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Pedagogical Innovation Perspectives from Engineering Faculty and Staff: Barriers and Affordances

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Abstract:

This research paper examines the barriers and affordances that engineering faculty and staff members perceive for pedagogical innovation within a single institution. Despite the urgent need for pedagogical change in engineering, the adoption of research-based pedagogies and innovation has been slow. Pedagogical innovation in engineering education has been a critical area of research driven by the need for the development of more well-rounded engineers with critical competencies for industry and supported by new technological advancements. Different researchers have suggested that the academic culture in engineering can influence the pace of pedagogical change, making it necessary to characterize the elements that faculty perceive as impactful for innovation. In this qualitative study, we interviewed two faculty members and three staff members, an academic advisor, a chair and director of development from an R1 research institution to explore their perspectives and experiences with pedagogical innovations within their current institution, focusing on engineering culture. We analyzed the interviews using a hybrid thematic approach guided by an initial set of codes that explored barriers and affordances by departmental, administrative, and engineering characteristics. During the process, we refined and reorganized the codes, identifying themes of affordances and barriers from the faculty perspective. These barriers were characterized in terms of administration, departments, and engineering culture, whereas the affordances were characterized in terms of engineering culture, institutional support, and change stakeholders. From our analysis, we found that students play a crucial role in these initiatives, serving as critical stakeholders who can potentially act as both barriers and affordances to pedagogical innovation. Additionally, some features of the academic cultural system in engineering were also discussed as key elements that can potentially foster or persuade the adoption of innovations. These findings could provide valuable insights for academic leaders and faculty developers who seek to foster pedagogical innovation in their institutions, enabling them to consider these views for alternative structures of support to address department-specific barriers.

Keywords: Pedagogical Barriers, Innovation Affordances, Pedagogical Change, Engineering Education

Introduction

In Engineering Education, there has been an urgent need for pedagogical adoption of research-based instructional methods (RBIM). For many years, researchers have called for action to modernize engineering pedagogy and develop well-rounded engineers (E. Berger et al., 2025; Froyd et al., 2012; Johnson et al., 2022). However, despite the relevance of these findings and the development of RBIM, the adoption of these methods in the classroom has remained slow (Affriyenni et al., 2025; E. Berger et al., 2025; E. J. Berger et al., 2022; Briody et al., 2022; Kraft et al., 2024; Landrum et al., 2017; Tran et al., 2025).

To understand the slow pace of adoption, researchers have investigated the environment where these changes occur. Several researchers pointed out the slow adoption of RBIM and suggested that issues relevant to adoption and adaptation could include engineering culture, administrative barriers, and instructor personal preferences (E. Berger et al., 2025; E. J. Berger et

al., 2022; Shadle et al., 2017). According to researchers, a positive educational climate and institutional support, such as alignment with the existing resources, collaboration and shared vision enable innovations to succeed, whereas a negative educational climate in which exist time constraints and workload, lack of resources, conflict in priorities of research over teaching, rewards and financial burdens can lead to their failure (Shadle et al., 2017). Therefore, we acknowledge that while faculty may have individual approaches, we need to consider the institutional and administrative environment, which sets constraints on innovation.

Despite the relevance of these general factors in RBIM adoption, the mechanisms or dynamics through which these innovations operate within research-focused environments remain underexplored. Literature often lists barriers but does not map the complex interactions between faculty, staff, and the specific institutional culture that sustains or deters these efforts. Furthermore, while faculty perspectives are well documented (Borrego et al., 2013; Borrego & Henderson, 2014; Henderson et al., 2011; Henderson & Dancy, 2007), staff voices who have role duties of administering resources and advising are often overlooked in the literature. This is critical because cultural features in a department create conditions in which innovation might be stifled (Rodriguez-Mejia et al., 2020). Additionally, staff are the first link to "institutionalization" due to their incentive scheme. These incentives often emphasize the "collective" (school or university) rather than the individual research, making them more effective than faculty at integrating innovations into the organizational culture (Rodriguez-Mejia et al., 2020).

