

## **Evaluating the Impact of Design Sessions on Participants' Perceptions of Diversity and Inclusion in the Professional Formation of Biomedical Engineers**

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## Introduction

A lack of diversity and inclusion (D&I) has been a major challenge affecting many engineering programs in the United States [1-3]. This problem has been persistent and difficult to address despite considerable amount of focused attention, enriched conversations, and resources. We believe that this problem persists, in part, because diversity and inclusion are often still framed as simply “numbers problems” to be solved. What is needed instead is an approach that understands and explores diversity and inclusion as interrelated with the epistemological (what do engineers need to know) and ontological (what does it mean to be an engineer) underpinnings of engineering and the presence of systemic exclusionary mindsets and behaviors that permeate various cultures of engineering. These issues are highly complex, interconnected, and not amenable to simple solutions; they require design thinking. Thus, we have initiated a research project that seeks to achieve an understanding of current cultures and of potential change strategies through a design thinking approach that involves stakeholders (students, faculty, staff, administrators, and alumni ) in the design process to co-create potential solutions within the School of Electrical and Computer Engineering (ECE) and the Weldon School of Biomedical Engineering (BME) at Purdue University [4]. This NSF-funded research is organized around three phases of design - inspiration, ideation, and implementation [4] as shown in Fig. 1 and addresses three interrelated research questions: 1) How might we make engineering more inclusive? 2) How might we better prepare engineering graduates for practice? and 3) How effective is the design thinking approach for addressing these complex issues?

In this paper, we focus on the third research question and highlight preliminary findings from the Weldon School of Biomedical Engineering (BME) at Purdue University. Six design sessions were facilitated by our research team in the Fall of 2017 in the Weldon School of BME, where a group of various representative stakeholders came together voluntarily to co-create and prototype programmatic solutions to address issues related to D&I and professional formation of biomedical engineers within the School. The design sessions were part of the ideation phase of our larger research project (see red box in Fig. 1).

By developing prototype solutions *with*, rather than only *for* representatives of stakeholder groups, we aimed to provide opportunities to develop deeper insights, perspectives, and understandings of views of diversity and inclusion, perceptions of social-technical integration, and the professional formation of biomedical engineers. We hypothesized that this human-centered co-design approach would lead to more innovative and effective solutions. As a first step toward understanding whether such an approach to design thinking is an effective strategy for addressing these complex issues, this Work-in-Progress paper evaluates the participants' perceptions of the design sessions, as well as the impact on their own understandings of diversity and inclusion in the professional formation of biomedical engineers. The research question for this paper was: How did stakeholder participants perceive the impact of design sessions on their understanding and value of diversity and inclusion in the professional formation of biomedical engineers? In what follows, we present the preliminary results of this formative assessment of

design thinking as a tool to promote disciplinary cultural change related to diversity and inclusion in a biomedical engineering program.

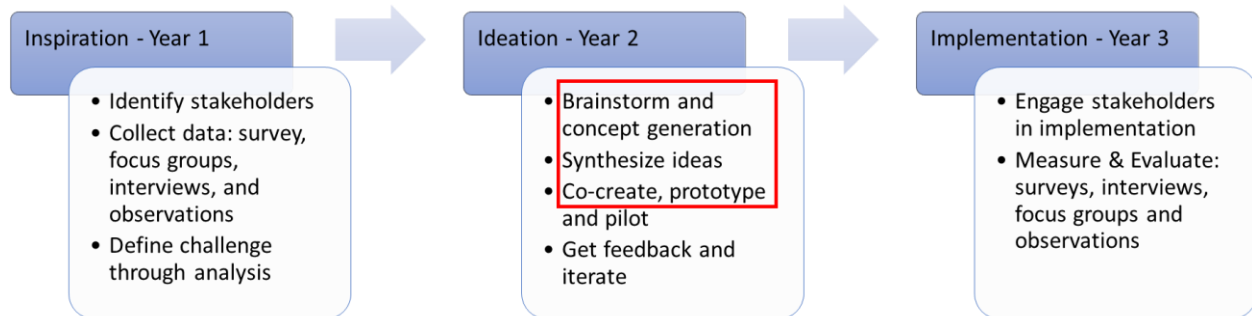


Figure 1: Design thinking process plan for larger NSF research grant (adopted from [4]). The components of the design sessions conducted in BME are highlighted within the red box.

### Diversity and Inclusion in Engineering

Integrating diversity and inclusion into an engineering program is a complex challenge. One of the reasons behind the persistent lack of diversity could be the presence of systemic exclusionary mindsets and behaviors that permeate various cultures of engineering and requires institutional-level reforms [5] and shifts in culture [6]. One model of such institutional reform has been described by Winters [7]. Winters defines inclusion as follows: “Inclusion is a value, and as such must be inherent in and integrated into all aspects of an organization’s culture.” Values are the moral compasses that guide organizational behavior. This means that how an institution collectively values diversity and inclusion determines how these concepts are integrated into the culture and social norms within the institution. Winters’ model discusses macro- and micro-level approaches to build an inclusive environment. Macro-level strategies are driven by “top-down leadership” which creates both *structural and procedural* modifications to address the rules and belief system that prevail in institutional environments and promote change [5, 8]. Micro-level strategies are driven by “bottom-up engagement” that entails individual actions such as: 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].

