ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #45266

Supporting Engineering Graduate Students to Create Inclusive Learning Environments: A Professional Development Program at a Hispanic-Serving Institution

Dr. Katherine R. McCance, The University of Texas at San Antonio

Dr. Katie McCance is a postdoctoral fellow at The University of Texas at San Antonio. She received her PhD in STEM Education, with a focus in Science Education, from North Carolina State University. Her research interests include STEM education at HSIs, professional development for STEM instructors, and interdisciplinary collaborations.

Supporting Engineering Graduate Students to Create Inclusive Learning Environments: A Professional Development Program at a Hispanic-Serving Institution

Keywords: Graduate, undergraduate, engineering

Introduction

Increasing diversity and equity remains a national goal for STEM (science, technology, engineering, and mathematics) education in the United States [1], as men and white individuals continue to receive a disproportionate share of STEM bachelor's degrees and are overrepresented in the national STEM workforce [2]. Creating cultures of inclusion at institutions and within STEM departments and classrooms is vital for the success of students from historically marginalized groups, and one way to achieve this is through instructors' use of inclusive pedagogies [1]. This can consist of instructors' practices and interactions that are culturally responsive, identity-affirming, asset-based, and that support students' feelings of belonging. However, these approaches still are not commonplace in postsecondary STEM. Professional development (PD) on inclusive teaching is critical for STEM instructors, including graduate teaching assistants (TAs), who play an important role in teaching undergraduate STEM students and creating equitable learning environments [3], [4]. PD for STEM TAs can enhance their teaching beliefs and practices [5]. Yet, graduate students typically lack experience and opportunities with PD, especially PD that is focused on inclusive teaching [6], [7]. This is problematic in the short term and long term, as graduate students may not be prepared or supported in their immediate work as TAs or in their potential future role as faculty.

Instructors' beliefs and confidence inform their practice [5]. STEM instructors' beliefs can impact student achievement, as reported by Canning et al. [8], who found that students - especially underrepresented minority students (e.g., Black, Latino, and Native American) - had lower academic performance in courses taught by STEM faculty who had a fixed mindset toward student learning. STEM graduate student TAs can benefit from PD that intentionally targets their "beliefs, confidence, and practice" [9]. However, teaching beliefs can be challenging to change and may show positive or negative shifts after TAs' participation in PD [9]. Therefore, more research is needed to understand STEM graduate students' beliefs about teaching, specifically in relation to PD focused on equity and inclusion, and the contexts and ways in which PD may impact TAs' beliefs.

The current work takes places at an R1 Hispanic-Serving Institution (HSI; 59% Latino/a students) in the Southern United States. HSIs graduate a large proportion of Latino/a STEM students and are well positioned to contribute to the diversification of the STEM workforce by serving students of color with diverse and intersectional identities in terms of race/ethnicity, transfer, low-income, and first-generation status [10], [11], [12]. Much of the HSI STEM literature focuses on undergraduate students' outcomes and experiences, and there is a need to study STEM pedagogies that support student success at HSIs [13].

This paper focuses on a pilot PD program for engineering graduate students that was implemented at an HSI for graduate students to build their knowledge, beliefs, and confidence in creating inclusive learning STEM environments. This paper will describe the context and

structure of the PD program, followed by preliminary qualitative and quantitative results from the first year of the program. The data collection and analysis focused on understanding the program's impacts on the engineering graduate students' confidence in and beliefs toward inclusive teaching. Finally, this paper will discuss future plans and considerations for expanding and sustaining the program for STEM TAs at the university.

Methods

Context

The pilot PD program for engineering graduate students was modeled off an existing faculty community of practice program at the university, that is part of a national, multi-institutional program [14]. During 2023-2024, 52 faculty at the university participated in the program, including 12 engineering and science faculty. The faculty program yielded positive undergraduate student outcomes within one semester of faculty's participation, such as an average 3% decrease in drop-fail-withdrawal (DFW) rates across all faculty participants' courses. Notably, a 9% decrease in DFW rates was observed for engineering and science faculty. The faculty program consisted of several hybrid workshops and small-group sessions that encouraged critical, reflective discussions, development of individual implementation plans, and administration of a formative feedback survey to undergraduate students three times per semester to obtain real-time feedback to promote change in the faculty members' teaching. The faculty and graduate student PD programs were part of a larger institutional initiative to enhance STEM student success at the HSI through systemic changes and policies and aimed to improve undergraduate engineering courses with historically high failing and withdrawal rates.