Therefore, this study aims to expand the literature by exploring the perspectives of not only faculty but also staff members regarding their experiences and views on innovation. As a note of discretion, we define pedagogical innovation broadly to encompass classroom techniques, curricular changes, and the creation of extracurricular learning spaces. Thus, we expect to characterize the perspectives of these participants and provide an insight into the map of barriers and affordances that they experience in innovation. Our research is guided by the following research question: How do engineering faculty and staff perceive the barriers and affordances of pedagogical innovations in a single R1 institution?

Background

Innovation and Adoption in Engineering Education

RBIM have shown to have a deep impact and potential to be implemented in many areas and have been a focus of interest for many researchers. These RBIM include a variety of approaches, such as peer instruction, small group problem solving, and collaborative learning environments (Affriyenni et al., 2025; Landrum et al., 2017), and many other interactive learning experiences that go beyond the classroom. In some contexts, when engineering faculty used these pedagogies, they perceived more positive experiences, facilitating their classroom activities and effectiveness (Tran et al., 2025). Despite all the advantages RBIM offers, its adoption has been a slow, gradual pedagogical change.

In STEM education, investigators have identified specific categories of barriers that faculty perceive as hindering the RBIM adoption and pedagogical change. Some important categories of barriers in STEM that have already been identified include resource inadequacy, autonomy challenges, time constraints, departmental division, and an unsupportive culture with research prioritization (Affriyenni et al., 2025; E. Berger et al., 2025; E. J. Berger et al., 2022; Evenhouse et al., 2018; Shadle et al., 2017). Many other researchers have shown that existing conflicts between research and teaching activities act as barriers to innovation and to students' resistance

to change (Affriyenni et al., 2025; Henderson et al., 2011; Henderson & Dancy, 2007). In addition, many innovations started with temporary external grants or other sources of money, creating fragility where these innovations can expire when funding ends (Kezar et al., 2011). However, it is important to note that often these findings rely primarily on faculty perspectives.

Organizational Culture in R1 Institutions

Organizational culture in engineering is critical when it comes to pedagogical change and innovation. Researchers have found that some pedagogical innovations failed to be disseminated during the trial stage, were constrained by institutional policy, or relied on a single motivated instructor (Borrego & Henderson, 2014). In R1 universities, researchers claim that one main cultural persistent element is the prioritization of research over teaching (Rodriguez-Mejia et al., 2020; Shadle et al., 2017; Tierney, 2008). This environment often creates tension because faculty highly value autonomy, which could create resistance towards RBIM if perceived as top-down mandates that reduce control (Rodriguez-Mejia et al., 2020).

In addition, several other factors can influence the abandonment of innovations and lead participants in the system to preserve past practices, especially if they believe those past practices 'work' sufficiently well. As R1 institutional culture rewards research productivity, when the innovation requires sustained effort that competes with research duties, faculty tend to go back to (what they perceive as) their primary role (Rodriguez-Mejia et al., 2020). Furthermore, this aligns with the quality assurance mechanisms, for example, ABET accreditation. These mechanisms can reduce the speed of innovation, because one approach with the least resistance is to maintain the system and strategies that ensured accreditation (Borrego & Henderson, 2014).

Lastly, a major barrier indicated in the literature is the complexity of the higher education system. The system's complexity makes it difficult to grasp the entire innovation process. Researchers suggest that stakeholders often focus narrowly on a single perspective and overlook influential factors and processes that a systems-level perspective could provide (Borrego & Henderson, 2014). For example, Borrego & Henderson (2014) presents the map of change theories in four categories: (I) Disseminating: Curriculum & Pedagogy, (II) Developing: Reflective teachers, (III) Enacting: Policy, and (IV) Developing: Shared Vision. These categories are based in two dimensions: aspect of the system to be changed (individuals vs. structures) and the intended outcome (prescribed vs. emergent). Thus, a stakeholder could focus extensively on developing curriculum and pedagogy (I), but fail to address the department culture (IV) or the reward structure (III), leading to faculty being disincentivized to use it. When stakeholders focus on the curriculum and pedagogy, it can lead to a "champions versus bureaucracy" framework, ignoring the broader map of the system that influences innovation. These findings help us narrow the focus to map the process of innovation as perceived by faculty and staff.