Thus, to make an engineering program more inclusive using these strategies, individual change-makers must first identify the inequities embedded in the organizational structures, identify and understand the range of individual stakeholder’s personal needs, biases, and stereotypes, and then develop inclusive practices that address these issues within that discipline. We proposed that since design thinking, and particularly human-centered design thinking [9-12], is an effective tool to get at core constraints and stakeholder needs and values for technical engineering problems, it might be an effective approach for understanding and analyzing the complex challenges of creating and sustaining more diverse and inclusive programs in an engineering school. We imagined that the outcome of such a transformed program would be engineers who are better prepared to participate in an increasingly diverse workforce with even greater social and ethical impact for a global public.

## **Human-Centered Design**

A human-centered design (HCD) approach involves designing *with* communities rather than *for* communities. HCD focuses on deeply understanding the needs and value perspectives of the people being served and on creating innovative solutions directed toward those actual needs [13]. It is worth taking note that industries are increasingly taking a design thinking approach [14, 15] to develop and implement solutions for addressing complex issues such as low-cost global healthcare [13], employee engagement, strategic planning [15], improvements in client-sales team relationships [16], and innovative health campaigns for infectious disease prevention [17, 18]. Kolko [18] argues that “There’s a shift under way in large organizations, one that puts design much closer to the center of the enterprise. But the shift isn’t about aesthetics. It’s about applying the principles of design to the way people work” (p. 1). One reason that design thinking is a successful strategy in the creation and implementation of effective new solutions, according to Brown and Wyatt (2015) [9], is that it embeds human insights deeply within the prototyping process and aims to get beyond the assumptions that block effective solutions. Quoting Brown and Wyatt (2015) [9], “Design thinking—inherently optimistic, constructive, and experiential—addresses the needs of the people who will consume a product or service and the infrastructure that enables it” (p. 29). This human-centered design orientation is especially important when creating and implementing strategies that require the stakeholders to change. Another reason a design thinking approach is successful is that it integrates local and often contradictory knowledge and contexts with the creation and implementation processes, a necessity for changing a culture [19-21].

## **Methods**

### ***Participants in Design Sessions***

All research protocols involved in this study was approved by the IRB of Purdue University. There were 15 stakeholder participants in the design sessions. They were representative students, staff, and faculty members who volunteered from the Weldon School of Biomedical Engineering. Participants were recruited to participate in the designs sessions through an email invitation sent by the research team. The 15 stakeholders who participated in the design sessions were a self-selected sample who had volunteered for the design process (and this research study), and for the diversity action committee of the School. Out of the total 15 participants, two were also members of the research team and so functioned in a dual role of facilitating the design sessions as well as participating in them. Three additional research team members, who were not from the School, also participated in the design sessions as facilitators and designers for a total of 18 participants in the design sessions.

### ***Design Sessions***

Six design sessions were held within the Weldon School of Biomedical Engineering (BME) at Purdue University during the fall semester of 2017. Each design session was two hours long and was conducted every other week in an active-learning space. In each session, the research team both facilitated and participated in the design thinking process by providing prompts and activities to guide the design thinking process through problem identification to solution design related to diversity and inclusion within professional formation. However, critical decisions about the process, such as including adding a sixth session, were made by the entire group.

Throughout the design sessions, all participants offered their insights into everyday practices and co-constructed knowledge relationally and through open dialogue, thus contributing to a participatory research and design approach [22, 23]. Within small, large, and “mixed” group formats, and with an awareness of their relative positions of authority in the School, the participants worked together on identifying underlying issues in diversity and inclusion in professional formation of engineers and collaborated to create prototype solutions.

In design session 1, participants mapped their own professional journey, while reflecting on moments in childhood, teenage, college, and professional years that played a key role in becoming an engineer and/or part of an engineering school. They also identified “moments that mattered” as well as “pain points” along the way. Participants were also asked to reflect and note their motivations behind participating in these design sessions, what diversity and inclusion meant to them, and who they thought was missing in the session.

In design session 2 and 3, participants reflected upon current and desired states related to diversity and inclusion in the culture of the School and specified the outcomes, behaviors, enablers and blockers of the desired states. These exercises were completed individually, then shared in small “mixed” groups (faculty, staff, and student members in groups together). These discussions often included insights about their own professional formation process and identity, as well as aspects of their personal journeys and identities.

Design session 4 was dedicated to uncovering the underlying issues perceived as barriers to diversity, inclusion, and professional formation. Design session 4 also included brainstorming potential solutions to overcome those barriers and discussing how to meet identified needs. Participants individually identified target issues they thought were feasible, prominent, and relevant to goals that mattered in addressing matters of diversity and inclusion in the School of BME, placed them on post-it notes along one professional journey map continuum, grouped similar issues together (themes), and voted for the top issues. Following this activity, the participants completed “How/Why” abstraction laddering [24, 25] in small groups to uncover underlying assumptions of the most important issues.

