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Living through the Culture Change: Faculty Perceptions of a Mechanical Engineering Departmental Teaching Culture Pre- and Post-Intervention

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1. Introduction

Culture change has often been cited as a crucial factor to achieve when supporting initiatives to advance student learning in undergraduate engineering education [1]. As the cultures of academic engineering departments adapt to promote pedagogical change to better meet the future needs of their diversifying student populations and develop them into experimental and innovative engineers, a primary goal for these departments must be providing faculty members with the necessary tools and resources to innovate in their teaching and effectively support their students. Faculty development, an established approach utilized in achieving change in teaching practices, is aimed at providing faculty with broad pedagogical skills or motivation and resources for self-improvement [2]. Common goals of change strategies proposed by faculty development researchers have focused on assisting faculty with improvement of their teaching practices through self-reflection or on providing faculty with new teaching resources or technologies that are broad and applicable in a variety of contexts. Within the research literature, successful strategies have been identified to specifically focus on changing faculty conceptions and beliefs [2]. These strategies often create meaningful conceptual change in faculty, which results in changes in practice [3], [4]. This has also been demonstrated within other educational levels, with the K-12 literature also demonstrating that significant educational change necessitates changes in beliefs [5].

Over the past four years, our National Science Foundation (NSF) IUSE/PFE: Revolutionizing Engineering and Computer Science Departments (IUSE/PFE: RED) grant team has engaged in a project entitled Teams for Creating Opportunities for Revolutionizing the Preparation of Students (TCORPS) to influence faculty perceptions around teaching and teaching innovation. The grant project's broader vision is to revolutionize the culture of the Mechanical Engineering (MEEN) department at Texas A&M University by focusing on faculty development and culture change to aid faculty in their efforts to implement pedagogical changes and to increase iterative and measured innovations in teaching. Successful assessment of our faculty development efforts not only involves understanding how faculty perceptions of teaching innovation change when presented with new frameworks, but also investigating faculty members' broader perceptions around the overall culture change process in the department.

2. Purpose

The purpose of this study is to understand how faculty perceptions of the MEEN departmental teaching culture may or may not have changed during the project. This examination was done through the analysis of semi-structured faculty interviews that were conducted pre-implementation of grant-related activities (e.g., summer faculty development workshops, educational forums) and post-implementation. The pre-implementation interviews were

conducted before the start of the grant to develop a baseline assessment of the culture for teaching and teaching innovation within the mechanical engineering department. The post-implementation interviews were conducted three years later in the concluding stages of the grant, with the purpose of documenting possible changes in faculty perceptions of the department's teaching culture as well as the impact of the NSF RED grant as it progressed. The utilization of interview methods was appropriate for this study as it is an effective tool to assess the impact of faculty development and acquire further detail into how faculty think about teaching, how they feel about cultural change, and how their perceptions impact their teaching choices [1], [6].

3. Method

Participants and Procedure

Pre-Implementation Interviews

Faculty members from the MEEN department at Texas A&M (n = 13) were randomly chosen and recruited to participate in semi-structured interviews between February and May of 2021. A variety of job types were represented in the participant sample, specifically tenure-track/tenured faculty, instructional professors, professors of practice, and lecturers. Instructional professors and professors of practice both exist under the larger umbrella of academic professional track (APT) faculty (those that are non-tenure, primarily teaching-focused, but in positions that are intended to be renewed rather than adjunct or visiting). The interviewers were members of the internal evaluation team (a smaller team within the larger grant team), which included two full, tenured professors (one from the Department of Psychological and Brain Sciences and one from the Department of Electrical and Computer Engineering) and two graduate research assistants. The interviews were conducted and recorded via Zoom and took place with one participant and either one or two interviewers. The interview protocol included a series of planned questions that focused on the positive and negative aspects of teaching in the department, innovating teaching in the department, personal challenges and successes with teaching, and other teaching-related experiences, preferences, and ideas. Audio transcripts and interviewer notes were analyzed via a thematic analysis approach.

