

## **An Engineering Faculty and an Intention to Make Change for Diversity and Inclusion: Creating Sustainable Change Efforts**

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# **An Engineering Faculty and an Intention to Make Change for Diversity and Inclusion: Creating Sustainable Change Efforts**

**Abstract:** Scholars of engineering education have acknowledged a need for greater connection between research and engineering teaching practice in order to see sustainable change in engineering schools. This study examines the contrast between STEM education research on the positive impact of faculty on diversity and inclusion and some engineering faculty's lack of actual involvement with these issues. We examine the faculty of an electrical and computer engineering (ECE) department at Purdue University using Fishbein and Ajzen's reasoned action model for behavior to determine factors in the department that influence faculty's intention to make change for diversity and inclusion. We conducted interviews with ECE faculty about diversity, inclusion and department culture, and then an inductive thematic analysis organized around the reasoned action model. The major themes revealed that many faculty do not see involvement with diversity and inclusion as a norm in the department, and do not recognize their power to influence these issues. Our conclusions provide recommendations for engineering departments to meaningfully involve their faculty in improving diversity and inclusion.

## **Introduction**

In 2012, a report from the American Society of Engineering Education (ASEE) titled "Innovation with Impact" called out the gap between engineering education research and educational practice in engineering schools [1]. The report stressed a need for engineering schools' faculty and administration to be actively involved in a cycle of research and practice of engineering education [1]. In simple terms, there is not adequate connection between the field of engineering education and engineering schools to create the impact we need to see for our students, and engineering faculty are too often uninvolved in and/or unaware of innovations in teaching. This study specifically examines the gap between the practices of engineering faculty and literature on these practices' impact on diversity and inclusion to gain understanding about how to create impactful, sustainable change towards a more inclusive field of engineering.

Researchers have identified engineering faculty as a strong influence on students' persistence in engineering, an issue that is especially crucial for underrepresented groups (including women and underrepresented racial minority students) who leave the field at a higher rate than their peers [2]. Packard identifies three broad factors crucial to the persistence of underrepresented students in STEM – interest (e.g. relevance, enjoyment), capacity (e.g. ability, self-efficacy), and belongingness (e.g. acceptance, inclusion) – and calls for faculty to encourage these factors in their students [3]. Various studies have shown the impact faculty can have on such factors. Positive relationships with professors have been shown to improve students' self-efficacy [4] and confidence [5], which in turn improve their help-seeking, effort, and critical thinking [4]. The amount and quality of instructor interaction and feedback a student receives has been shown to predict group skills, problem solving skills, and engineering competence [6]. Alternatively, low student-faculty interaction has been shown to negatively impact self-efficacy and academic confidence [4], which means that a lack of effort on the part of faculty to interact with students can actually cause harm.

The known effects, both positive and negative, that faculty interaction can have on students implies that actively involving professors in diversity and inclusion efforts such as inclusive teaching strategies will be important for change. However, as we have noted in our own study, many engineering faculty do not take advantage of their potential for positive impact. This caused us to ask: What would be needed to develop engineering faculty who actively and consistently work toward improving the diversity and inclusion of their students? To answer this, we looked at what is required for faculty to develop an *intention to make change for diversity and inclusion*. In this study, we define “diversity” as the presence of diverse backgrounds among students, while “inclusion” is their full acceptance into the culture of their school. The term “diversity and inclusion” stresses the importance of both factors working together. We defined an intention to make change for diversity and inclusion as necessary for faculty to take any of a broad category of actions towards the goal of “making change.” This could include implementing inclusive teaching methods, or other ways of participating in culture change towards improving diversity and inclusion. As a guiding framework for the analysis, we used the model for intention given by Fishbein and Ajzen’s theory of reasoned action. The reasoned action model has been used previously in engineering education to examine the relationship between students’ intentions and their success in engineering [7]; however, here we switched the focus to faculty.

We thematically analyzed interviews with faculty of an electrical and computer engineering (ECE) department at a Purdue University to gain insight on what factors contribute to or prevent the development of the intention to make change for diversity and inclusion. Electrical and computer engineering programs across the United States are known to have particularly low representation of women and other underrepresented students compared to other engineering majors [8]. Therefore, in these programs faculty awareness of and participation in diversity and inclusion efforts is especially crucial. Our study was guided by the following research questions:

- I. How do beliefs within the ECE department influence the faculty’s intention to make change for diversity and inclusion?
- II. What individual, social or information background factors influence those beliefs?

In the concluding section of this paper, we make recommendations based on our results for sustainable faculty development initiatives aimed at improving diversity and inclusion.

## **Theoretical framework**

The theoretical framework through which we examined the various influences on faculty’s actions is Fishbein and Ajzen’s *reasoned action model* for behavior, which is summarized in Figure 1. The core idea of the reasoned action model is that any behavior is directly predicted by an intention to perform that behavior, and that intention is created through three main factors: attitude, perceived norm, and perceived behavioral control. *Attitude* toward a behavior, whether positive or negative, is informed by a person’s assessment of the outcomes of performing the behavior (*behavioral beliefs*). The *perceived norm*, or social pressure to perform a behavior, is informed by a person’s beliefs about others performing or approving of the behavior (*normative beliefs*). A person’s *perceived behavioral control*, or perception of their ability to perform the behavior, is informed by their beliefs about the power they have (*control beliefs*). In other words,

a person will likely perform a behavior if they see it as positive, accepted and/or encouraged, and if they believe they can. [9]