Session 5 was designed to deepen the understanding the scope of the needs, iterate with problem framing, and refine potential solutions. Participants framed their design challenge, using a worksheet that guided them to phrase their problem statement as a design question, state the impact they were intending to achieve, think of possible solutions and their contexts and constraints, and finally visualize the intended and unintended consequences that might happen because of the solution.

Session 6 focused on reviewing the recommended conceptual designs (prototype solutions) and identifying which of the conceptual design recommendations (or which parts of them) should be advanced to implementation phase. Participants worked individually, and then in small groups on finalizing the specific recommendations, creating its design specifications, and metrics of success to address the identified key issues in diversity and inclusion and professional formation of engineers.

## **Data Collection**

A month following the final design session, all 15 stakeholder participants were invited to participate in individual interviews. The delay of one month was chosen for both assessment and logistical factors. One month allowed the participants to reflect on their participation in the design sessions and spanned the Winter break between fall and spring semesters. The interviews were conducted by two of the research team members, one of whom was from the School of BME while the other was from the School of Communication. All but three of the participants elected to be interviewed; therefore, the total sample size of the interview study was 12. One of the interviewees was a member of the School administration as well as a faculty member and was counted as a faculty for data analysis in this study. The participants and their approximate representation of each stakeholder groups in BME is given as a percentage in Table 1 below.

Table 1: *Interviewed participants' stakeholder category and approximate percent representation of that category within School of BME*

<b>Participants Interviewed</b>	<b>Stakeholder Category</b>	<b>Approximate % represented by interviewed participants in BME</b>
<b>6</b>	Faculty / Administration	10 % of total faculty in BME
<b>3</b>	Staff	10 % of total staff in BME
<b>3</b>	Undergraduate Students	1 % of total undergraduates in BME

Building upon on assessment measures of design thinking effectiveness proposed by Royalty et al. [26] and Schmiedgen et al. [27], the interviews involved the following seven criteria for measuring the effectiveness of the design thinking process as perceived by the participants:

- a. *change in participant's understanding of diversity and inclusion and its role within professional formation of biomedical engineers in the school*
- b. *change in importance of diversity and inclusion to the participant for the professional formation of biomedical engineers in the school*
- c. *degree of impact on participant's thoughts about the role of diversity and inclusion in professional formation of biomedical engineers in the school*
- d. *degree to which it revealed any systemic barriers to diversity and inclusion within the school*
- e. *degree to which it provided new ideas for solving problems related to diversity and inclusion in professional formation of biomedical engineers in the school*
- f. *likelihood of recommending the design thinking process for solving problems related to diversity and inclusion in professional formation of engineers*

Each interview was conducted by one of two members of the research team, lasted approximately 30 minutes, and was recorded and transcribed for analysis. Each criterion above was explored both quantitatively and qualitatively. The participant's responses to the quantitative interview questions were collected by asking participants to rank their responses on a Likert-type scale where typical representation of scores were: Not at all = 0, Only a little = 1, Moderate/Some = 2, Very much = 3, To a great deal = 4 for each question.

## Data Analysis

The qualitative responses emerging out of interviews are being analyzed using a thematic analysis approach [28, 29] to code underlying conceptual themes about participants' experiences. Since the thematic analysis is still in progress, the focus of this paper is only on the quantitative responses from interview data, while we provide preliminary insights from qualitative data collected from the interviews, that shed light in deciphering some of the quantitative responses. The quantified data collected during the interviews is presented in box plot format to provide descriptive statistics-based preliminary insights about their perceptions of the effectiveness of design process as ranked by the participants. In the future phase of data analysis, quantitative data from an additional survey as well as the qualitative data from post-design process interviews and design session artifacts will be analyzed and integrated into a more robust understanding of stakeholder perceptions.

