture that values research over teaching and show how CoPs provided support through peer networks and shared implementation that promoted educational improvement.

Despite their distinct experiences, all participants faced common challenges, including high teaching workloads, limited recognition for teaching efforts, and resistance from peers. CoPs provided tools and strategies to address these barriers, such as fostering interdisciplinary collaborations, using technology, and implementing structured feedback mechanisms. These strategies improved teaching practices and fostered a culture of faculty engagement, shared practices, and teaching innovation.

Participation in CoPs significantly influenced faculty members' teaching philosophies and practices, leading to enhanced student outcomes. The Resilient Innovator’s work on adaptive course learning system and digital testing system demonstrated how collaborative efforts can be expanded to produce broader solutions, while the Balanced Strategist’s focus on scaffolding addressed student anxiety effectively. The Writing Integration Champion’s integration of writing into engineering education exemplifies how CoPs can inspire systemic curricular changes.

Limitations and future research

This study is subject to several limitations that should be considered when interpreting its findings. First, the sample size is limited to three cases, which may constrain the generalizability of the results. While these cases offer rich and detailed insights, broader studies with larger and more divergent samples are necessary to confirm the patterns identified here. Second, the findings are specific to a single institutional context, and universities with different cultures, resources, and support systems may experience different outcomes regarding the role and effectiveness of CoPs. Finally, the reliance on self-reported data from interviews introduces

potential biases, as participants might emphasize the positive aspects of their experiences or downplay challenges they encountered.

Building on the findings of this study, future research could more explicitly examine how faculty Communities of Practice (CoPs) contribute to developing an entrepreneurial mindset (EM) in engineering education. Participants showed a mindset consistent with EM principles, such as initiating collaborative solutions, building connections to support innovation, and creating lasting value [12], [13]. Though EM was not an explicit focus of the CoP projects, these aligned practices suggest that CoPs are a promising structure for cultivating EM among faculty. Future studies could explore how CoPs foster curiosity, build connections, and create value in engineering classrooms, also assess their impact on student learning. Examining this alignment could offer practical strategies for integrating adaptability and entrepreneurial thinking into both faculty development and course design.

In addition, future research should explore how institutional and peer support structures within CoPs can reduce barriers to teaching innovation. It could also examine how CoPs help faculty manage demands between research and teaching expectations, and what recognition or reward systems are most effective in helping faculty continue to engage in teaching-focused efforts in a research-intensive university.

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