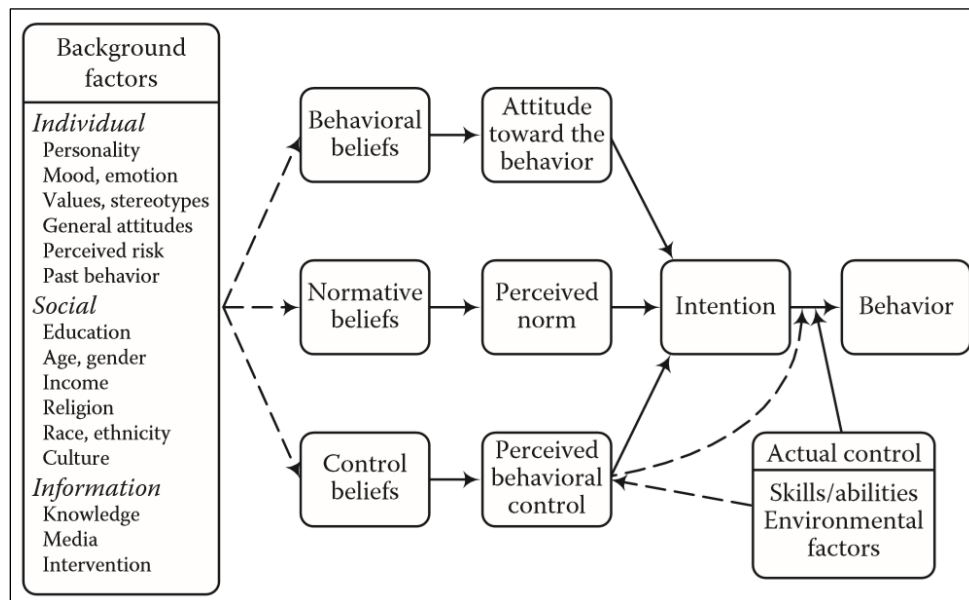


Figure 1: The reasoned action model (figure from [9])

A person's behavioral, normative and control beliefs are influenced by diverse background factors such as individual characteristics, social influences and the information available to them. The relationships between background factors and beliefs can be highly context-specific, and are not laid out explicitly in the reasoned action model [9]. Therefore, one of the goals of our analysis was to explore how the beliefs of ECE faculty are informed by background factors in the context of their department.

The ECE department culture acts as one background factor. We conceptualize the department culture using Schein's model for organizational culture, which has been used previously to study engineering cultures [10] and runs parallel to the reasoned action model. In Schein's model, an organizational culture is made up of three levels: *artifacts*, which includes structures, processes and behaviors; *espoused beliefs and values*; and *basic underlying assumptions* [11]. A culture's artifacts are informed by its espoused beliefs and values, which are in turn informed by its basic underlying assumptions. This organizational culture model echoes the way that behavior is developed from beliefs, which are developed from background factors in the reasoned action model. However, while Schein's model provides a framework for the department culture – telling the story of how the faculty operate as a whole – the reasoned action model deals with the motivations of the individual professor. Within the reasoned action model, culture represents only one of many possible background factors that influence an individual.

Although the model is most often employed in quantitative studies, for which Fishbein and Ajzen recommend examining a carefully defined and specific behavior, we, in contrast, apply the structure and terminology of the reasoned action model as a framework for a qualitative thematic analysis and examine not a single behavior but any behavior toward a broad *goal*: making change for diversity and inclusion. This strategy was chosen in part due to the broad and general

nature of the interview data, which was not collected with the final theoretical framework in mind. Regarding the use of their model to examine goals, Fishbein and Ajzen state [9]:

“Our reasoned action approach can help to predict and explain any intention, not only intentions to perform specific behaviors but also intentions to attain goals. However, as a general rule, the link between behavioral intentions and behavior is stronger than the link between goal intentions and goal attainment.” (p. 324)

Therefore, our usage of the model does not follow the protocol usually necessary to reliably predict behavior. Rather than for prediction, we use the reasoned action model to understand on a high level which faculty beliefs affect their intention to make change for diversity and inclusion, and how we can design future interventions that target these beliefs.

## **Methods**

A major motivation for this study was that diversity and inclusion in engineering is a “wicked” problem [12]. The issue is complex; there are many factors at play and the problems themselves are not always what they seem. Acknowledging the complexity of the subject, this study was guided by an interpretivist research philosophy, which aims to discover themes within participants’ own experiences rather than applying an existing framework from the beginning [13]. Therefore, the goal of the interviews was to broadly explore the culture and perceptions around diversity and inclusion of ECE faculty at the university under study. The goal of the analysis, then, was to identify themes among the interviews collectively which represent opportunities for, or barriers to, improved diversity and inclusion in this department. Rather than attempt to label an engineering department as “good” or “bad” at diversity and inclusion, we instead work to label some of the factors that might prevent further progress, as much as is helpful to fashion solutions.

Recruitment of ECE faculty for interviews occurred via both convenience and purposive sampling [14]. Regarding convenience sampling, some faculty self-selected by responding to a department-wide email requesting volunteers. To increase the number of interviews, recruitment also occurred in person. Purposive sampling focused on increasing the gender diversity of the sample by encouraging women faculty to participate. In total, 11 faculty interviews were conducted between January 2016 and May 2017, representing about 12% of the ECE faculty at the time. Only one interview, 9% of our sample, was with a female faculty member; this percentage compares to the 15% female faculty in ECE at the time. Data was not collected on participants’ racial identity. The semi-structured interview protocol was loosely based on Godfrey’s cultural dimensions of engineering education [10], which provided an engineering-specific framework built on Schein’s organizational culture model. Thus, in addition to faculty’s personal histories, questions explored: ways of doing, thinking and being as an ECE engineer; faculty perceptions of diversity and inclusion; faculty-faculty, student-student and faculty-student relationships; and ECE’s relationship to the larger engineering community.

Consistent with the interpretivist research philosophy, the first author conducted an inductive thematic analysis [15] on the interview transcripts to identify themes around diversity and inclusion. Coding was completed using the software NVivo 12 in two stages. Inductive first cycle coding focused on thoroughly categorizing ideas from the interviews with descriptive and

paraphrasing codes. Technical details of engineering concepts were excluded from coding due to their limited relevance to the study. Nine of the 11 interviews were coded before reaching saturation, a point at which further coding revealed no new ideas related to the research interest [14] (no new codes had appeared in the last three transcripts coded). First cycle codes were organized and prefixed according to nine general categories (Table 1). Second cycle coding grouped and connected the first cycle codes into larger themes via the construction of a visual network diagram, or thematic map (see example in Figure 2). At this point, a subset of the themes generated from second cycle coding inspired the final research question, pertaining to faculty's intentions towards diversity and inclusion. The reasoned action model was identified as the theoretical framework, and the second cycle themes were integrated into a final thematic map (Figure 3) and corresponding written analysis around the three main factors for intention.