## Results and Discussion

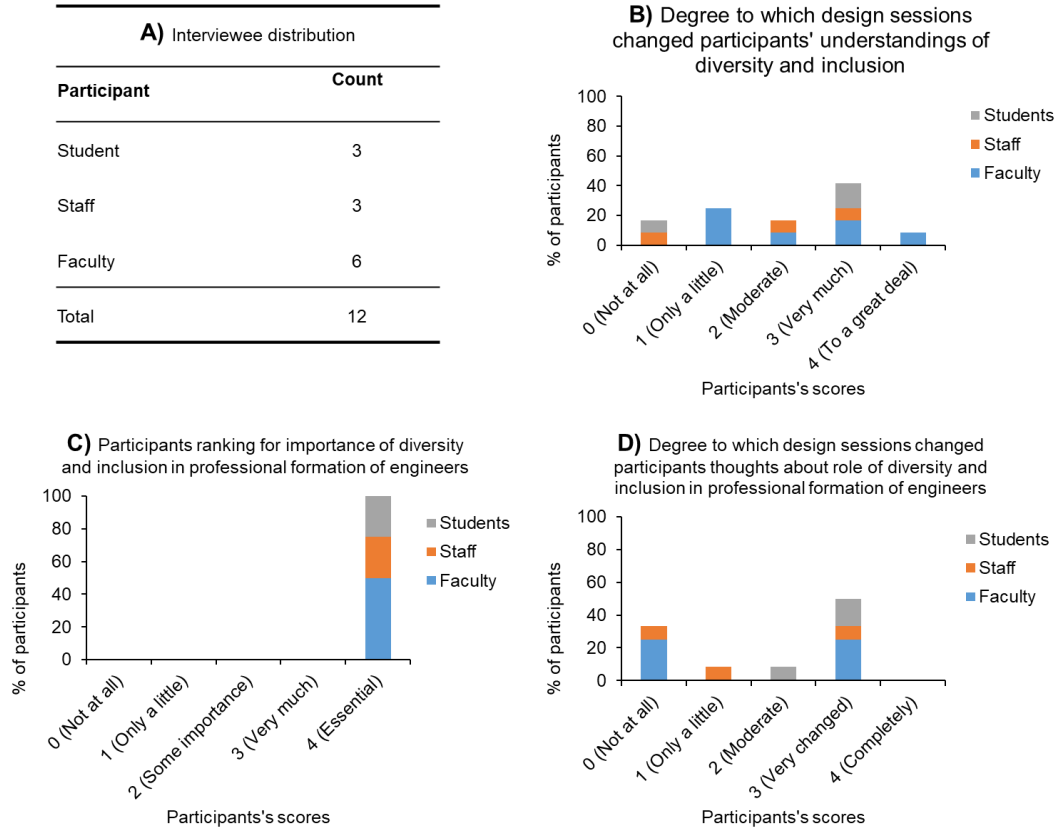


Figure 2: A) Faculty-staff-student distribution of interviewees who participated in BME design sessions. B) Distribution of participants' scores for degree to which participation in design sessions changed participants' understanding of diversity and inclusion; C) Distribution of participants' scores for the role of diversity and inclusion in professional formation of biomedical engineers; D) Distribution of participants' scores for degree to which design sessions impacted participants thoughts about the role of diversity and inclusion in professional formation of biomedical engineers.

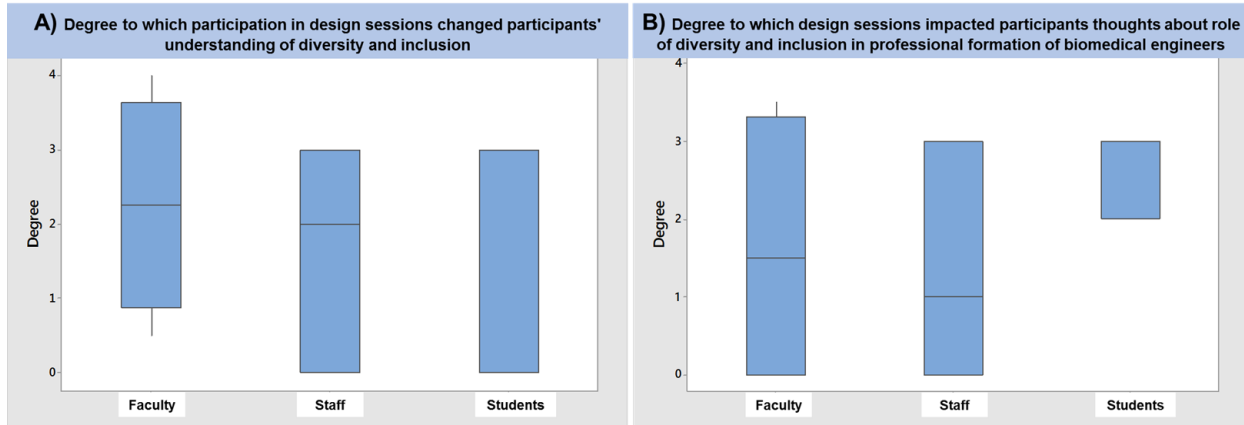


Figure 3: A) Box plot representation of degree to which participation in design sessions changed faculty, staff and students' understanding of diversity and inclusion; B) Box plot representing degree to which design sessions impacted faculty, staff and students' thoughts about the role of diversity and inclusion in professional formation of biomedical engineers.

***Insight # 1: The design sessions had a strong impact on many participant's understanding of diversity and inclusion***

The measurement criteria [a] focused on whether there was change in participant understanding of diversity and inclusion terms and its importance in professional formation of engineers within their school of BME. The participants were asked in the interview to rank the degree to which the design sessions changed their understandings of diversity and inclusion and how so. The interview participants are grouped by faculty, staff, and students (Fig. 2 A) to give sample size for each of the faculty, staff and student groups. Here, we report the quantitative responses of the participants in the form of a histogram shown in Figure 2 B. 50 % of participants indicated that the design sessions changed their understanding very much (a score of 3 or 4). However, for some participants, the design sessions did not change their definitions of diversity and inclusion at all. For example, when asked about the role of design sessions in changing her definitions or understanding of diversity and inclusion, Kiara replied that “It really didn't change my understandings at all. Since my background, some of the research I did as a history student both grad and undergrad has dealt with diversity inclusion aspects. I'm very familiar with the field. So, I didn't ... it didn't change anything. From what I understood.”