Post-Implementation Interviews

Faculty members from the MEEN department (n = 8) were recruited to participate in semi-structured interviews over the summer of 2024. Seven of the eight interviewees participated in the initial interview study and all eight interviewees were involved in grant-related activities, with six engaging in teaching innovation projects. The interviews were conducted and recorded over Zoom. All the interviews were conducted and analyzed by two graduate research assistants in the Department of Psychological and Brain Sciences; one of the research assistants was also involved in the initial interview study. Many of the same questions were asked in the post-implementation interviews as in the pre-implementation interviews. Additionally, questions pertaining to the impact of the NSF RED grant were asked, such as how the grant has impacted

faculty members' expectations and feelings about teaching, whether the grant has impacted the teaching culture in the department, and how the grant may have impacted their efficacy for teaching and teaching innovation. Audio transcripts and interviewer notes were analyzed via a thematic analysis approach [7].

4. Results

4.1) Themes from Pre-Implementation Interviews

Perceptions of Teaching and Teaching Innovation

Overall, the faculty participants had very positive perceptions of teaching. Specifically, the participants appreciated the opportunity to interact with and build meaningful relationships with students and positively contribute to their learning experiences. All of the participants also shared the same perceptions regarding the teaching mission of the MEEN department, specifically that the primary goal is to produce high-quality engineers and empower these students to be prepared for the challenges of industry. Another recurring theme regarding the teaching mission was ensuring that students possessed not only the necessary technical skills, but also the necessary soft skills for solving societal engineering problems and making a noticeable impact in their communities.

While overall feelings about teaching were positive, several aspects of teaching were highlighted as disliked, such as the amount of grading and the focus on assessments. Given that these interviews took place in the Spring 2021 semester when the university was engaged in COVID-mitigation strategies, including significant increases in online teaching, it is not surprising that participants indicated struggles with incorporating online instruction into their teaching methods. One participant mentioned their difficulties with managing dual modes of teaching (both online and face-to-face instruction). Another participant mentioned that they did not enjoy teaching online because they could not achieve the same interaction with students as they could in face-to-face instruction and they were unable to provide an active learning environment.

Regarding teaching innovation, participants also had positive feelings. Participants saw teaching innovation as an important component of teaching and many of them were already engaging in small innovations or improvements in their courses (e.g., flipped classrooms). Many of the faculty also believed that they possessed the skills needed to be innovative in their teaching. Faculty participants possessed a wide variety of experiences, both academic and industry, valuable expertise in mechanical engineering fundamentals, and experience in engineering education research. Many participants also mentioned some of the university resources available to them that could aid with teaching innovation. An oft-mentioned university-wide resource was the Center for Teaching Excellence, which provides university faculty with resources and services to improve their pedagogical approach, enhance their courses, positively impact student learning outcomes, and prioritize teaching excellence.

Even though faculty members possessed the skills for and interest in teaching innovation, there was still apprehension regarding engagement in innovative teaching. Much of this apprehension stemmed from a perception that there was not enough space for creating innovative teaching strategies for student engagement as there was a perceived department-wide expectation that faculty just needed to be "adequate" at teaching. Additionally, faculty members expressed uncertainty about outcomes of teaching innovation and concerns about the risk of failing after putting in significant effort, with one particular participant stating that they did not always engage in teaching innovation because they "cannot guarantee the outcome and it's going to require so much from the time and effort".

Barriers to Teaching Innovation

All of the participants discussed barriers that prevented them from prioritizing teaching innovation. The most frequently mentioned barrier was that there was not enough *time* to dedicate to teaching innovation, one of the most commonly cited barriers for faculty change [8]. This theme of time also was connected to the differing *competing priorities* of faculty members. Participants who were tenure-track stated that the requirements associated with receiving tenure, specifically the emphasis on research, restricted them from spending more effort on teaching and teaching innovation. Participants who were APT faculty stated that their extremely high course loads also prevented them from devoting attention to innovation. Some barriers mentioned were also structural in nature, such as a perception that the department was more invested in standardization across sections and semesters rather than in innovation. This aspect of standardization was related to logistical issues regarding course innovation. Within the MEEN department, faculty members teach multiple sections of the same course, so there is frequent coordination between the instructors so that the student experiences across the different course sections remain consistent. This resulted in participants feeling apprehensive about implementing pedagogical innovations as other instructors resisted these changes and preferred a standardized and familiar approach to be utilized across the multiple sections. Another structural barrier was the lack of continuity in courses that faculty teach semester to semester. Although faculty members provide their course preferences, there is not much control in choosing the courses they teach each semester. Faculty members were unable to teach the same course in accompanying semesters, making it difficult to effectively measure differences in potential pedagogical innovation outcomes between groups of students or engage in possible teaching experiments.