*Table 1: First cycle coding categories*

<b>Category (Prefix)</b>	<b>Description</b>	<b>Example Codes</b>
Sentiments (S)	Feelings about their job	S-Rewarding to help others grow S-Resentment regarding conflicting responsibilities
Motivations (M)	Motivations to pursue and continue their job	M-Career progression and money M-Beauty of engineering
Values (V)	Values and responsibilities within the job	V-Mentoring V-Research
Actions (A)	Teaching methods and other actions by faculty to improve the student experience, including diversity and inclusion	A-Arranging diverse teams A-Faculty diversity workshops
People (P)	The interpersonal culture of the department; perceived types of students and professors	P-Professors too busy for students P-Students staying in their comfort zone
Conflicts (C)	Perceived barriers to change in engineering academia	C-Small recruitment pool C-Student resistance to diversity initiatives
Engineer (E)	Characteristics of a typical or successful engineer	E-Math, science and technical skills E-Problem solving and critical thinking
Diversity (D)	Ideas and attitudes about diversity issues	D-Diversity of experiences D-Lack of women in engineering
Student Experience (SE)	Perceptions of student sentiments about the program	SE-Disconnect between school and industry SE-Struggling with academics

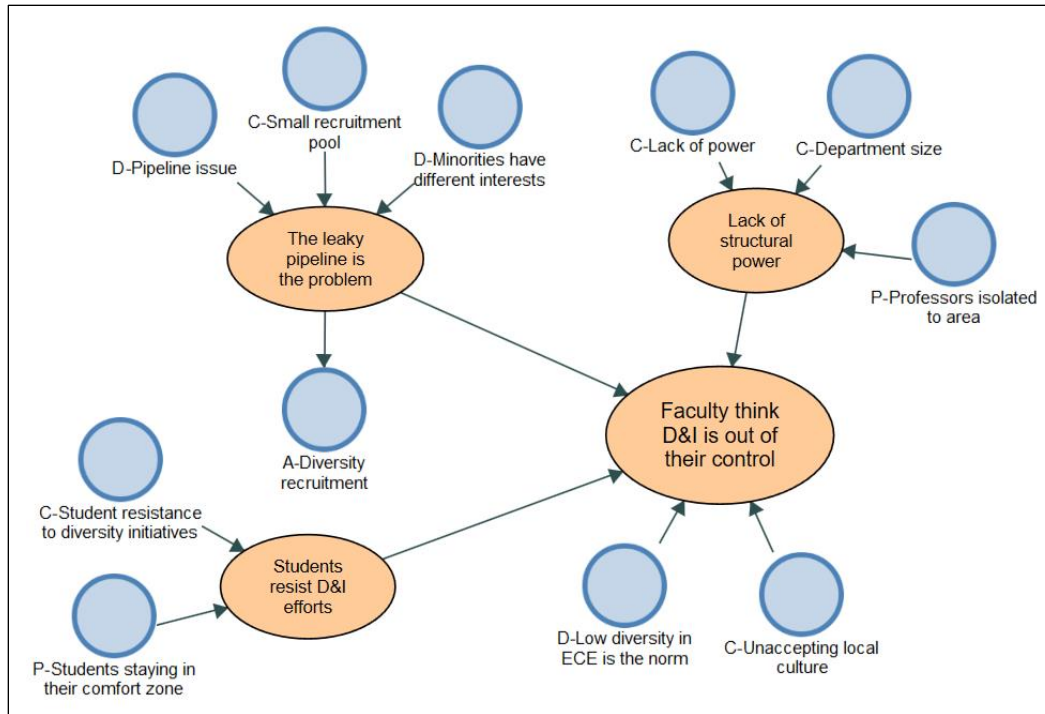


Figure 2: Example of second cycle coding / theme building

## Results and discussion

Given the effect faculty can have on the inclusivity of their school via their interactions with students, we are interested in how faculty's perceptions of their role align with their potential impact. We investigated this question by analyzing this ECE faculty's *intentions to make change for diversity and inclusion*. Using the reasoned action model, we claim that if a faculty member develops such an intention, they will take some personal action to improve diversity and inclusion in their school. This means they must have a positive attitude toward diversity and inclusion, perceive a norm to take such action, and perceive behavioral control over diversity and inclusion. Here we analyze the major themes from the interviews within the framework of the reasoned action model (Figure 3). Working backwards from the observable to the inferred, we first discuss evidence of the faculty's intentions, and then discuss the evidence, beliefs, and background factors relating to each of the three factors for intention in turn. The participants have been given pseudonyms and are listed in Table 2.

### *Intention to make change for diversity and inclusion*

A major theme which emerged in the early stages of analysis and originally inspired the investigation of faculty's intentions is that the ECE faculty's involvement in diversity change efforts appears rather passive and inconsistent. Discussion of diversity issues among faculty primarily arises around admission and hiring decisions, and otherwise is perceived as highly optional based on the individual faculty member's interest. One interview participant summarized faculty discourse around diversity this way:

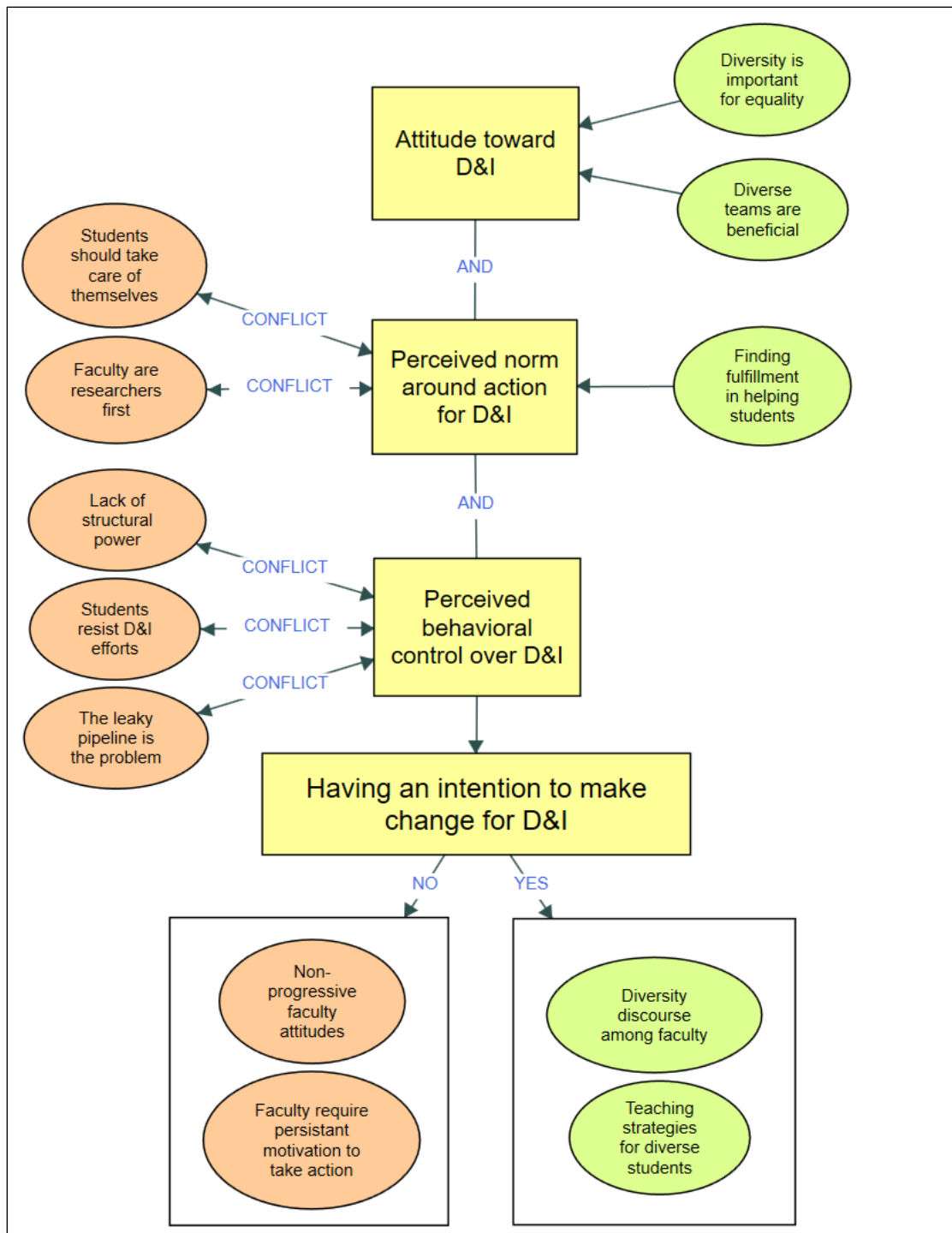


Figure 3: Overview of analysis framework



“A lot of the time, it's more of a soft topic, in a sense. You can't really force people to do it. [...] I think it's more in a self-supported way. For example, some of the women faculty [...] try to meet on a regular basis to chat and talk. Then I think our department head is very open to suggestions [...] A lot of times, it may be because of some event or something that stirred up a discussion [...] Then I think it's a matter of how much it matters to the individual.” – Evelyn

Similarly, although a small number of participants mentioned teaching strategies for different learning styles, they perceived that the implementation of such strategies was also up to the individual professor and was fairly uncommon. Some participants mentioned that faculty diversity workshops had arisen in the past, but they died out when there was no one to actively champion them. Other than a recent effort in some courses to pre-select diverse student teams (discussed further below), which notably focuses on students' inclusion of each other rather than faculty's inclusion of students, at the time of study there did not appear to be any consistent effort in the department to get faculty involved in improving diversity and inclusion. Because behavior is directly linked to intention, this raises concerns about this ECE faculty's intention to make change for diversity and inclusion.

While individual ECE faculty members may or not have an intention to make change, as we argue in the following sections, many of the background factors present in the department, including aspects of the culture, tend to inhibit the development of such an intention. Namely, while faculty seem to have a positive attitude toward diversity and inclusion, prominent values and beliefs in the department such as a prioritization of research and a lack of perceived power conflict with the development of perceived norm and perceived behavioral control.

*Table 2: Participant information*

<b>Pseudonym</b>	<b>Gender-identified</b>	<b>Years of Experience as Faculty</b>
Edgar	Male	14
Edward	Male	2
Eli	Male	6
<b>Elijah</b>	Male	15
<b>Elliott</b>	Male	26
<b>Emmett</b>	Male	*
Eric	Male	17
<b>Ethan</b>	Male	2
<b>Eugene</b>	Male	40
<b>Evelyn</b>	Female	2
<b>Everett</b>	Male	22

\* This participant did not disclose their years of experience in the interview

**Bolded** participants are quoted in this paper

### ***Attitude toward diversity and inclusion***

For faculty to have a positive attitude toward diversity and inclusion, we expect them to acknowledge its current state as a problem and to believe that improving it will bring some

positive outcome. Generally, the ECE faculty interviewed did show evidence of such a positive attitude, and their reasoning fell very consistently into two themes: (a) the importance of diversity for equality, and (b) the benefits for students of working with diverse groups of people.

### *Importance of diversity for equality*

“Well, the first things that come to my mind [about diversity and inclusion] are minority students and women. Especially in an engineering program and in ECE where we don't have enough women.” – Elliott

Faculty frequently began their discussion on diversity by acknowledging the unequal demographics of the ECE department. As of the time of the interviews, participation of women was only 15%, while underrepresented minorities were even fewer at 5% [16]. Meanwhile, a high international student population (38%) [16] posed unique cultural challenges. These statistics appeared to be common talking points at faculty meetings, especially when it came to admissions and hiring decisions, and faculty generally expressed a desire to see the demographics of the department more closely reflect that of the population at large. Among some faculty, there was also an understanding of deeper concepts related to diversity and equality. For example, some acknowledged factors other than race, nationality, and gender that contribute to diversity, such as culture and life experiences, and that these factors can create added challenges for affected students. A few also shared their experience with the idea of unconscious bias, and the importance of identifying and countering it.