For other participants, the design sessions did not change their understandings but expanded their understandings of how other people perceive diversity and inclusion. For example, when Emma was asked about the role of design sessions in changing her definitions or understandings of diversity and inclusion, she responded that “it hasn't changed that definition for me. But it has really opened, especially coming from the East Coast, it's opened my eyes as to how naïve a lot of other people are with respect to what diversity and inclusion is.”

Within all the participants, the faculty members indicated a greater impact of design sessions in changing their understanding of diversity and inclusion (Fig. 3 A), compared to the staff or students. To quote one faculty member's response, “I think we uncovered some things that I didn't think about. The traditional idea of diversity inclusion America has to do the classical



minorities like basically Blacks, Hispanics, Native Americans and that's pretty much it. But there are several unappreciated minorities that are not classically defined and one of them [*name omitted*] came up with and that's veterans."

One of the participants – Adan, expressed that the change in his definition of diversity and inclusion came after hearing students' perspectives. He responded: "I think the biggest change was probably what came out of the student feedback in the sessions, and that was thinking of diversity not just in a cultural sense but even educational diversity. Students showed some passion about how non-inclusive some areas are where they don't find the specialization that they're looking for. But, yeah, in addition to that just identifying even boundaries of diversity. Good points that came up were not just thinking about general or broad diversity, but applying it to the local area we're in. And from the sessions I learned about specific things that are kind of more applicable to our Indiana area that should be taken into consideration, versus more of the national or international ideas that I had of diversity."

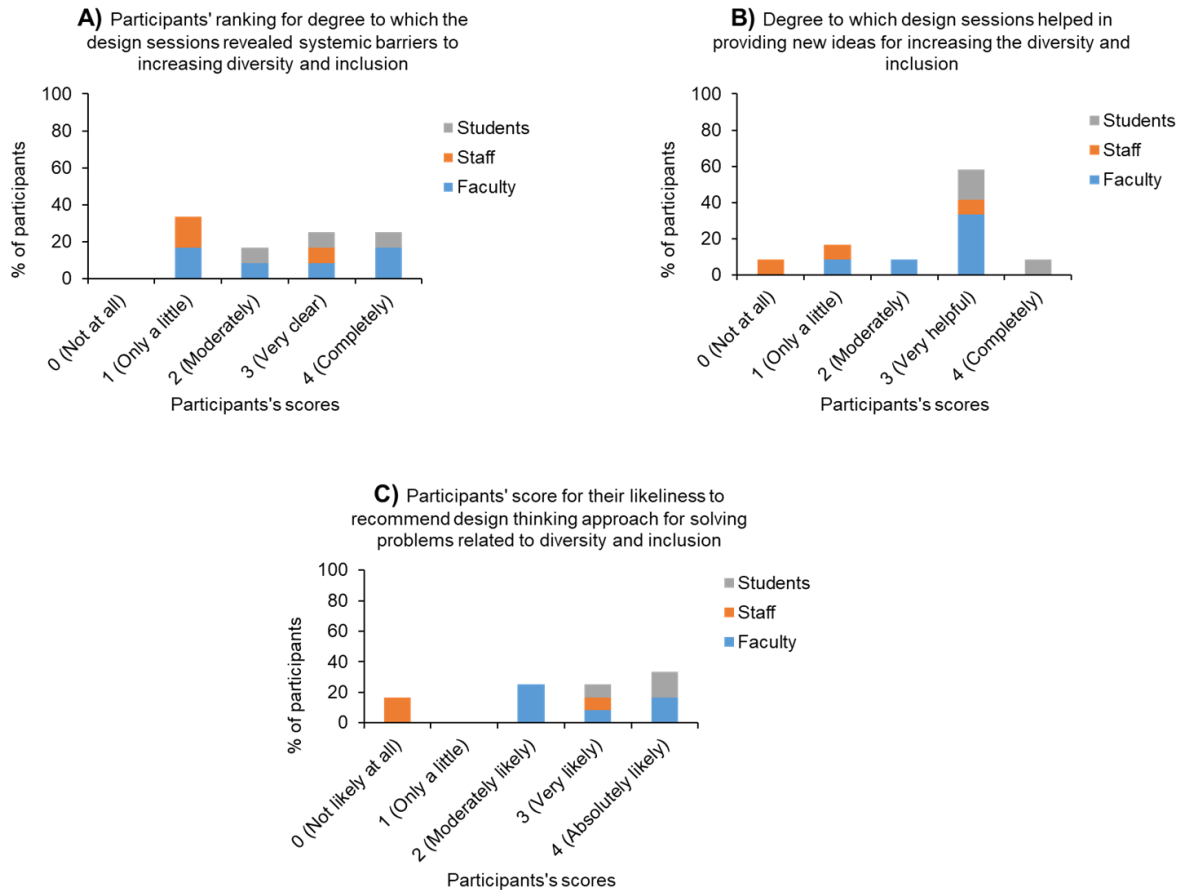
***Insight # 2: Diversity and Inclusion was perceived as playing an essential role in professional formation of biomedical engineers in the school***