Perceived Inconsistencies in the Departmental Teaching Culture

Another theme that emerged from the interviews pertained to general perceived inconsistencies within the departmental culture as it relates to teaching and teaching innovation. Throughout the interviews, there was frequent mention of both positive and negative aspects of the teaching culture. Multiple participants discussed the department's openness regarding teaching innovation, with one participant mentioning that there were not any barriers to proposing new courses and another stating that the department often supports faculty members

getting involved with research grants to further improve their pedagogy. However, there was also consistent discussion around this shared understanding among faculty members that they should put minimal effort into teaching as teaching is not a primary mission or priority ("Research, then teaching, then service"). Understandably, this messaging exists at a university-wide level as well (and across academia), given that participants work at an R1 institution of higher education and a large majority of funding comes from research engagement.

Multiple participants also spoke of this noticeable spectrum of faculty involvement when it comes to teaching and teaching innovation. Participants noted that a reasonable number of faculty members really cared about teaching; they often thought critically about their teaching decisions and were willing to put in the effort to develop more effective teaching techniques. Participants also mentioned that much of the growth in pedagogical investment came from the increasing number of teaching faculty, who had more opportunities to focus on teaching quality and effectiveness, as compared to tenure-track faculty. However, on the opposite side of the spectrum, participants stated that there were faculty members who just do not care about teaching effectiveness and teaching innovation. Many faculty members prioritized research, as previously mentioned, and there also was difficulty getting buy-in for teaching innovation from certain faculty members who were more established and tenured.

Another major concern was the inconsistency in recognition or acknowledgement of teaching innovation. While one participant mentioned that the department did reward faculty members with annual research and teaching awards, participants' answers seemed to suggest that there is a lack of structure when it comes to incentivizing or rewarding innovative teaching. Participants had the impression that faculty members are not necessarily rewarded for their teaching because they are expected to conduct research. One participant, in particular, also described at length their perceptions around inconsistencies in who often gets acknowledged. They stated that they believe the recognition of faculty members' teaching innovation efforts is unequal, in which some people are favored over others, the same faculty members get acknowledged repeatedly, and other faculty members' efforts are not rewarded or acknowledged at all.

4.2) Themes from Post-Implementation Interviews

Increase in Discussions around Teaching and Teaching Innovation

A common theme that emerged within the follow-up interviews is the participants' acknowledgement of increased discussions around teaching and teaching innovation in the MEEN department. This was presented as one of the more significant and positive impacts of the RED grant on the departmental teaching culture. Multiple participants highlighted the noticeable increase in positive discussions about teaching innovation. Additionally, there was also increased involvement of faculty members in those teaching discussions, and particularly an increase in the involvement of tenure-track faculty. Participants mentioned that there was a significant increase

in the volume of meetings and conversations about teaching strategies and methodology. The conversations were also extremely productive and beneficial as they enabled the generation of new ideas and the sharing of knowledge and expertise around teaching innovation. Participants also discussed how information and research around effective and meaningful pedagogical practices became much more accessible.