### *Benefits of diverse teams*

“When you have the opportunity to talk to people with different backgrounds, different genders, different cultures, you simply learn different things. As simple as that. When you learn different things, you are more aware of different opportunities, or in some cases, different mistakes to avoid. That helps you be more successful in your career.” – Elijah

A popular lens through which faculty looked at issues of diversity and inclusion was that of their role in the professional formation of students. Specifically, faculty believed that the experience of working and getting along with peers very different from them would be valuable in students' future careers. Many faculty not only acknowledged that diverse teams are common on real engineering projects, but also that they produce better work due to the variety of experiences and viewpoints that each team member brings to the project. For some faculty, their viewpoints on diverse teams were informed by their own experiences working in academia; they mentioned the importance of communication skills, including maintaining professional relationships with colleagues they didn't agree with, to maintaining a harmonious environment among diverse faculty. The language faculty used when speaking on diverse teams was often focused on practicality; they stressed the importance of being “cordial” and “getting along,” with a focus on completing quality engineering work.

### *Behavioral beliefs and background factors*

The faculty's emphasis of diversity for equality and the benefits of diverse teams reveals that they believe improved diversity to be an overall positive outcome. These behavioral beliefs were

very similar between all the faculty interviewed. Faculty showed a belief that men and women, as well as minority and majority students, should have representation in engineering equal to that in the general population. They also shared a belief that diverse engineering teams are beneficial both to individuals' professional development and to the final engineering product. Due to their focus on the presence of a diverse population in itself, it seems that faculty's behavioral beliefs lean more on the positive aspects of "diversity" over "inclusion."

The consistent shared behavioral beliefs we see here are encouraged by a variety of background factors within the context under study. The fact that these professors originally agreed to participate in a study about diversity implies that, at least among our sample, it is a personal value of theirs. However, the ECE department also communicates the importance of diversity to its faculty in several ways. Some faculty mentioned being impacted by the department leadership's personal emphasis on diversity:

"We elect these people directly, and we respect them for all kinds of the right reasons, and I think that having that come from them probably builds support in faculty members who might otherwise be a little bit less enthusiastic about it." – Ethan

Additionally, the school requires professors to attend a diversity workshop upon hire, and additional diversity training is required for professors to serve on a search committee. Faculty are also increasingly required to include a diversity statement in research grant applications. For example, the National Science Foundation's Computer & Information Science and Engineering (CISE) division has recently begun to encourage grant applicants to include a "broadening participation plan" in their proposals [17]. All these various influences combine to consistently encourage a value of diversity among ECE faculty.

### ***Perceived norm around action for diversity and inclusion***

For faculty to perceive a norm around action for diversity and inclusion means they perceive that a majority of their peers approve of and personally take actions to improve diversity and inclusion in their school. In other words, it means that faculty would see diversity and inclusion as an important part of their job. Of the three major factors for intention in our context, this factor is perhaps the most entangled in prominent ideas about the role of an engineer. The first theme around perceived norm was faculty's view of their role as primarily that of a researcher. The second was a belief that students should have to advocate for themselves for help. A third theme emerged around identifying faculty members who prioritized teaching as a special group because they found personal fulfillment in helping students.

#### ***Faculty are researchers first***

"In an R1 institution, it's the publish or perish sort of philosophy [...] If you're going to stick around, you have to be able to do original research. You also have to be able to teach because that's our mission, but it is not as emphasized as it is in other disciplines, at other institutions." – Eugene

"If students come to you during the office hours and want to know a little bit about research or something else, you should be able to open up and [...] give

them time and attention. [...] Some faculty don't do it, because they're busy doing other things and they're happy to see students go away.” – Everett

A variety of internal and external factors cause the faculty interviewed to prioritize their roles as researchers above those as teachers and mentors. When asked about their motivations to become a professor, very few faculty mentioned a desire to teach; instead, they cited a variety of reasons including the respect given to the profession, the salary, the freedom of “being your own boss,” or convenience due to life circumstances such as a spouse working at the same school. Some sought academic careers as alternatives after bad experiences working in industry. Once hired, faculty expressed frustration with trying to balance the responsibilities of research, funding, and teaching, and perceived them all to be in conflict for their limited time. They felt a need to prioritize in order to survive, and considering the lack of motivation for teaching, it is unsurprising that the result was a deprioritization of teaching in favor of research and funding responsibilities. This deprioritization is evidenced by the fact that faculty usually thought of research first when speaking about their jobs, with teaching sometimes mentioned afterward and framed as an additional requirement placed on them by the school. Faculty also generally agreed that the time they must dedicate to research limits the time they can spend on relationships with undergraduate students, and that undergraduates cannot expect much access to professors unless by the professor's personal choice.

#### *Students should take care of themselves*

“I hate to be one of those people that say I got through it so everyone else can get through it too, but there's a lot of truth in that. If you're really interested in what you want to do, you'll figure out a way to make it happen.” – Eugene

Faculty revealed through their interviews that they expect a very high level of independence and self-discipline from students. A common attitude about students was that they approach professors primarily to ask for better grades, or to ask for the answers to problems without trying hard enough to find solutions themselves. Faculty displayed an aversion to accommodating students in order to avoid being unfair; some related this to their own experience, believing that their own students should not receive more help than they did when they were in school. Students were expected to be independent learners who know how to seek resources on topics they don't understand, to have a very strong work ethic, to be patient and persistent when solving problems, and to be ambitious in seeking opportunities to further their learning and their careers. It seemed that mostly such ambitious students receive mentoring from faculty, since they are persistent in attending office hours and making themselves known. Therefore, the level of education and mentoring which students receive depends strongly on the students themselves.

