Engineering Faculty Perceptions of Diversity in the Classroom

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Abstract

Broadening participation and enhancing diversity remains a challenge in STEM disciplines. Many universities have strategic diversity plans; however, very few include an assessment of program success or utilize faculty as a primary vehicle to achieve the desired outcomes. Previous work suggests faculty play a key role in promoting diversity in higher education and creating an inclusive environment in the classroom. Few studies have explored faculty perceptions of their role in promoting diversity and a single study identified factors that contribute to faculty applying strategies to promote diversity concepts within the course content. Additionally, previous research has highlighted the need for departmental and institutional support for faculty interested in adopting teaching practices that promote diversity and inclusion. Therefore, it is important that we understand the motivations and supports needed for STEM faculty to include diversity concepts in the classroom to promote inclusivity. The guiding research questions for the current study are: 1) What perceptions do faculty hold about diversity and inclusion? 2) How do faculty's personal experience with diversity and inclusion impact how they integrate diversity and inclusion in their classroom? 3) How can we effectively use professional development to aid faculty in creating more inclusive environment for diverse learners?

The data reported here is from the pilot for a larger case study design informed by institutional change models and faculty motivation. Taking lessons from recent engineering education research that describes strategies that encourage faculty to adopt instructional innovations, we paralleled our research to capture faculty practices for implementing diversity concepts into engineering course content. The pilot included 10 engineering faculty participants representing all faculty ranks and both research and teaching tenure tracks. The participants completed a short survey with multiple open-ended questions, followed by individual interviews exploring responses and allowing further clarification. The faculty came from two large research intensive universities with strong engineering reputations (five from each university). The survey was administered through a commercially available data collection software program and the individual interviews were audio recorded.

The results from this initial pilot study discuss how our faculty participants defined diversity and inclusion, the resources they view as important to promoting diversity and inclusion, how their personal experiences inform their views on diversity and inclusion in the classroom, and what they would look for in professional development around diversity and inclusion.

Introduction

Broadening participation and enhancing diversity remains a challenge in STEM disciplines. Many universities have strategic diversity plans; however, very few include an assessment of program success or utilize faculty as a primary driving force behind diversity initiatives. Previous work suggests faculty play a key role in promoting diversity in higher education and in creating an inclusive environment in the classroom[1]. For example, faculty support can influence

female student's perception of the engineering climate[2], faculty interactions can impact minority student grades[3], and faculty can effect general performance and retention in engineering[4]. However, very little is known about faculty beliefs about their role in promoting diversity. Additionally, previous research highlights the need for departmental and institutional support for faculty interested in adopting teaching practices that promote diversity and inclusion[5] as well as providing resources such as institutionally sanctioned faculty development or training to overcome barriers multicultural teaching[6]. Therefore, it is important that we understand the motivations and supports needed for STEM faculty to include diversity concepts in the classroom that promote inclusivity.

It is important to understand how diversity and inclusion concepts are incorporated into the college classroom as teaching and learning are at the heart of the academic mission and the student population has changed in terms racial composition and social norms. Most previous research on diversity and inclusion has focused on campus climate or departmental culture rather than the classroom as the unit of analysis. Furthermore, the studies that have considered diversity in the classroom have highlighted diversity related course or cross-cultural learning between domestic and international students. Although student interactions are an important part of the learning environment, the role of faculty in promoting diversity and creating an inclusive classroom is not well understood. A dearth of literature exist on the role of faculty in promoting diversity in the learning environment, especially in STEM. As a result, engineering faculty have few resources to learn about strategies to incorporate diversity into the classroom and lack detailed procedures for implementing these practices into their course development. We seek to bridge this gap in the literature by capturing engineering faculty perceptions about including diversity in the classroom and identifying what barriers prevent them adopting these concepts into their personal and collective teaching practices and pedagogy.