The Roles of Staff and Students in Pedagogical Change

On the other hand, staff perceptions about pedagogical change have been an underexplored area of research. Previous research exploring staff views has identified themes of staff as agents of change and characterizing cultural models (Briody et al., 2022). In their findings, they highlighted that staff have the potential to make a difference through a collaborative culture, in which leaders interact to make effective changes in Higher Education institutions (Briody et al., 2022). Additionally, research suggests that innovations are more likely to survive if they are run in collaboration with staff members whose job duties align with the initiative (Rodriguez-Mejia et al., 2020).

Students, in contrast, do not interact with the innovation in the same way as other stakeholders; however, they intervene in the innovation process with metrics, as the last stakeholder, to enable adoption. For example, higher education institutions rely on students' evaluation of teaching (SET) as one of the primary metrics for faculty performance. Researchers have found that faculty performance is measured by several factors that are related to grades and perceptions of ease from students (Stroebe, 2020). As these SET are critical, faculty often avoid exploring RBIM, which can lower their SET score and potentially jeopardize tenure and promotion, causing faculty to withdraw these methods (Henderson et al., 2011; Stroebe, 2020).

We used the findings from our literature review to categorize them within our initial study framework. We summarize these categories by affordances, such as engineering culture, institutional support, and stakeholders. Conversely, in the case of barriers, we synthesize the categories into three different levels of operation: a broad engineering culture, institutional administration, and a specific department level.

Conceptual Framework

We frame this research within Scott's Institutional theory (Scott, 2005) and use the three-pillar framework as our theoretical lens. This framework posits that institutions exist under three pillars called regulative, normative, and cultural-cognitive pillars. We chose this framework because academic culture and innovation occur within a bounded domain with a regulative structure (Rules, metrics, policies, sanctions), a normative structure (roles and duties), and a culture-cognitive structure (Common beliefs, shared logics of action). Consistent with this framework, we acknowledge that elements perceived as barriers may operate across different scenarios within the regulative, normative, and cultural pillars; accordingly, we present institutional perceptions as a map of interacting factors.

Methodology

We employed a qualitative single-case study design (Yin, 2018) to explore the perceptions of faculty and staff about the pedagogical innovations in a Mechanical Engineering Department within an R1 university external to the authors' affiliation. We chose a case study approach to specifically capture the contextual nuances of the engineering culture within a single department in an institution, providing insight into what could influence how pedagogical innovation is perceived, adopted, or rejected.

Participants

We conducted semi-structured interviews with five stakeholders representing distinct hierarchies within the institution: one department administration (chair), two tenured faculty, and two staff members (director and advisor). The participants and their roles are described in Table 1. This stratified sampling strategy allowed us to capture and seek data triangulation, capturing perspectives from people who play various roles in innovation development and implementation.

Table 1. Five stakeholders with distinct hierarchies who participated in the research

Participant	Role	Gender
Alpha	Staff – Director of Development	Female

Beta	Administrative – Chair of Department	Male
Gamma	Professor of Mechanical Engineering	Male
Delta	Professor of Mechanical Engineering	Female
Epsilon	Staff – Undergraduate Advisor	Female

Data Analysis

We employed a hybrid thematic analysis approach (Fereday & Muir-Cochrane, 2006) which combines both deductive and inductive coding strategies. In the deductive phase, we used an *a priori* codebook we established based on literature on pedagogical change in engineering, categorizing data into two primary categories: Barriers and Affordances. Following our hybrid approach, we deductively mapped the principal codes from our literature review (faculty freedom, supportive culture, educational shift, inclusion, ABET, faculty participation, EER perception, research vs. teaching, bureaucracy, lack of resources). We categorized these codes into three principal subcategories for barriers and three for affordances. For barriers, we focus on structural, cultural, and administrative themes. For affordances, we focus on institutional, external, and cultural themes. We then engaged in inductive coding during the process.

We identified emergent themes that did not fit the initial framework, specifically about *the perception of faculty and staff on the role* of students as agents in the process of pedagogical innovation in engineering. We engaged in a series of iterative processes with emergent themes, in addition to the deductive themes, to arrive at the last set of themes and categories.