#### *Finding fulfillment in helping students*

“Quite often, the research takes a role of teaching by the professor to the student, and some professors won't have the time to do it. [...] Some professors thrive on it. They love the fact that there is a very smart student, she or he, interested in doing something with them. They like it.” – Everett

A small number of ECE faculty did express a value of teaching specifically. They were motivated to teach when they applied for the job, and / or they find it rewarding to help students learn and grow. One professor mentioned actively checking on the mental health of all his graduate students, inspired by his own advisor from his time in school. Most faculty seemed to view such teaching-focused professors as outside the expected norm, but existing due to an acceptable personal preference. This view is evidenced by the way faculty framed a value of teaching as a personality trait, either of themselves or others, rather than as an accepted norm the way they framed a value of research.

### *Normative beliefs and background factors*

The conflict we see within faculty between research and teaching responsibilities results in a belief that research is more inherently a part of their job than teaching. This belief is evidenced by the fact that when the faculty feel pressure to prioritize aspects of their job due to limited time, they feel they “have to” prioritize research at the expense of spending time with students. Notably, although many faculty spoke about their teaching suffering due to research, not even the participants who enjoyed teaching mentioned lessening their research load to focus on it. Additionally, the fact that discussion of a value of teaching always revolved around specific examples of teaching-focused professors revealed an interesting dynamic: while innovation in research is a core and valued responsibility in the ECE department, innovation in teaching is a choice based on personal interest. The second major normative belief among many faculty was that it was their job to offer help or mentoring to undergraduates only when students reached out for it. Faculty believed that independence and self-discipline were vitally important to being a successful engineer, and that if they freely offered help to students, they would not develop these qualities. However, this belief conflicts with the engineering education literature on two counts. First, student-faculty interaction has been shown to have positive effects on almost every factor for success in engineering, including self-efficacy, help seeking, effort, problem solving skills, and engineering competence [4], [6]. Second, since underrepresented students in STEM often suffer from stereotype threat [18], they may be less likely to independently seek help out of fear of confirming negative stereotypes about themselves, and will therefore be denied access to vital resources by default.

The background factors which influence these normative beliefs largely have to do with common values among engineering cultures, specifically a *value of the tangible*, as exemplified by the prioritization of “hard” subjects like science over “soft” ones like interpersonal skills, and a *value of the difficult*, or the conflation of struggle with worthwhile work. The “research first” belief we see among ECE faculty is closely tied to a value of the tangible, since it exemplifies a valuing of science over human relationships. Such a value, which has been noted in other studies of engineering cultures [10], was directly observed by some participants who mentioned that it is not uncommon for faculty in the department to need convincing that diversity and inclusion are worthwhile goals via emphasis of their “practical” benefits to engineering:

“This is to forget that some people approach diversity from a social justice point of view. I think that is true too, but [...] that's never a winning argument. It may be an argument that you believe as a principle, but with people [...] who are bean counting and so on, the argument that will probably win is more something that

hits their pocketbook, which is that I can give you a better design if you include more people. [...] That's the way to convince people.” – Everett

The prioritization of research is also encouraged by the ECE department which, like many engineering departments, hires primarily based on research credentials rather than teaching. Additionally, faculty mentioned feeling consistent pressure from the department to excel in research, which is likely due to the prominent role of research accomplishments in faculty evaluations. The reward system in the department, in turn, sets the standard for what faculty should value in their jobs. The high expectations that faculty place on students exemplify a value of the difficult, because faculty perceive students' education as more valuable when they have to struggle to obtain it. This is another deeply rooted value in many engineering cultures [10], [19], where difficulty is seen as a point of pride.

### ***Perceived behavioral control over diversity and inclusion***

Finally, for faculty to take action, it is crucial that they perceive behavioral control over diversity and inclusion; in other words, this means they must recognize the impact of their own actions as faculty on the diversity and inclusion of the department as a whole. However, we found that the ECE faculty tended to emphasize larger powers outside themselves as primarily responsible for diversity and inclusion. The major ways they denied their impact were through citing a lack of structural power, describing students as resistant to change efforts, and framing diversity in engineering as a “pipeline problem.”

#### *Lack of structural power*

“We would never sit and have a faculty meeting and decide on something important for the whole faculty. You cannot have 93 people all opinionated in one room.” – Ethan

“In all honesty I don't know what to do about [diversity]. I think some of these decisions are made by people who are free to make decisions, and so it's not necessarily that we're bad.” – Elliott

When speaking on creating change in ECE, faculty identified the large size of the department as a major obstacle. With almost 100 faculty total, they perceived it as nearly impossible to have the entire department be involved in decision making, or to agree on new policies or teaching strategies. This seemed to be exacerbated by what some faculty described as a fierce independence amounting to stubbornness among some of their peers. As a result, faculty described being isolated in groups according to their research areas, rather than feeling like part of a larger department community, which contributed to feeling a lack of influence over the department as a whole. Additionally, some faculty felt that major improvements in diversity and inclusion would come from policy decisions made above their level in the university administration, and therefore that faculty's impact was limited.

#### *Student resistance*

“Of course, there are courses where they do not allow you to self-select. They pick your partner for you. [...] That can create conflicts. Of course we say, ‘This

is a good opportunity for you to improve on your communication skills,’ but students may not see it that way. They see that, ‘Okay, I’m trying very hard to get a good grade and you place a humongous obstacle in front of me, why should I do that?’” – Emmett

One change effort for diversity and inclusion that was in progress in the department at the time of study was focused on improving student relationships through the deliberate formation of diverse project teams. This effort was a response to faculty's observations that students tended to isolate themselves to groups based on nationality and race. Many faculty expressed frustration with the complaints they received from students after this experiment, which they viewed as students’ refusal to step out of their comfort zones. These complaints caused faculty to feel that the impact of further change efforts would be limited by student resistance. However, one faculty member admitted feeling that their strategy for creating the teams and informing the students had been naive, and that with a better strategy the response could have been more positive.