To measure criteria [b], how important were diversity and inclusion for the professional formation of biomedical engineers in their school, participants were asked to rank the degree of importance of the diversity and inclusion in the professional formation of biomedical engineers in their school, on a Likert-type scale of zero to four, where 0 = Not at all, 1 = Only a little, 2 = Some importance, 3 = Very much, and 4 = Essential.

The response of participants is shown in Figure 2 C. All participants indicated that diversity and inclusion was completely essential to the professional formation of biomedical engineers within the school. It is important to note that all participants - faculty, staff and student members, regardless of whether they had work-experience as professional engineers or not, equally felt that diversity and inclusion played an essential role in professional formation of biomedical engineers.

***Insight # 3: Student participants were most influenced by the design sessions in shaping their thoughts about role of diversity and inclusion in professional formation of engineers***

To quantify responses of participants in measurement of criteria [c], whether the design sessions impacted participants' thoughts about the role of diversity and inclusion in professional formation of engineers, and if so, to what degree, participants were asked to rank their responses on a Likert-type scale of zero to four, with 0 = not at all changed, and 4 = completely changed (Fig. 2 D and 3 B). While about 33% participants said that the design sessions did not change their thoughts about role of diversity and inclusion in professional formation of engineers, 50% said that the design sessions very much changed their thoughts. The group that was most affected by the design sessions was that of the students with all three of them indicating responses as moderate to very changed. Preliminary analysis of the transcripts of the student verbal responses indicated that they "hadn't really considered the professors' perspectives on how to include diversity and inclusion in teaching", and that the design sessions brought it out to influence them.