Graduate Student PD Program Structure

The graduate student PD program consisted of six discussion-based workshops offered in-person with a synchronous online Zoom option to accommodate graduate students' schedules. Each workshop focused on a different topic (e.g., establishing a growth mindset culture, inclusive learning environments, identity safety, feedback; see Table 1 for the general PD schedule).

Table 1. General program schedule

Activity	Description
Pre-survey	Pre-survey link administered; due by Workshop 1
Workshop 1	Introductions, goals, expectations, prior knowledge/experience
Workshop 2	Establishing a Growth Mindset Culture Due: Reflection 1
Workshop 3	Understanding Your Students, course demographics activity + Guest speaker Due: Reflection 2
Workshop 4	Encouraging an Inclusive Learning Environment, Connections in the Classroom, and Identity Safety + Guest speakers Due: Reflection 3
Workshop 5	Providing and Receiving Feedback + Guest speaker Due: Reflection 4

Workshop 6	Celebration of completion, individual presentations of learning Due: Final reflection and implementation plan
Post-survey	Post-survey link administered; due by end of semester

The workshop curriculum was adapted from the national program to fit the institution's HSI identity and graduate student audience, such that participants framed their thinking within the university-specific student demographic profile. STEM faculty guest speakers who had expertise in student-centered instruction and/or participated in the faculty PD program were invited to present during the workshops. The guest speakers discussed their own involvement in the faculty program, how it benefited them and their students, as well as practical strategies that the TAs could consider adopting to make their teaching more inclusive. Collaborative activities and discussions were integrated in each workshop to allow participants to apply their learning and make connections between the workshop topics and their experiences. The graduate students completed written reflections after each workshop to allow them to integrate and internalize their learning. A Canvas LMS (learning management system) page was developed to house all PD materials, resources, and reflection submissions.

The graduate student program was modified from the faculty version in a few ways to best support the graduate student participants. For instance, the guest speakers were added to provide the graduate students with real teaching examples from STEM faculty. Additionally, the graduate students were not able to administer the formative feedback survey to undergraduate students, due to challenges with the TA appointments. Therefore, the program shifted to focus on developing a deeper understanding of and reflecting on inclusive teaching, rather than implementation and feedback on their teaching.

Participants

To recruit graduate students for the pilot PD program, an application was shared with engineering faculty and engineering graduate program coordinators before the start of the spring 2024 semester. The application also was sent directly to engineering graduate students assigned as TAs for the semester. Six engineering graduate students submitted applications and were accepted to participate (Table 2). All participants expressed interest in inclusive teaching and/or faculty careers. One of the graduate students served as a TA in the fullest capacity (i.e., taught weekly recitation sessions). As mentioned above, challenges with TA appointments prevented most of the participants from actively teaching in a TA role.

Table 2. Demographics of engineering graduate student participants in the pilot PD program

		n (%)
Gender	Female	3 (50%)
	Male	3 (50%)
Race/Ethnicity	Latino/a	2 (33.3%)
	Middle Eastern	4 (66.7%)
Student Status	Master's student	3 (50%)
	Ph.D. student	3 (50%)

International Status	Domestic student	2 (33.3%)
	International student	4 (66.7%)
Teaching Status	TA	1 (16.7%)
	Not a TA	5 (83.3%)
Program	Mechanical engineering	2 (33.3%)
	Electrical and computer engineering	2 (33.3%)
	Civil engineering	1 (16.7%)
	Architecture	1 (16.7%)
Career Intent	Faculty	3 (50%)
	Industry	1 (16.7%)
	Faculty and industry	2 (33.3%)

Data Collection and Analysis

To explore whether the PD impacted the engineering graduate students' confidence and beliefs in inclusive teaching, quantitative data from pre- and post-surveys and qualitative data from the program application and five reflective journal assignments were collected and analyzed. All participants provided consent for the collection, analysis, and presentation of their data. Due to the voluntary nature of the program and educational research, some graduate students did not complete all surveys or assignments.