### *The pipeline problem*

“Well, the problem with diversity [...] is that it is a pipeline issue. [...] Unfortunately for us, the biggest constraint is the pool. We don't have enough women to start with. All of engineering is like 28 percent [of] freshmen [...] and then we have to fight for them, and then some areas tend to be better at drawing women than others. [...] That’s a constraint for us.” – Everett

A very popular way to describe the diversity problem in engineering is as a “leaky pipeline,” which refers to the way that underrepresented students “leak” out of engineering at certain crucial transitions, like those from high school to college, and college to graduate school [20]. Interviewed faculty often referred to this metaphor when thinking about diversity and inclusion in their department. At the university under study, freshman engineering students all participate in a universal first-year engineering program before choosing their majors. Faculty expressed frustration and a level of hopelessness with the fact that ECE struggled more than other engineering majors to attract underrepresented students, particularly women, at this crucial transition. Some rationalized this with the possibility that women somehow naturally have less interest in ECE by virtue of their gender. Generally, the construction of diversity in engineering as a “pipeline problem” contributed to faculty feeling that diversity in their own department was limited by this more powerful external force that manifested in the students themselves. It also naturally caused a focus on diversity recruitment among current diversity initiatives in the department; concerning current initiatives, faculty brought up events held to attract underrepresented students, and the special attention that is paid to the applications of both underrepresented prospective students and faculty. The high level of focus on the recruitment stage contributed to faculty frustration because the failure of their efforts left seemingly no other options open for change.

### *Control beliefs and background factors*

ECE faculty revealed three reasons why they believe they do not have power over diversity and inclusion. The first was a belief that the improvement of diversity and inclusion would necessarily come from department-wide changes. This belief becomes clear in the way faculty

perceive their lack of structural power within the department to be a major obstacle to diversity and inclusion efforts. In contrast, while structural change is of course also necessary, studies on student-faculty interaction show plenty of evidence for the impact of a single professor on the inclusivity their students feel [4], [6]. The second was a belief that students were uninterested in improved diversity and inclusion, which came from the resistance faculty saw to forming diverse teams. This belief seemed to discourage faculty from future change efforts with current students. The third major control belief was one in the pipeline model for diversity in engineering. This model has been criticized in recent years for its narrow definition of an engineering career path as a “a neatly linear march through set academic gatekeepers” [21], which ignores the real complexities of engineering pathways and causes undue focus on the transitions where students “leak out” rather than the entire student experience [21]. Despite these criticisms, the pipeline metaphor was still pervasive among the faculty interviewed and served to demotivate their involvement with diversity and inclusion because they did not believe they had an impact outside of recruitment efforts.

The most evident background factor influencing the faculty’s negative control beliefs is a lack of information about their impact on inclusivity for students. Their focus on a lack of larger structural power and adherence to the pipeline model shows that they are unaware of the effects they can have on the persistence of underrepresented students through everyday interactions. Thus, while we saw before that the department leadership effectively communicates the importance of diversity and inclusion, they apparently do not communicate how faculty can integrate diversity and inclusion into their jobs. Another background factor that contributes to faculty feeling unable to participate in larger scale change is a lack of a concept of community culture in ECE. Faculty’s feelings of isolation from each other were summed up by one participant who described the department this way:

“It’s really like a whole bunch of little consulting companies that for some reason live under the same umbrella. But we have little to do with each other.” – Elliott

Faculty cannot participate in changing a culture they cannot see. This lack of community feeling can prevent faculty from understanding how students perceive the culture of ECE and how that affects their experience because they do not believe a “culture of ECE” exists.

## **Conclusions**

The three factors necessary for intention could be rephrased from faculty’s perspective as “I care about this” (attitude), “I should do something about it” (perceived norm), and “I can do something about it” (perceived behavioral control). Without any one of these factors, faculty are able to justify not taking action; they turn into “It doesn’t matter,” “It’s not my job,” or “There’s nothing I can do.” By diving into the beliefs and background factors behind the development of each of these factors, we can identify important implications for faculty development efforts aimed at encouraging sustainable action from engineering professors.

The interviews revealed that department leadership’s visible support was a notable influence on faculty’s development of a positive attitude toward diversity and inclusion. While some faculty might enter the profession already having developed such an attitude themselves, engineering departments can ensure that attitude is strengthened and maintained by consistently



communicating a commitment to diversity and inclusion to their faculty. Department leadership can do this by making diversity and inclusion a regular and important part of faculty meetings and discussions.

The interviews also revealed that faculty deemphasized their roles as teachers because of a perceived norm to prioritize research, which originated from cultural values of the department. Faculty showed evidence of a value of the tangible, which contributed to the feeling that “hard” research was more important than relationships with students, and a value of the difficult, which informed a belief that helping students too much would devalue their learning experience. However, because teaching and mentoring strategies offer an immediate way faculty can make a difference in diversity and inclusion, to get faculty involved in sustainable change efforts, it is vital that they first recognize teaching as an important part of their jobs. Therefore, engineering departments must encourage a value of teaching and directly counter contradictory cultural values like those observed here. One important way this can be done is by restructuring the reward system in the department. When promotion and tenure policies are based almost exclusively on research accomplishments, as is the case at many research universities, it is implied to faculty that teaching is not important, and they begin to see it as a distraction. Offering a pathway to promotion based on innovations in teaching would be a powerful statement on a department’s commitment to their students.

Finally, the interviews revealed that faculty perceived a lack of behavioral control over diversity and inclusion. Partially due to adherence to the pipeline model, they did not see their impact on diversity and inclusion outside of participation in recruitment efforts, which often left them frustrated. Considering the wealth of existing work on faculty’s impact on diversity and inclusion, a simple way engineering departments can combat this feeling of helplessness is by providing more information to their faculty based on current research in engineering education. Communication between engineering education and other engineering departments must be improved, and engineering professors must be expected to at least be aware of significant discoveries in teaching, especially those relating to a crucial and topical issue like diversity. Also, the analysis showed that many faculty were unaware of the existence of a department culture, which precludes them from attempting to change it. Therefore, a powerful step toward change would be to foster more of a sense of community in engineering departments, and to get faculty thinking about how all the factors in their department collectively impact students.