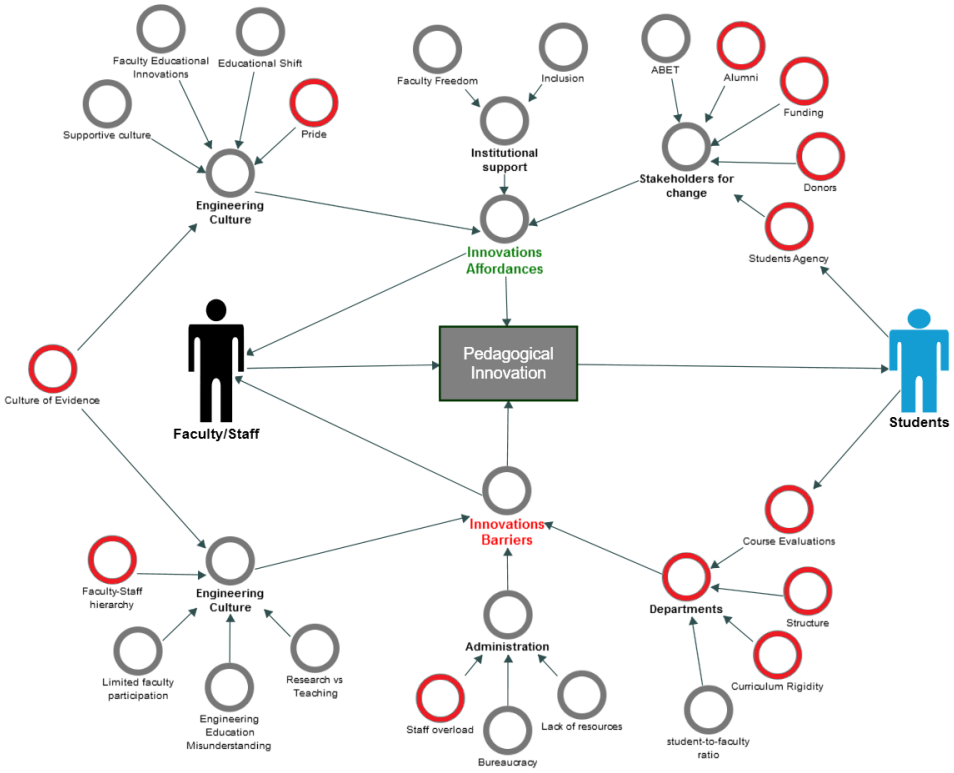
Trustworthiness

To ensure methodological rigor, we ensured trustworthiness by having the co-authors review the quotes, themes, and connect with their experience of the data. Additionally, trustworthiness was enhanced with the triangulation of the data presented by other participants and quotes that support their perceptions. By using this approach, we focus on ensuring that the findings and interpretations are not an artifact of the sole interpretation of the first author.

Findings

We present our themes not just categorized as a static list of barriers or affordances, given that participants perceive these factors as more complex and acting as both. Our approach revealed that pedagogical innovation in this R1 institutional context is not a top-down mandate, but a dynamic negotiation and tension between elements that can act both as barriers and affordances, as shown in Figure 1. We represent our emergent findings in red. Central to this tension is how faculty and staff perceive the students. Participants identified students as the catalyst to overcome cultural and institutional resistance, but also as the final barrier that any pedagogical innovation must pass.

Figure 1. Pedagogical innovations: faculty and staff perception of barriers and affordances



Note: Authors made. Grey color: codes from the deductive phase. Red color: codes found from the inductive phase.

Regulative Barrier: The Culture of Evidence

Participants consistently identified a system of metrics, specifically end-of-course surveys of instructors, called by participants "students' evaluations," and tenure metrics based on research, as elements that hinder innovation. While administrators emphasize the "culture of evidence" (Beta), where teaching innovations must be "scientifically vetted" (Beta), some faculty perceived this as a penalty for their innovations. One participant (Delta) noted that despite the learning gains in a flipped classroom, the innovation was "killed basically by student evaluation scores" (Delta) and mentioned how they went back to traditional lectures because of that. Another faculty member perceived the tenure process in which innovation is seen as a risk, for example, when expressing that they have been told "to keep [their] head down" to focus on traditional research while getting tenure to explore their interests (Gamma).