Quantitative data was collected using a pre- and post-survey administered using an online Qualtrics link. Each survey included two items about growth/fixed mindset ("To be honest, students have a certain amount of intelligence, and they really can't do much to change it," and "Your intelligence is something about you that you can't change very much."). The two items have been administered to STEM faculty [8] and are common measures for students' degree of fixed mindset [15]. The mindset items used a reverse-coded Likert scale (5 = strongly disagree, 1 = strongly agree), such that a higher score represented a stronger growth mindset orientation. The pre- and post-surveys also included eight Likert-scale items (5 = strongly agree, 1 = strongly disagree) related to the graduate students' confidence in their ability to teach using inclusive practices (e.g., "I feel confident in my ability to establish a growth mindset culture"). The confidence items were developed by the program team to measure outcomes from both the faculty and graduate student PD programs, but similar items have been validated by DeChenne et al. [16]. Descriptive analyses were conducted on the pre- and post-survey responses, using average scores.

Qualitative data included open-ended responses to a question on the program application and post-survey that broadly asked, "What does inclusive teaching mean to you? What does it look like in practice?" which was used to identify whether participants conceptualized inclusive teaching differently after completing the program. Additionally, reflective writings were collected from the graduate students following each workshop to gain a more nuanced understanding of the graduate students' experiences, learnings, and insights from the PD program and to gather feedback to improve the program in future iterations. The graduate students submitted their written reflections online via the LMS. The following questions are examples of the reflective prompts that were provided to participants:

1. Please share the key takeaways and insights you gained from the most recent workshop. What did you learn?
2. How did the workshop impact your own growth and perspectives, as an instructor and/or student? Did it resonate with your personal experiences?
3. Reflect on how your new understanding and skills can impact students' experiences and outcomes.
4. How do you plan to apply what you've learned?
5. What remains unclear for you? Is there anything you are confused about or still have questions about?
6. Other feedback about the workshop.

For the final reflective assignment, the graduate students were asked to reflect on their overall learning and experience in the program and discuss specific strategies, plans, and challenges for future implementation. The qualitative responses were analyzed using an inductive approach [17] to identify common themes across participants.

Results

Growth Mindset

Overall, participants reported moderate fixed/growth mindset perspectives; the average score for the group was 3.8 at the beginning of the program and 3.3 at the end of the program (Table 3). At the end of the program, three participants had strong growth mindset orientations, with average scores of 4.0 or greater. Of the five graduate students who completed the pre- and post-surveys, two did not experience any change in mindset, two experienced a slight positive shift in mindset, and one experienced a negative shift in mindset. The student with a negative shift (participant 3) may be a result of response error, because other data collected from this participant revealed a positive PD experience and growth mindset perspective.

Table 3. Pre- and post-survey results for growth mindset and confidence in inclusive teaching practices.

	Growth Mindset*		**Confidence in Teaching****	
Participant	**Pre (Average)**	**Post (Average)**	**Pre (Average)**	**Post (Average)**
1	2.0	2.0	3.9	4.5
2	4.0	4.5	4.4	4.8
3	5.0	1.0	4.4	4.4
4	4.0	4.0	4.0	5.0
5	4.0	5.0	4.4	3.8
6	N/A	3.0	N/A	4.0
Average	3.8	3.3	4.2	4.4

*For growth mindset, 1 = strongly agree, and 5 = strongly disagree, such that higher scores reflect stronger growth mindset.
**For confidence in inclusive teaching, 1 = strongly disagree, and 5 = strongly agree.