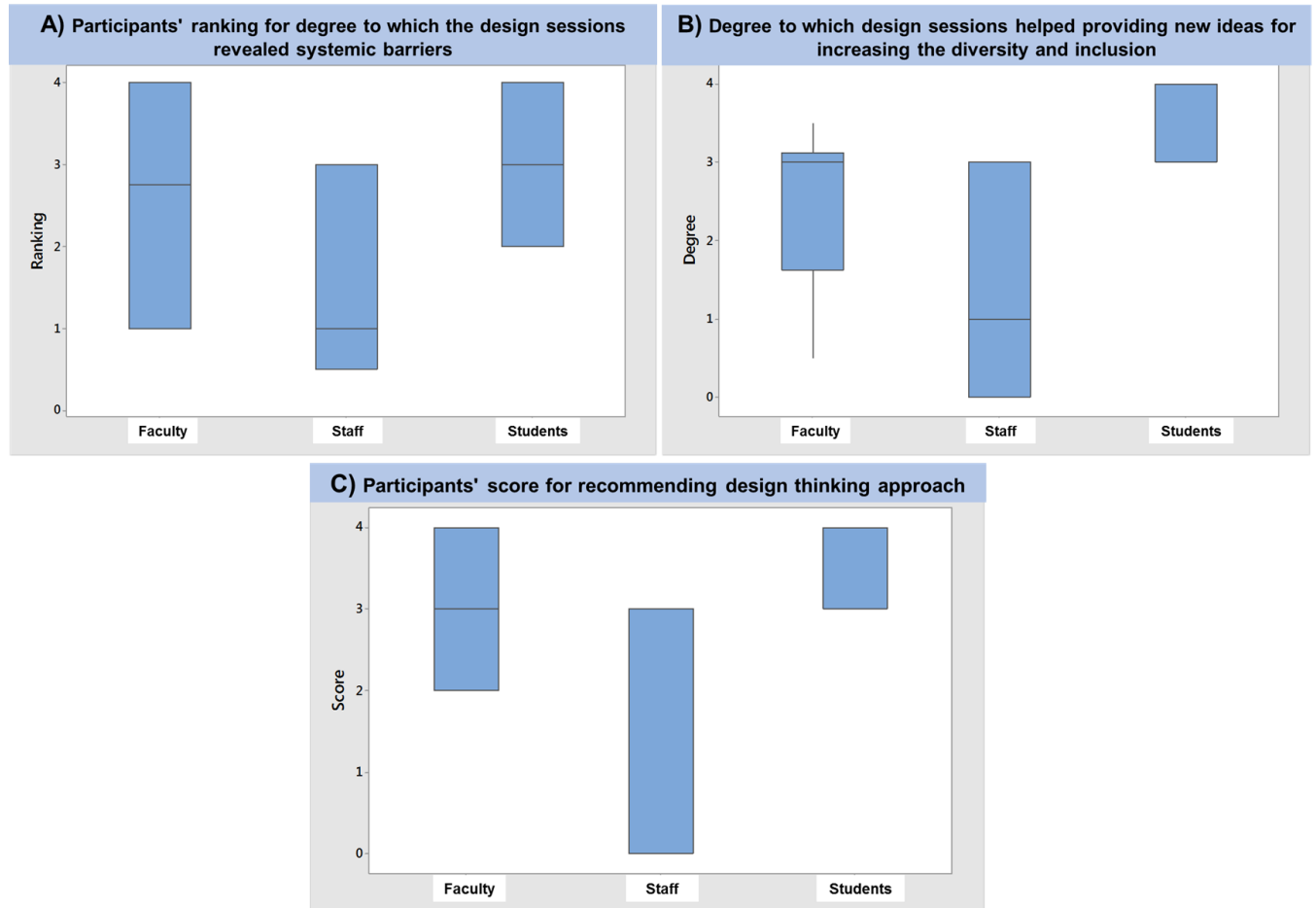


*Figure 4: Distribution of participants scores in response to A) The degree to which design sessions revealed systemic barriers to increasing diversity and inclusion (D&I); B) The degree to which design sessions helped in providing new ideas for increasing the D&I in the professional formation of biomedical engineers (BME); C) Their likeliness for recommending design thinking approach to solve problems related to D&I in professional formation of BME.*

***Insight # 4: Design sessions had impact on revealing systemic barriers to increasing diversity and inclusion in professional formation in the school***

The measurement criteria [d] focused on looking at the participants' self-ranking for the degree to which design thinking revealed the systemic barriers to increasing diversity and inclusion in professional formation of engineers in the biomedical engineering school. The participants had a mixed response to this question. While 50% of participants reported that the design process revealed the systemic barriers to “only a little degree” (a score of 1 on the Likert-type scale) or to a “moderate” degree (a score of 2 on the Likert-type scale), the other 50% reported it to be “very clearly” revealed or be “completely” revealed (Fig. 4 A). In general, we observed that the faculty and student groups had the higher median level scores about success of design process revealing systemic barriers and that the median of the staff group is lower than that of the students and faculty - who felt that the design sessions were successful in revealing systemic barriers (Fig. 5 A). This difference could be attributed to the fact that the two of the three staff participants have previous background in working with diversity and inclusion issues and that they were already aware of the systemic barriers, so the design process did not reveal any new barriers for them.

However, given the prior experience of staff in working with diversity and inclusion issues, it will be very important to consider the valuable contributions of the staff in design sessions and explore how these contributions played a role in the design process, when analyzing the thematic analysis and integrating the data.



*Figure 5: Boxplots representing participants rankings for A) degree to which design sessions revealed systemic barriers to increasing diversity and inclusion; B) degree to which design sessions helped provide new ideas for increasing the diversity and inclusion in the professional formation of biomedical engineers; C) likeliness of recommending design thinking approach to solve problems related to diversity and inclusion in professional formation of biomedical engineers*

***Insight # 5: According to faculty and students, design sessions helped provide new ideas to solve problems related to increasing diversity and inclusion in the school***

In measuring the effectiveness of design thinking process, the next criterion [e] was the participants' self-rankings in terms of degree to which the design sessions helped in providing new ideas for solving problems related to diversity and inclusion in professional formation of engineers. Here, again the participants were asked to rank their responses on a Likert-type scale of zero to four, with zero = not at all helpful, and four = completely helpful (Fig. 4 B). About

66.67% participants reported that they felt the design sessions were “very helpful” or completely helpful (a score of 3 or 4) for providing new ideas for addressing diversity and inclusion in the professional formation of biomedical engineers in the school. Of those 66.67%, 33% were constituted by faculty group, 25% were constituted by student group, while staff only represented 8.33% of participants that felt that design sessions were very helpful or completely helpful in providing new ideas (Fig. 4 B). The boxplots also confirm that while faculty and students felt that the design process was helpful in providing new ideas, the staff did not feel that the design sessions were very helpful in providing new ideas (Fig. 5 B). Similar to Insight #4, one possible explanation for this discrepancy is that 2/3 of the staff came to design sessions with previous background of training and exposure to diversity and inclusion conversations and their verbal transcripts showed that they had already thought about those ideas before going into design sessions. For example, Joshua mentioned “...for me, it really didn't bring anything new to the table for me, in terms of I understand the key issues of diversity and I understand the systemic problems and I understand areas, and I've thought about this before, areas that could really impact our representations of diversity, and everything that I had thought going into this, I still thought going out of it, and nothing new was generated for me. ...For me personally, but remember I'm sort of a unique person in this group.”