Neglecting the influence of any one of the three factors discussed here when attempting to bring faculty into diversity and inclusion change efforts may cause well-intentioned programs to fail for seemingly no reason. This failure in turn increases frustration and apathy around change efforts, which is detrimental to progress. In fact, the reasons for the failure may just be more complex than was assumed. To see effective, sustainable change, attitude, perceived norm and perceived behavioral control must be addressed together. However, we also cannot neglect the impact of *actual control*, which mediates behavior even after intention has been developed [9]. Appropriate policy decisions must be made to facilitate faculty taking action. In the case of inclusive teaching, faculty must be allowed the time and resources to implement new strategies. In short, no significant change will come from a simple solution; every aspect of the department must be examined for compatibility with the desired change.

This study inspired the creation of an inclusive teaching “tip sheet” for ECE faculty (attached), designed to emphasize faculty’s impact on inclusion and give practical ideas for how they can integrate inclusive practices into their everyday jobs. A future study will investigate through another round of interviews how the tip sheet interacts with faculty’s intention to make change for diversity and inclusion and identify further intervention strategies.

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# Your Everyday Impact on Inclusivity

Increased student diversity, a major goal of the ECE department, starts with fostering an inclusive culture. As the primary links between students and the department, you as faculty have the power to shape its image and the student experience. Here are some ways to start thinking about your role in inclusivity.

## Everyday informal mentoring impacts student persistence

Effective mentoring plays an immense role in the persistence of underrepresented students, and is often discussed in the context of formal mentoring relationships like those with advisors or employers. However, other everyday mentoring opportunities also have high impact, and are often overlooked. **Informal mentoring** already occurs in your classrooms, office hours, and interactions with students outside of class. Take advantage of this opportunity to embed inclusive practices into what you already do every day.

## Inclusivity benefits everyone

Inclusivity means making sure every student can reach their full potential, not catering unfairly to certain groups. ECE students of *all* backgrounds report that the high-pressure environment makes their experience in the program one of “survival”. Inclusivity means approaching students with the intention of **helping them not only survive, but thrive, grow, and become empowered** through their time here. Although these practices are especially vital to the success of underrepresented students, who often enter with low confidence and low capital, all students will benefit, including those with differences you can’t see.

“ When you tell people [you're going into ECE] they're like, oh you're crazy. [...] It's so hard to see yourself in a position of success when everyone is telling you how easy it is to fail. [...] I feel like more people should just be supportive, and let people know that there's resources out there to help them achieve their goals. [...] Like, if that's what you want to do, you can get there. [...] I didn't get that vibe when I first started.

”

- Purdue ECE undergraduate

This student expresses the discouragement they felt upon deciding to switch from another major into ECE. This shows how everyday interactions with students can influence persistence.

This student expresses how pre-existing self-doubt of underrepresented students makes them especially vulnerable, and shows the power of the words of faculty. Inclusive teaching practices can combat harmful messages like this.

“ As a woman, it is extremely difficult to tell whether a lack of technical knowledge is due to fewer technical opportunities throughout our lives or, god forbid, a lack of interest in ECE in comparison to our peers. [...] This is exacerbated by your professor telling you that you must have “the knack” to be a successful engineer, and, if you don’t have it, you will always have to work harder to be on a level playing field.

”

- Purdue ECE undergraduate

Keep reading for simple inclusive practices to incorporate into your teaching.





# Inclusive Teaching Ideas for Faculty

Dr. Becky Packard identifies three factors crucial to the persistence of students in STEM. Organized by these factors, the following teaching ideas are compiled from Dr. Packard's book on STEM mentoring<sup>2</sup>, Engage Engineering<sup>1</sup>, and Purdue ECE student interviews:

## Interest

Students need to feel that course content is interesting and important to the world and their own futures. Underrepresented students may enter ECE with little exposure as to what engineers can really do in the field. Technical material should always **connect to the bigger picture**.

- \* **Incorporate active learning to keep students engaged:** Facilitate class discussions or debates on course material; Ask for (voluntary) participation to solve example problems in class
- \* **Connect course material to the real world and people:** Explain the real applications of practice problems; In lectures, talk about how the material fits into human life and the future
- \* **Showcase career paths which use your course material:** Invite guest speakers working in the area of your course to talk about their work, even if just via Skype; Talk to students about the variety of careers in ECE
- \* **Embed research experiences into courses:** Create assignments that emulate what researchers in the area of your course actually do; Talk about your own research in class

## Capacity

Students need to feel like they have the resources to succeed in engineering. Underrepresented students often underestimate their own abilities. It is vital that faculty express a **growth mindset**, the belief that ability is not fixed but can improve, to encourage students to keep trying.

- \* **Provide consistent feedback so that students can recognize their progress:** Return graded exams and assignments as soon as possible; Utilize peer feedback activities to limit extra grading load
- \* **Provide opportunities for students to build confidence:** Break up complex problems and projects into distinct steps; Structure project requirements to prevent more confident students taking over the technical work
- \* **Destigmatize students needing help:** Invite students to office hours and schedule them conveniently for students; Preemptively provide extra resources for historically tricky material
- \* **Embrace questions in class:** Respond with "Thanks for asking," or "That's a good question" to encourage asking more; Utilize HotSeat and Piazza to allow students to ask anonymously

## Belongingness

Students need to feel that people like them belong in the engineering community. Underrepresented students are at a disadvantage because they have so few relatable role models in ECE. You show students who belongs through **who you invest time into**.

- \* **Promote diversity in student leadership roles:** Consider diversity representation in your selections for assistants; Encourage underrepresented undergraduate students to apply for extra-curricular leadership positions
- \* **Include diverse students in class participation:** Arrange seating in clusters so that underrepresented students are not isolated; Ask for participation from students who haven't spoken so a diverse group is heard
- \* **Use diverse engineers as examples:** Showcase the accomplishments of diverse engineers when discussing real applications; Represent diversity in practice problems that involve people
- \* **Show interest in individual students:** When possible, learn and address students by name in class; Ask students how they're doing when you see them outside of class

## More Resources

1. **For more ideas** to incorporate into your teaching: [www.engageengineering.org](http://www.engageengineering.org)
2. **For further reading** on inclusive mentoring: Packard, Becky Wai-Ling. 2016. *Successful STEM Mentoring Initiatives for Underrepresented Students: A Research-Based Guide for Faculty and Administrators*. Stylus.