Furthermore, one participant identified a specific cultural barrier regarding how Engineering Education Research (EER) is understood and measured. The participant commented that while the department encouraged high-quality research and teaching, it did not recognize EER as a "true research discipline" (Delta). Also, they described how in the institution, they perceived EER was often treated as an informal activity that "lecturers do on the side," rather than a rigorous field requiring deep research training (Delta). Additionally, Delta noted that the department relied entirely on SET scores for teaching evaluations, which lack the robustness of EER-validated measures. These perceptions highlight a broader institutional divide between research and teaching. This arguably underscores the precarity of Non-Tenure Track (NTT) faculty, who are often expected to perform this "on the side" work without the institutional

recognition or protection of Tenure-track research, all while being measured by restrictive SET metrics.

Normative Tension: Structural Rigidity versus Stakeholders for Change

Faculty described the curriculum as "relatively rigid and linear" with complex processes for approval, which felt like "suffering 1000 paper cuts" (Gamma). Nevertheless, we found that participants described ways to bypass these barriers, thanks to **stakeholders for change**, participants who provide **financial freedom**, which allowed innovations to advance. Some of these funds were described as discretionary, obtained through external grants and alumni donations rather than the institution's in-house budget.

Participants described that innovation is often driven by alumni donors who want to fix gaps in their education (Alpha). For others, investments from private donors provide instructors with the autonomy to pursue innovations that surpass bureaucracy, so they "don't have to ask" when using the funds intended to build extracurricular spaces (Gamma). Lastly, from an advising perspective, due to monetary restrictions and the high number of students (>500), staff have adopted an approach of "finding ways to do them for free," like using existing technology, like open software or free platforms, because of a lack of resources or time for structural reforms (Epsilon).

Cultural-Cognitive Paradox: Perceiving Students as Agents for Change

Our most significant and emergent finding is how faculty and staff perceive the dual roles that students play. Participants perceived students as both affordances and barriers: as affordances for programmatic work, facilities, and spaces that can support administrative calls, but as barriers to in-class innovation. For participants, students can act as mediators between the cultural and administrative barriers through their agency or student demand. For some participants, the expressions of students lining up "out the door" for innovation spaces created a visual that the administration could not overlook (Gamma). Similarly, others noted that innovations responded directly to student feedback loops (Epsilon).

However, students can also deter some pedagogical innovations. Students could exert pressure on pedagogical innovations through students' course evaluations. Faculty, particularly Delta, noted that students' grade anxiety often translates into resistance to pedagogical changes they find unfamiliar or risky. Delta reported that after incorporating active learning strategies, they received pushbacks from students and felt forced to revert to traditional methods. While this resistance is shown as lower ratings on these students' evaluations, these scores are an essential metric for the teaching component of tenure and promotion (Delta, and reinforced by Beta). The students' capacity to exert pressure on innovation makes them critical agents of change, able to demand innovation that supports faculty initiatives or push faculty toward traditional methods to ensure positive evaluations.

Barriers and Affordances and the Institutional Pillars

According to Scott's Institutional theory and its three pillars, we framed these findings from the Faculty and Staff perspective. This mapping of findings is summarized and synthesized in the Table 2.

Table 2. Findings mapped into Scott's Institutional Pillars

Scott's Institutional Pillars	**Affordance (Enablers of Innovation)**	**Barrier (Inhibitors of Innovation)**
Regulative *(Rules, metrics, policies, sanctions)*	Alternative Funding Structures and Discretionary Funds	Strict Tenure Metrics, Restrictive SET, Curriculum Rigidity
Normative *(Roles, duties, expectations)*	External stakeholders for change providing value	Research hierarchy, Undervaluation of EER, Faculty hierarchy.
Cultural-Cognitive *(Common Beliefs, shared logics of action)*	**Students demand and advocate for innovation.**	**Student grade anxiety and resistance to non-traditional pedagogy.**

Note: Bold font indicates the main finding of the paper on faculty and staff's perceptions of students as affordances and barriers.

Discussion

Our study characterized barriers and affordances for pedagogical innovation within a single department at an R1 institution. We highlight that innovation is a more complex system that goes beyond the "champions versus bureaucracy" framework often found in the literature. By mapping our findings to Scott's Institutional Theory (Table 2), we offer insight into how, in this department, pedagogical innovation operates within a framework shaped by the actions of different stakeholders. These stakeholders provide resources and streamline processes across the normative and regulative pillars. Simultaneously, this streamlining is constrained by a culture of evidence, which shapes this streamlining, and eventually allows the innovation to reach the final filter perceived by faculty and staff: the validation or disapproval of students.