Throughout the interviews, one of the most mentioned topics was the development of the Teaching Community of Practice (TCOP) within the MEEN department. Communities of practice have been demonstrated to be instrumental in promoting both individual and collective change in teaching practices [1], [2], [9], [10], [11]. As described by the participants, the TCOP functioned as one of the primary mechanisms for facilitating and increasing discussions around pedagogical innovations. The TCOP formed out of the monthly meetings that were organized by the RED grant team in which faculty members presented updates on their teaching innovation projects, discussed any challenges, and sought advice from attendees; however, the formation of the TCOP came from faculty members not on the grant team. Currently, participant perceptions indicate that the TCOP is becoming institutionalized and the community is being maintained after the conclusion of the RED grant. Multiple participants spoke to how beneficial the TCOP is in providing a venue to discuss topics related to teaching and teaching innovation. Faculty members have increased opportunities to share and discuss ideas and participants have highlighted how the interest and engagement is becoming more organic. Within the current TCOP format, faculty members volunteer to lead discussions or presentations and they often propose topics for meetings that are not related to funded research, but more so of general interest. The TCOP, among almost all participants, is perceived to have played an integral role in promoting a culture of innovation in teaching within the department.

Participants mentioned that, as a result of these increased discussions, MEEN faculty are embracing and becoming more interested in teaching and teaching innovation. Many of the participants discussed their and their colleagues' participation in engineering education conferences to disseminate knowledge locally and externally. Additionally, the RED grant has been perceived as fostering a sense of community and collaboration across the department. Ultimately, the RED grant's impact on teaching discussions and the creation of additional departmental resources, such as the TCOP, has set a positive precedent for dialogue around pedagogy, with one particular participant stating that it has "created an undercurrent for self-sustaining discussions of teaching practice".

Positive Shift in Departmental Culture for Teaching and Teaching Innovation

A recurring theme in the follow-up interviews was participants' awareness of a noticeable positive shift in the departmental culture around teaching and teaching innovation, particularly in support, acknowledgement, and recognition. Overall, participants noted that the current culture exhibits much more commitment to teaching and there is greater emphasis on the importance of teaching effectiveness and innovation. There was discussion around the administration being

more supportive and encouraging to faculty incorporating innovations in their teaching. Teaching and teaching innovation was perceived as being valued by the department and leadership recognized the effort and dedication necessary to accomplish effective and meaningful instruction.

Increased support and resources. A noticeable subtheme was participants' recognition of an increase in departmental support and resources. Many participants noted that, in addition to the TCOP, there were more mechanisms in place to support teaching and teaching innovation. APT faculty participants, in particular, noted the increased attention placed on teaching in faculty retreats, which made the retreats feel much more relevant and inclusive to these participants. There was also mention of a Teaching Faculty Enhancement Committee that would organize workshops about different topics that are important to teaching faculty. Multiple participants also spoke about the distribution of discretionary funding for faculty to attend conferences, implement classroom innovations, and engage in professional development opportunities (e.g., training, workshops, courses). Participants also spoke of the availability of course releases so they could have more time to implement innovations into certain courses. Participants noted that the tools and resources provided by the department have empowered them in their efforts to improve their teaching, with one participant stating that it is "motivating" to see others appreciate their work.

Creation of new norms and underlying assumptions. Many of the participants' answers highlighted the RED grant's influence on the creation of new norms and underlying assumptions within the departmental culture. Participants noted that the department leadership's continued efforts to prioritize teaching, encourage innovation, and unify faculty had a cascading effect on the faculty, as many of these changes were supported by the majority of faculty members. Participants also spoke about the creation of synergy and collaboration within the department as many of the teaching projects included a combination of APT and tenure-track faculty working together. They also spoke about the increased dissemination of engineering education research findings as more faculty present at conferences. This new norm has also been set in place for incoming faculty members as the emphasis on teaching innovation is now being discussed throughout the recruitment/interview process with potential hires. A number of participants mentioned that almost all new faculty are involved in innovation in some capacity, demonstrating that the standard and norm for effective and innovative pedagogy has been established for newcomers. Participants note that there is increased appreciation for teaching innovation and that these discussions and efforts around effective teaching have become more routine. The establishment of these new cultural norms have resulted in department members seeing the need for teaching innovation and developing a broader awareness of and interest in it.