Brief Literature Review

Incorporating diversity into the classroom is a type of institutional change or reform. Institutional reform to promote diversity and inclusion has been described in an inclusion model developed by Winters[7] . The Winter's model for inclusion defines inclusion as a group with shared values that must be integrated into all aspects of an organization's culture to become intrinsic for a group. The author went on to suggest that shared values are the compass that frame and guide organizational behavior. In other words, how we collectively value diversity and inclusion will determine how we integrate these concepts into the culture and social norms within the field of engineering. Winters model proposes combined macro and micro behaviors to build an inclusive environment, driven by "top-down leadership and bottom-up engagement"[7]. At the macro level, the role of the institution is to create both *structural and procedural* modifications to address the rules and belief system of the prevailing environment and promote change[8]. At the micro level, the Winter's model calls for three individuals actions: 1) acknowledge inequities in our social structure; 2) actively address personal bias and stereotypes; and 3) engage with inclusive practices in everyday and professional tasks[7]. For example, individual faculty can practice inclusive behaviors or act as a change agent that motivates peers to implement reform[9]. Also, faculty directly impact the learning environment by making curriculum choices. Diversity in the

curriculum was covered by the work of Geneva Gay[10]. In her 2010 article, she explicated four pedagogical principles to incorporate diversity into the curriculum: 1) beliefs and ideas about diversity influences the way people teach; 2) new and different methods and perspectives are needed to educate new teachers to encourage the adoption of teaching practices that promote diversity and inclusion early in their career; 3) vary instructional delivery and assessment practices to create more learning opportunities for a variety of student identities; and 4) be culturally responsive by explicitly linking students prior knowledge to the academic language used (e.g. translate disciplinary language to accessible language for students)[10]. Based on the large body of literature highlighted here, that is not meant to be exhaustive, but provides a starting point for identifying pathways to integrate diversity into an engineering classroom.

Looking into successful models to promote institutional change, communities of practice (COP) have been stressed in the literature as a successful medium. Recent initiatives applied more robust theories of change such as building a COP or supporting faculty networks to infuse reform[11]. For example, a COP was utilized to promote instructional innovation throughout the entire college of engineering in a recent study[12]. A COP is a potential technique to influence faculty beliefs that impact faculty motivation to engage with instructional innovations such as implementing research based instructional strategies (RBIS's). Furthermore, Henderson[13] concluded that effective change strategies strive to change faculty beliefs prior to changing behaviors with long-term interventions that operates within the complex university system and develop a strategy compatible with that system. Compatibility with system requires an understanding of the culture and relevant faculty beliefs. Therefore, barriers identified by the research regarding faculty integration of diversity in the classroom suggests that these beliefs must be identified and addressed to enhance faculty motivation.

Optimizing faculty motivation is another approach to impact education reform. Faculty motivation and autonomy have been linked to student learning (mostly in K-12); however, few studies look at these constructs in higher education or engineering. One study related to faculty motivation and autonomy is the work of Borrego and colleagues that investigated the fidelity of implementation of RBIS's[14]. When considering faculty motivation to implement instructional innovation, RBIS's provide a useful example for the research team to reflect on how to implement diversity and inclusion concepts into engineering education. The results of the Borrego et al. study suggest that knowledge of RBIS alone does not ensure effective implementation[14]. The details and nuances regarding the context were a barrier to faculty successfully implementing a new pedagogy and achieving the anticipated student outcomes. This suggest that our research should gather data not only about faculty knowledge of diversity and inclusion concepts, but also explicate the details of translation and the role of context. Also, according Maruyuma and Morena[15] faculty may feel prepared and comfortable to address diversity issue in the classroom but that does not ensure implementation. As a result, we seek to understand faculty beliefs about diversity and inclusion in the classroom, what motivates them to implement inclusive practices, and what support (including contextual knowledge) do they require to successfully implement inclusive practices. The guiding research questions for the current study are:

1) What perceptions do faculty hold about diversity and inclusion?
   - How do faculty define diversity and inclusion?
   - Who do faculty view as responsible for diversity and inclusion efforts?
2) How do faculty's personal experience with diversity and inclusion impact how they integrate diversity and inclusion in their classroom?
3) How can we effectively use professional development to aid faculty in creating more inclusive and diverse learning environments?

Methods

The data reported here is from the pilot for a larger case study design informed by the institutional change models and faculty motivation. The pilot included 10 engineering faculty participants who represented all faculty ranks and both research and teaching tenure tracks. The faculty came from two large research intensive universities with strong engineering reputations (five from each university). The participants completed a short survey with multiple open-ended questions, followed by individual semi-structured interviews exploring responses and allowing further clarification. The survey was administered through a commercially available data collection software program and the individual interviews were audio recorded.