***Insight # 6: Faculty and student participants were more likely than staff to recommend design thinking for solving problems related to diversity and inclusion***

The sixth criterion [f] for measuring design process success was looking at the participants' self-ranked score for their likeliness of recommending the design thinking process to others, for solving problems related to diversity and inclusion in professional formation of engineers. It was revealed through the participants' responses, that 83.33% of design session participants were in favor of recommending the design process, while 16.67% were not. Of the various groups of participants, the faculty and student groups indicated that they were more likely to recommend the design process to others (Fig. 4 C and 5 C), while 2/3 of the staff indicated that they were not likely to recommend the design process at all. Two reasons could explain these differences. First, 2/3 of the staff did not have any experience of working with design process or much familiarity with the convergent and divergent processes of the design process; whereas, the faculty and students were well familiar with the design process concept because of specific training with the engineering design process. So, this 2/3 of the staff felt confused and lost at times within the process and indicated that having a clear focus, defined goals, and fully identifying the problem before moving to solution space will be helpful in future. Second, because of the previous exposure of the staff members to diversity and inclusion concepts, the design process was much less productive for them. These insights are extremely important and valuable for improving the design process in future. Suggestions included: clarifying the purpose of each design session, intervening in the process to check if process is going in right direction, increasing the representation of diverse groups in the design sessions, funneling down how each participant understood diversity and inclusion overall and then at university, engineering school, and department levels. These helpful, rich suggestions provided by the participants are being used to improve the design thinking process productivity.

## **Conclusion**

Overall, the quantitative data analyzed to date suggest that stakeholder participants perceived that the design process had a positive effect in addressing some issues related to the complex challenge of increasing diversity and inclusion in biomedical engineering school. Specifically, stakeholders in the school of biomedical engineering reported that the design sessions impacted their perceptions in following ways:

- impacting participants' understanding of diversity and inclusion
- positively impacting participants' understanding of the importance of diversity and inclusion in professional formation of engineers
- revealing systemic barriers to increasing diversity and inclusion in professional formation in the school
- providing new ideas to solve problems related to increasing diversity and inclusion in the school

While we acknowledge that the implementation phase of the design process may more directly reveal the effectiveness of design sessions in addressing diversity and inclusion issues in the professional formation of biomedical engineers, this Work-in Progress allowed us to explore the impact of design sessions on perceptions of the stakeholders about diversity and inclusion in professional formation of biomedical engineers. We also observed that the involvement of stakeholders in design sessions promoted ongoing conversation about diversity and inclusion within the department, and it was realized that the benefits of these conversations may impact culture and feelings of engagement within the department. The design sessions thus provided an opportunity for community building, through direct engagement of students, faculty, staff and administrators as stakeholders, and a huge opportunity for promotion of feeling that individual stakeholders are part of the process of making the cultural change. Thus, we noted that the benefits of design sessions might not be merely limited to solutions generated on diversity and inclusion issues in the department, but may be extended beyond them to generate a change in culture of the school through on-going conversations and engagement of the stakeholders.

## **Limitations and Future Scope**

Despite the initial findings indicating a positive impact of the design sessions in aspects as listed above, there are several limitations to this study that must be considered. The study was limited by the small number of stakeholder participants who had self-volunteered to join the design sessions; 10% of faculty and staff and 1% of the undergraduate students. There was also very small representation of the graduate student population (one student participant was a combined degree BS/MS graduate student) which represents a significant stakeholder category in the culture of the School. While a larger participation in the design sessions might have been desired for greater representation, this could have proved logistically difficult or even less effective as a design process. We also recognize the limitation of selecting stakeholder participants solely from within the School, particularly a school with a low level of diversity. Seeking participants from those who are not yet included in the School or those who have been excluded would likely yield valuable insights into both extant barriers and potential solutions.

It is also worth noting that this was a co-design process where stakeholders were also participants in the design process and the mixed categories of stakeholders meant there were

power dynamics present in all sessions. Despite these power dynamics, all the participants were able to voice their insights about everyday practices of professional formation and together co-construct knowledge relationally and throughout the design sessions. However, it should also be realized that the application of design thinking could be hindered by challenges such as that of communication and understanding gap between the various designers since the problems addressed by designers rarely fall solely within the boundaries of any one of subject matter [30]. Clarifying the purpose of design sessions and design process to the participants at each stage of design could help in future in addressing these challenges.

In addition, preliminary transcript analysis of the interviewed stakeholder participants indicates that they recognized also that the design process could be improved by increasing the diversity and number of participants attending the design sessions, and improving the focus of design sessions. Additionally, qualitative data obtained from the interviews has not been analyzed to date. This analysis will be critically important to capture the fuller insights from the participants' interviews and other artifacts that they submitted during the design sessions. The BME design session participants' evaluation of the recommendations that came from the design sessions also needs to be analyzed carefully.

The findings from this study will be valuable as an initial indication of whether a human-centered design thinking process can be used successfully for providing new, valuable and feasible ideas for addressing the diversity and inclusion in professional formation of engineers in a specific program. We believe that full analysis of this data will be useful within the larger research study and to guide the second set of design sessions with the comparison school of ECE. Furthermore, comparison with the design process outcomes and evaluations in ECE are expected to provide insights about how two very different engineering disciplinary cultures might be impacted by a design thinking process.

### **Acknowledgements**

This work was made possible by a grant from the National Science Foundation (EEC-1636446). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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