Positive Shift among Faculty in their Approach to Teaching Innovation

Another prevalent theme was the participants' acknowledgement of the positive impact of the RED grant on their approach to teaching innovation. For many of the participants, the

RED grant provided an array of helpful structures and strategies to utilize when approaching innovation and improving in their pedagogy. In particular, participants spoke of the benefits of the overall pedagogical innovation approach presented in the summer workshop, specifically in aiding in their creation of reasonable and achievable goals and progress in their innovation efforts. The multiple summer faculty development workshop exercises were seen as helpful, with a participant stating that the increased repetition and engagement helped them to improve in their teaching innovation efforts. The introduction of monthly progress meetings was also beneficial for the participants as they felt they were able to gather insights and advice from other teams within their cohort and apply those lessons to their own teaching innovation projects. Participants also noted the grant's impact in showing the range of innovative ideas and enabling the generation of new ones. Additionally, participants felt that these strategies positively impacted their perceived self-efficacy regarding teaching innovation as they became more agile, the innovation process became faster and more manageable, they could focus on student outcomes (e.g., engagement, performance) more effectively, and they became better at prioritizing goals and actions, especially when making small increments.

Significant shift in mindset and perceptions. Multiple participants alluded to a positive shift in their mindset and perceptions around teaching innovation. Participants greatly benefited from the grant's overall focus on incremental and iterative innovations as they perceived this approach as much more accessible. In the pre-implementation interviews, many participants spoke of their apprehension to engage in teaching innovation as they felt there was a significant amount of risk and uncertainty that was not worth the time and effort. Within the department, innovation was previously viewed as a process that needed to be large and resultantly overwhelming. Within these post-implementation interviews, however, participants noted that the RED grant demonstrated that it is possible to make small pedagogical changes and assess their impact and effectiveness. Participants spoke of an increased willingness to try new things; one participant spoke of their recent use of electronic versions of assessment and grading tools, which enabled them to retain data more efficiently for student outcome comparisons between semesters and address grading concerns in an easier and more equitable manner for their students.

The opportunity to view innovation as a more iterative process was key in positively shifting participants' views about teaching and teaching innovation. Regarding teaching, participants stated that they recognized that teaching needs to be done well and on a deeper level and that there needs to be more emphasis on teaching quality. Multiple participants spoke of their increased enthusiasm about teaching as well. Regarding teaching innovation, participants stated how they came to understand the importance of innovations in teaching and recognize the depth and breadth of teaching innovation and developed a better appreciation for how much intentional effort goes into innovation. Ultimately, the participants acknowledged that innovation can still be a somewhat intimidating process, but their responses indicated a newfound willingness to be uncomfortable and vulnerable in their teaching journey and be open to the multiple possibilities

for innovating and improving teaching, with one participant aptly stating, “The more that I teach, and the more that I think about innovation, the less confident I am. And that doesn’t bother me anymore.”

5. Discussion and Implications

The insights gathered from the pre- and post-implementation interviews have provided valuable evidence of culture change within the MEEN department. Prior to the start of the grant, faculty participants highlighted their interest in teaching innovation, but many also detailed their struggles with implementing classroom innovations, specifically regarding a lack of time, fears of failing, and concerns about inadequate recognition from the department. As the grant has concluded, many of those same participants have noted a significant positive change in the departmental culture around teaching and teaching innovation. Within the department, there has been observable improvement in the amount of positive and meaningful teaching discussions, sharing of ideas and expertise, institutionalization of multiple teaching-supportive mechanisms, and teaching self-efficacy of faculty members.

The lessons learned from this study can be quite impactful for other departments also seeking sustainable culture improvements. These discussions with faculty members highlighted the need for accessible change frameworks that portray innovation as an incremental and manageable process. Departments should also support and empower faculty members to become change agents and serve as exemplars for contributing to the culture change. Departments should also create mechanisms and communities where faculty members can share their change recommendations and highlight opportunities for improvement in the department. Department leaders should also champion these culture changes by also serving as exemplars for the desired change behaviors, regularly recognizing faculty members’ efforts and contributions to teaching, and allowing faculty members to have autonomy and responsibility in the change process. Ultimately, culture change must be a collaborative and participatory process that provides members with the necessary resources and support to succeed.

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