Exploratory pilot study

The goal of this pilot study was as an exploratory investigation into the topic. Before beginning the larger scaled study, we wanted to test the viability of our methods to ensure their effectiveness for exploring faculty beliefs and perceptions around diversity and inclusion. Our research design called for participants to complete an open-ended survey, then participate in a one-on-one interview with one of the researchers. Through this pilot study, we discovered that the initial survey results were not as rich as the interview responses, but by completing the survey, the participants were primed for the interview and were more mindful in how they responded during the interview with constructive examples or stories. Due to the sensitive nature of the topic, beliefs about diversity and inclusion, the survey allowed participants to think about the topic in the safety of their own space before being asked more probing and detailed questions during the interview creating thick, rich descriptions of their beliefs and perceptions. As a result, the surveys served as a priming element for the participants with the interviews offering deeper, richer responses, the results here will be focused on the interview responses.

Additionally, for this pilot component, we did not want to limit our exploration by focusing on one specific theory or framework, but wanted a very open analysis to identify emergent themes and directions for this research. Since this was an initial exploration, we did not want to bias or limit the scope of the study or the analysis. Moving forward to the larger study, we will further explore the alignment between our findings and the relevant social science theories discussed in the literature review as well as others.

Recruiting participants

Due to the pilot nature of this project, participants were recruited by the PIs based on their availability and willingness to complete the survey and interview. The selective recruitment allowed for a diverse participation and an optimal sample to provide initial response to the survey and interview protocol. At one university, the participants were selected based on their participation in teaching-centered activities, such as faculty development workshop, internal grant projects focused on classroom innovation, or instructional support consultations. At the other university, the pilot study was discussed with colleagues of Author 1 and an initial list of potential pilot participants was developed. Ultimately, all participants were recruited via a recruitment email that contained the project description and a link to the survey questionnaire.

Data collection

The survey included eight, open-ended items, one item confirming their willingness to also participate in the interview, and six demographic items. The open-ended items included items like: How do you define diversity? How do you define inclusion?, Is diversity important to engineering? Why or why not? What is YOUR current role or responsibility in your department to promote diversity and inclusion in your classroom?, Who is responsible for promoting diversity and inclusion in your department?, and Have you had previous training about diversity and inclusion? Why or why not? The demographic items included rank, teaching experience (in years), gender, race/ethnicity (followed by specifically identifying as Latino/Hispanic), and first generation PhD.

The interview protocol included approximately eight questions that closely mirrored the open-ended survey items, but allowed the interviewer to dig deeper into the participant's responses. Additionally, participants were encouraged to think about how their personal experience with diversity (or lack of diversity) has influenced how diversity and inclusion are included in their classroom management and teaching practices. The interviews were semi-structured allowing for multiple follow-up questions from the interviewer to help explore the participant responses.

Data analysis

Due to the pilot nature of this study, the data analysis included the PI who completed the interview summarizing the responses from each participant using the audio recording for each interview question. The summaries were compiled into one data file to allow for easier consideration across participants and across questions. The PIs also met virtually to discuss the interviews they completed and the themes they observed across participants. Again, this is pilot study, so the investigators were hoping to identify initial themes and probe the integrity of the data collection instruments.

Multiple aspects of the study design established and maintained the credibility of the data collection and the trustworthiness of the resultant answers to the research questions. First, all aspects of the pilot study design are consistent with qualitative methods[16] commonly found in engineering education research. Next, both authors performed bracketing techniques throughout the duration of the study to examine our bias and reflect on methods to minimize their impact on

the study design or analysis[17]. For example, all themes and results were discussed by both authors to reach a consensus on interpretations conclusions. Also, we worked strategically to maintain a balance providing enough detail about the context in which the research occurs to inform the readers while maintaining participant anonymity in accordance with our institutional IRB guidelines. Furthermore, both authors used an interview protocol to ensure the consistency among interview topics, developed analytical memos to support emergent theme identification, and audio recorded interviews for future reference. Finally, as time permits, all themes will be verified by the participants through member checking and discussed with intellectual neighbors. Therefore, despite the exploratory nature of the pilot study, our methods and study design effectively address qualitative research criteria to uphold standards of quality[17].

Results

Defining diversity and inclusion, why they are important, and how they relate to each other

At both universities, when asked to define diversity, the participants focused on "different." Many noted specifics such as people of different races, ethnicities, gender, socioeconomic levels, etc. Others used a more open definition such as different life experiences or backgrounds. When asked to define inclusion, many participants mentioned making sure everyone feels welcome or included, and ensuring there is an opportunity for everyone to engage and participate. All of the participants felt both diversity and inclusion were important to engineering. Most referenced diverse perspectives with respect to problem solving and design as important to engineering; highlighting that it is important that different perspectives are present and considered in engineering, particularly during the design process[18].