Confidence in Inclusive Teaching Practices

The graduate students reported high levels of confidence at the beginning and end of the program (Tables 3 & 4). They reported slightly more confidence in their overall teaching abilities after the program (M = 4.4, SD = 0.61, n = 5) than before the program (M = 4.2, SD = 0.61, n = 6). Five of the six graduate students reported high levels of confidence at the end of the program, with average scores of 4.0 or greater. The greatest pre-to-post differences were in the graduate students' confidence in their ability to reflect on how their mindset as an instructor impacts students' experiences in the classroom (0.7-point increase by the end of the program, Table 4) and to use student data and feedback to inform their teaching (0.4-point increase). The item with the greatest pre-to-post decrease was, "I am confident in my ability to create an inclusive learning environment" (0.3-point decrease).

Table 4. Pre-and post-survey results for the eight items related to confidence in inclusive teaching practices.

I am confident in my ability to...	**Pre (Average) *n* = 5**	**Post (Average) *n* = 6**
Establish a growth mindset culture.	4.6	4.5
Understand my students' personal backgrounds to inform my teaching.	4.2	4.3
Create an inclusive learning environment.	4.6	4.3
Encourage meaningful connections in the classroom.	4.4	4.5
Promote students' identity safety.	4.0	4.3
Provide feedback to students.	4.2	4.5
Use student data and feedback to inform my teaching.	3.8	4.2
Reflect on my mindset and how it impacts students' experiences in the classroom.	3.8	4.5

**For confidence in inclusive teaching practices, 1 = strongly disagree, and 5 = strongly agree.

Beliefs About Inclusive Teaching

In their written reflections, all graduate student participants reported positive experiences and learning from the program. Several described their participation in the program as a "transformative experience." Before starting the PD program, the graduate students' conceptions of inclusive teaching were broad and vague. For instance, Participant 4 described inclusive teaching as involving "good collaboration," and Participant 5 stated simply that "everyone can benefit from it [inclusive teaching]." Participant 1 provided a slightly more detailed response on their application, acknowledging that inclusive teaching involves "understanding that students come from various backgrounds with diverse cultures," and "adopting adaptive teaching methods and employing various teaching strategies [that] can cater to different learning styles and abilities." No other participants mentioned the importance of understanding students' diverse identities as a crucial part of inclusive teaching. Rather, there was a greater emphasis on collaboration and using various teaching strategies, without providing further explanation.

At the end of the program, participants expressed the importance of understanding the students that they teach and designing adaptable learning environments and pedagogies around that understanding. All participants mentioned the importance of understanding students' diverse and

unique identities, backgrounds, cultures, and/or abilities. For instance, Participant 4 stated, "Inclusive teaching, to me, embodies a pedagogical approach that respects and values the diversity of students, recognizing that each learner brings unique experiences, backgrounds, and perspectives to the learning environment." The graduate students' responses also discussed potential strategies, such as fostering feelings of respect for students, accommodating individual and unique needs, and conveying inclusivity through teaching, communication with students, and course materials. Participant 2 said that inclusive teaching meant "being able to best accommodate the class holistically and tailoring to individuals on an as needed basis, and providing everyone with reasonable and able means of education, learning, and study materials."

The engineering graduate students expressed that the program enhanced their beliefs about teaching, creating inclusive learning environments, and the role that instructors play in fostering students' feelings of belonging, motivation, and academic performance. The following is an exemplar statement from Participant 2's final reflective writing:

> The [program] has encouraged me to adopt a more empathetic and student-centered approach. Recognizing the psychological and emotional dimensions of student learning has led me to consider how academic policies and teaching practices can sometimes inadvertently contribute to student stress and disengagement. This shift towards a more empathetic pedagogy aims to create a learning environment that fosters student well-being and academic engagement.

Participant 2 also described an actionable plan for his intended practices for providing feedback to future students:

> I am particularly keen to implement formative feedback strategies that focus on progress and improvement over time rather than purely summative assessments. This includes providing more regular, detailed feedback on assignments and fostering a classroom environment where students feel they can take risks and learn from mistakes without undue penalty...I plan to redesign assignment rubrics to emphasize growth and include self-assessment components for students, allowing them to reflect on their learning processes and outcomes.

