

# The impact of a pilot program incorporating inclusive teaching practices intervention in graduate chemical engineering education on retention efforts

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## Abstract

There is a need for a more racially and ethnically diverse engineering workforce in the United States. Recruiting and retaining members of underrepresented minority groups in engineering education is a critical aspect of this process. Most retention programs, however, have focused primarily on supports outside of the classroom and neglected to examine the benefits of incorporating inclusive teaching practices across the curriculum. In this paper, we present microinterventions that were incorporated in two core chemical engineering classes. Data was obtained to study the impact of these interventions on students self-perceptions of department climate, classroom engagement, and sense of belonging.

## Keywords

Active learning, sense of belonging, retention, graduate education.

## Introduction

There is a critical need for more, and more diverse, engineers in the U.S.[1,2]. Although the number of members of underrepresented racial groups (i.e., African Americans, Latinxs, and Native Americans) in engineering has increased over time, these groups remain underrepresented in engineering relative to the overall workforce, and this underrepresentation increases as level of education increases (i.e., engineers with doctoral degrees are a less racially and ethnically diverse group than those with bachelor's degrees [1]). Increasing the diversity of engineers is important because more diverse teams can produce more creative, innovative, and effective solutions to problems [6, 8]. In addition, the background characteristics of engineers may impact the types of problems they examine and the populations that benefit from their work (e.g., [5]). The best engineers are adaptable team players who work to include a diversity of views while also attending to ethical obligations. Our profession's lack of diversity cannot be separated from the systemic racism in our society; thus, addressing these societal ills and its impact on the engineering profession requires re-envisioning engineering education to be more inclusive and equitable.

Creating a more diverse engineering workforce begins with increasing the diversity of engineering students. Many attempts to increase the diversity of the engineering student population focus on recruitment, but retention of students is also critical [7]. Many retention programs are grounded in a student affairs perspective and emphasize support and engagement outside of the classroom (e.g., student affinity groups). Particularly at the graduate level, however, positive classroom experiences are critical to student success. Inclusive teaching practices support learning and

success for all students, but are especially effective at closing achievement gaps between students who are traditionally well-represented in a given academic context and those who are not (e.g., students of color, first generation college students, women in STEM;[3,4]). Well-established inclusive teaching practices include collaborative and active learning, transparency around learning goals and assessments, and opportunities for students to learn from the experiences and knowledge of their peers [3]. Inclusive teaching practices encourage team-based learning and attention to the perspectives of others, facilitating students' acquisition of skills needed for working in diverse teams, both currently and in the future.

## Methods

In this work, the specific task was to promote inclusive teaching practices in a chemical engineering graduate program, with a particular focus on two core chemical engineering graduate courses (a required technical course for first year graduate students and a required seminar course for all graduate students in the program). Below, we describe the inclusive practices that were implemented.

First, the syllabus in these two classes were reenvisioned to intentionally make it anti-racist , by following evidence-based practices. These included:

1. Adding a profile picture of the instructor showing the faculty member in a setting that show-cases their multidimensional identity (humanizing the instructor).
2. Clearly stating the purpose of office hours, where they are held, how students can schedule office hours.
3. Adding a section on inclusion where the focus is on a welcoming message to all students.
4. A separate section on “Tips to do well in this class” that demystifies the preparation and makes expectations for the class clear and transparent.

For the core technically class, the class was also taught in an active learning set-up, where students were asked to sit in groups, at semi circular tables. Each period included at least one group/team-based activity, where students had opportunities to discuss problem-solving strategies and worked together. Additionally, at the beginning of the week, students were asked to work together to informally present a summary of topics covered in the previous week.

For the seminar class, the students were asked to work in groups to come up with names of invited speakers that they would wish to invite. External speakers were then intentionally picked to showcase a diverse group of scholars. Additionally, a few of the internal speakers were intentionally selected to address topics that focus on the “hidden curriculum” in graduate school. Specifically, speakers were asked to discuss “role of mentors beyond your advisor”, how to be an effective GTA, understanding and managing faculty advisor expectations, were some of the topics that were discussed.

Data were collected to examine the impact of this microintervention on students' self-reported perceptions of department climate, classroom engagement, and sense of belonging.

### Results:

In order to examine the impact of the microintervention on students, we compared pre-intervention data (from a survey of the full department in February 2022) to post-intervention data (from a survey of students in one of the core intervention courses in May 2022). Results indicated that compared to the full department, students in the intervention group reported similar levels of classroom engagement and sense of belonging, but had more positive perceptions of climate within the department. These findings suggest that even relatively minor changes to teaching in core graduate courses can impact students' feelings of inclusion within their graduate programs, and that more intensive interventions might have even larger impacts on student attitudes and retention.

### Summary:

Recruiting and retaining members of underrepresented minority groups in engineering education is a critical aspect of addressing the need for a more racially and ethnically diverse engineering workforce in the United States. Most retention programs, however, have focused primarily on supports outside of the classroom and neglected to examine the benefits of incorporating inclusive teaching practices across the curriculum. Further, while the underrepresentation of African American, Latinx, and Native American engineers increases as level of education increases, support focused on retention of graduate students from diverse backgrounds is limited. This project aimed to promote inclusive teaching practices within a graduate program in chemical engineering. The project involved a) fostering inclusive teaching practices in select core graduate courses, b) offering workshops on inclusive teaching practices for faculty and graduate teaching assistants, and c) data collection from students on department climate, sense of belonging, classroom engagement, and barriers faced. In this paper, we have discussed the inclusive practices implemented, and the impact of these practices on student retention. Our data analysis showed an increase in the sense of belonging of students who participated in the classes where these interventions were implemented. Research has shown that student success in a program is directly related to their feelings of sense of belonging [9].

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