One contrasting element between diversity and inclusion that appeared in multiple interviews was the idea that diversity was a more abstract goal that faculty had less control over than inclusion. One faculty commented, "As far as diversity goes, I have little control over that. I see a lot of those decisions being made by the students in what classes they sign up for or kinda above my head in how students are distributed into sections, so there's not a ton that I try to do there except having students recognize the diversity that exists within the group." This idea that within the classroom, faculty do not have control over the diversity of the students that are there was present in multiple interviews. Multiple faculty noted they can't control the students that show up in their classroom, but they can make sure that all the students there feel included and welcome. The faculty often cited "policy and admission procedures" that dictate the diversity of the student body in their department (i.e. low control or autonomy), but expressed their clear role to support inclusion practices for whoever was present (i.e. higher control or autonomy).

Administrative support and responsibility for diversity and inclusion

The faculty in the study responded similarly to identifying designated personnel with the primary responsibility for promoting diversity and inclusion in their classroom or in general within their department. The common responses included "no one" is a designated person or "I don't know" responses. Typically, the participants described the lack of a formal role for supporting or promoting diversity and inclusion within their department, let alone in their classroom. However, as noted in the above section, participants commented about limited to no ability to control or be

responsible for diversity in their classroom, but some did note an informal responsibility to create a welcoming environment in the classroom for their students. A few participants suggested that having a designated person to promote diversity and inclusion would aid them in including these concepts in the classroom and course content. The participants were able to define diversity and inclusion as well as express the importance of diversity, however they were generally not aware of who is or has ever been responsible for formally promoting diversity and inclusion. Overall, the participants described a lack of allocated resources to promote diversity and inclusion, including the lack of committed designated personnel. It is also important to note that multiple faculty felt they would be supported by their department for any personal activity to promote diversity and inclusion.

Despite the participants not "knowing" who is responsible for promoting diversity and inclusion in their department, some faculty members expressed personal values that encouraged them to promote diversity and inclusion within their department. For example, an African-American professor expressed the personal value and social responsibility to promote diversity and inclusion as previous personal, professional encounters suggest that the realization of diversity in engineering remains an unrealized cultural characteristic. Others indicated personal values and choices of service such as serving as faculty advisor for students groups (e.g. women in "discipline" or supporting student chapters of professional societies) as promoting diversity and inclusion. Multiple types of service were mentioned by the participants including being a diversity representative on a faculty search committee. A few participants had official responsibilities regarding departmental admissions and specified their indirect approach to promote racial or gender diversity by advocating for the acceptance of a diverse student pool. As a result, the emergent theme in the current study is the lack of delegated personnel to promote diversity and inclusion, but faculty exercise their personal values to promote diversity and inclusion within their normal professional activities.

Impact of personal experience

Closely related to the participant's designation of who is responsible to promote diversity and inclusion is another theme, the impact of their personal experience. The personal experience included any previous events the participants considered a diversity issue or situation. For example, female participants discussed how being a female engineer had influenced their definition and value of diversity and inclusion. One participant mentioned how being raised in a lower socioeconomic status (SES) sensitized him to the lack of SES diversity in engineering and how SES can impact access to opportunities such as attending a top engineering school. The participant's statement implies that engineering as a field has become classed with variation in access based on SES. The participant went on to say "I have witnessed discrimination" based upon his childhood where he was denied certain interactions based upon his SES. Another participant described being a first generation student and not having a voice during his undergraduate education because he identifies as a racial minority that attended a large research intensive university that is a predominately White institution (PWI). The participant later reflected on his undergraduate experience and noted his "limited social capital" attributed to his status as a racial minority studying engineering. In general, the participants described some

identity dimension and previous personal experience that increased the salience of diversity and inclusion in their teaching practices. Furthermore, the personal experience theme may also be connected to the participant's identity and willingness to engage in promoting inclusive practices despite this not being part of their formal responsibilities.