A central finding of our work is the **faculty and staff perceptions** of the paradoxical dual role of students as both the principal affordance and the primary barrier to innovation (Figure 1) – an element often overlooked in the literature. Although students act as a lever for change, aligning with theories of organizational culture that view students as consumers (Henderson & Dancy, 2007), they can also drive bottom-up change. They can demand change, for example, by asking for innovation spaces as we found in our study. However, our analysis revealed that students also act as the last barrier to innovation's survival. Thus, this creates a paradox in which institutional culture encourages innovation to support students' success, but students' evaluations can punish them if that innovation does not suit them, feels risky, or makes them feel uncomfortable with their grades – all of which, in turn, shapes faculty behavior (Stroebe, 2020). Conversely, for staff who deal with large numbers of students and lack resources, they must rely on free alternatives to address their advising innovations. These findings are relevant to faculty and administrators, who rely on students' evaluations as part of these roles' evaluations.

Additionally, our analysis shows how external funding through a parallel resource flow enables innovations to succeed, allowing faculty to exercise freedom and autonomy. While these mechanisms allow faculty who can access them to act in favor of the innovations, it also generates concern regarding the maintenance of these activities. In our study, participants

reported that some innovations succeeded because individuals sought external resources rather than through institutional mechanisms, due to existing barriers. Hence, our findings suggest that pedagogical innovations developed in-house are highly dependent on external funding mechanisms for their initiation and initial development, posing potential sustainability risks when those funding mechanisms end. This similarly applies to staff, who lack economic resources for implementing innovations using paid technological tools. Lastly, other innovations have succeeded thanks to students' ability to make them visible to the administration, or "student demand." This highlights the underexplored power of students as agents of change within the academic ecosystem.

Implications

For academic leaders and faculty developers, our findings suggest that encouraging innovation without additional mechanisms, such as cultural integration, stakeholder collaboration, and funding, is often insufficient if the culture of evidence castigates them for taking risks. Pedagogical innovation requires moving beyond individual agency alone and strengthening a system that supports them. To do so, our systems should shift from rigid metrics of student satisfaction toward a more diverse set, including long-term retention, skills development, and perceptions of positive pedagogical change. Thus, measuring the impact of these initiatives in the long term allows faculty to iterate and negotiate without feeling pressed to return to traditional methods to preserve their evaluation scores.

In addition, as our findings show, some faculty initiatives are highly dependent on external funding, making them fragile in the long term. One opportunity is to investigate, through empirical research, mechanisms for transitioning successful initiatives that rely on external funding into the institutional budget, ensuring they can survive even when those mechanisms end.

Finally, different opportunities exist for faculty development, from strengthening alternatives for funding initiatives to potentially reducing pressure by countering pedagogical innovation initiatives toward tenure. Furthermore, recognizing that staff, such as advisors and development officers, are often surrounded and closer to students than faculty, and their insights could be valuable in the curricular planning committees.

Conclusion

Our research successfully identified the affordances and barriers associated with a pedagogical innovation in an engineering department in a single R1 institution. By mapping these findings onto Scott's Institutional Theory, we showed how these barriers and affordances are integrated into a complex system spanning regulative structures, normative expectations, and cultural-cognitive beliefs. Faculty must navigate funding through different mechanisms to implement their pedagogical innovations successfully. However, success is not guaranteed. We highlight how, in this system, faculty and staff perceive students as critical agents of change, not only by advocating for change but also by deterring pedagogical implementations. Additionally, external pressures, such as the institution's engineering culture, curriculum, and administration, play a critical role in shaping the landscape in which these innovations operate.

Therefore, it became important for academic institutions, leaders, and developers to seek opportunities to reinforce pedagogical innovations. We suggest that future work could focus on characterizing the operational paths that pedagogical innovations follow across different institutions and map the role of different stakeholders. Thus, by understanding the operation of

these activities, it is possible to inform and suggest mechanisms to support innovation and to train faculty to achieve change.

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