Professional development

Participants were specifically asked about their experience with training around diversity and inclusion. Some participants had participated in some form of formal diversity or inclusion training, but most could not recall or had not participated in this specific type of training or faculty development. When asked how diversity and inclusion training could be made more impactful and meaningful, a common response was to make sure the person leading the training was an expert in diversity and inclusion and how to integrate them into the classroom. A number of participants seemed very open to integrating diversity and inclusion into their classroom, but were unsure how to do it and did not feel they had time (due to other position demands like tenure) to figure it out. Having an expert provide training would allow busy faculty to discover easy and efficient means for integrating diversity and inclusion into their classrooms.

Another element that was brought up when talking about training was the idea of creating a safe-space to ask questions and have an open discussion. One participant (a white male assistant professor) noted that diversity and inclusion was a sensitive topic, so he felt he wasn't able to have honest conversations about it very often. He felt a training to facilitate these discussions would be "very helpful" where he could express thoughts and ask questions without inadvertently offending someone. As noted in these results, faculty perceptions about diversity and inclusion are often linked to personal experiences, when facilitating professional development around these topics, ensuring a safe space for honest conversation is key.

Discussion

The study results produced emergent themes that contribute to multiple bodies of literature mentioned in the literature review but described elsewhere. First, the faculty in the pilot felt the concept of diversity was out of their control, but creating an inclusive classroom was well within their purview. As a results, the participants emphasized their willingness to work on inclusive practices rather than diversity, which is consistent with faculty autonomy studies. Next, the participants wanted both formal and informal support to include diversity and inclusion concepts within the classroom. Some participants had chosen to participate in formal diversity training and professional development. However, since we need to modify faculty beliefs about diversity and inclusion, the informal strategies should accompany any formal approach taken. This conclusion suggest that interdisciplinary collaborations may provide engineering faculty with the opportunity to gain some exposure to diversity and inclusion strategies not readily available or provided by the home department. In addition, the participants mentioned the desire for administrative support, beyond verbal support, but the appropriate resource allocations including hiring dedicated personnel and providing access to experts on implementing diversity and inclusion practices. For example, the informal support should include mechanisms to allow authentic conversations/dialogues around diversity and inclusion. That is to say, the training

should be flexible enough to accommodate varying knowledge levels about diversity and inclusion practices, especially in the context of engineering culture.

Limitations

Despite our interesting results, there are limitations to our study that are worth noting. First, this study is a small, exploratory pilot study. These results were meant to begin to explore faculty perspectives on diversity and inclusion. These results are not meant as generalizable findings, but as the beginning of the conversation and exploration of this topic. Second, the pilot participants were selected from a convenience sample creating a response bias limitation. The participants selected for this study were actively working to improve their teaching or had some experience with previous diversity efforts. The participants in the pilot are not necessarily representative of the larger population of engineering faculty.

Conclusions and Future Work

Overall, engineering faculty were able to clearly articulate their views on diversity and inclusion. All of the participants saw value in promoting and integrating these ideas into the engineering culture. However, there was a dearth of practical mechanisms for integrating these into the academic culture as well as visible administrative supports. Faculty felt less control over compositional diversity in their classrooms, expressing a "you get what you get" perspective with respect to the students that are enrolled in their classes each semester. Faculty expressed more informal and personal responsibility to create a welcoming and inclusive classroom. Many faculty referenced personal experience and drive to facilitate learning environments where all perspectives are valued. Many of the participants noted a desire to integrate diversity and inclusion efforts into their classroom, but were not sure of the practical details for implementing such efforts effectively. Multiple participants noted a need and desire for diversity and inclusion training that allowed for authentic dialogue and practical solutions that could be implemented in their classroom. In combination, the conclusions of the study illuminate opportunities for engineering faculty to collaborate with non-engineering faculty to gain access to resources that support their personal interest in including diversity and inclusion practices as part of their pedagogical decisions for engineering courses. Furthermore, these collaborative efforts could be the foundation of a community of practice for engineering faculty engaged in introducing diversity and inclusion into their teaching practices, following the process of other instructional innovation dissemination strategies[19].

Moving forward, we will be exploring a larger study to discuss these topics with a wider range of faculty at a more diverse set of universities. The research design proved beneficial in having a reflective, primer survey to start participants thinking about their perceptions regarding diversity and inclusion before the more in depth interview. Reaching out to more faculty, especially those who are not active in diversity and inclusion or teaching innovation efforts, will aid in the further exploration of this topic and verification of this experimental design. Additionally, exploring these topics with faculty at different types of institutions will add to the robustness of the results moving forward.

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