Discussion and Conclusions

The pilot PD program yielded positive outcomes and learning for the six engineering graduate student participants, overall. There is modest evidence for the potential of the PD to strengthen some graduate students' growth mindset orientation and promote confidence in inclusive teaching. On average, the graduate students had moderate growth/fixed mindset orientation at the end of the PD. Half of the participants had strong growth mindset perspectives, with post-survey averages of 4.0 or greater. Some of the graduate students' scores were slightly higher than STEM faculty members' growth mindset scores [8]. Canning et al. [8] reported an average growth mindset score of 3.87 for STEM faculty, using a scale of 1 (strongly agree) to 6 (strongly disagree). Although the graduate students did not report a strong growth mindset orientation, on average, it is promising that fixed mindset beliefs are malleable and can be shifted to growth mindset beliefs with simple, low-cost interventions [8]. Additionally, less experienced

instructors, such as TAs, may be more likely to change their teaching beliefs than more experienced instructors [9].

After participating in the PD, the graduate students reported high levels of confidence in their ability to use various inclusive teaching practices, such as confidence in reflecting on the impact of their mindset on students' classroom experiences, using student data and feedback to inform their teaching, and promoting students' identity safety. These pilot results align with previous research that reported high TA confidence and self-efficacy [9], [18], [19]. Wheeler et al. [9] found that chemistry TAs had high teaching confidence before and after participating in PD but no significant change in confidence. Other research suggests a positive association between STEM TA self-efficacy and PD participation [16]. While it is important to consider that beliefs (including confidence and self-efficacy) and practice do not always align, some studies have shown that high TA self-efficacy is related to student-centered approaches to teaching [20]. On average, the graduate students reported lower confidence in their "ability to create an inclusive learning environment" (0.3-point decrease), which should be further explored in the future, because low confidence can prevent TAs' ability to teach effectively [9]. However, the overall high confidence reported by the TAs in the current study may suggest their potential for student-centered teaching approaches.

Qualitatively, the graduate student participants demonstrated a more nuanced conceptualization of inclusive teaching at the end of the program and reported valuable learning and actionable intended practices. Although it was not evident in all participants' qualitative responses, there was some evidence of the graduate students' "outward" thinking and "concern for student learning," which previously has been reported for TAs with high self-efficacy [20]. For instance, one graduate student in the current study (participant 2) saw their role in students' learning and discussed specific practices that they would like to implement to improve students' learning, engagement, and wellbeing. Additional analysis will be conducted to further understand the engineering graduate students' experiences and outcomes from the PD, which will inform future iterations and expansion of the program as well as contribute to the literature on inclusive teaching PD for engineering graduate students, specifically at HSIs.

Lessons Learned and Future Plans

As this was a small pilot program, several challenges arose during the program, and lessons were learned to modify the program in future iterations. For example, the original plan (and the focus of the faculty program) was for TAs to not only learn about and reflect on inclusive teaching, but also collect formative feedback from their students and modify their teaching throughout the program. However, only one graduate student was a TA and had full access to undergraduate recitation sessions; two other graduate students were teaching assistants but were involved with grading and minimal classroom instruction. For this reason, the focus of the program was shifted toward learning about and discussing inclusive teaching, and away from implementation and formative feedback. In future iterations, consistent classroom, laboratory, and/or recitation instruction will be a criterion to participate. It is expected that the TAs' real-time classroom experiences and the feedback cycle will generate rich discussion, challenge TAs' thinking about inclusion and equity in STEM, and enhance TA and undergraduate outcomes.

The small sample size for the pilot PD program limits the quantitative portion of this work, but future iterations of the PD will recruit more TAs to address this challenge. The PD will be expanded to include STEM TAs across the university. To accommodate a group that is expected to be larger and even more diverse, the adoption of some self-paced, asynchronous, and/or pre-recorded program components will be included to work with schedule conflicts. Workshops will continue to leverage diverse perspectives from faculty with expertise in inclusive and innovative STEM teaching. To further sustain the program, it will be institutionalized, which will occur through partnering with the university's Graduate School and the Teaching and Learning office, which house many PD programs and communities of practice for its instructors.

References

[1] National Academies of Sciences, Engineering, and Medicine, "Indicators for Monitoring Undergraduate STEM Education," Washington, DC, The National Academies Press, 2018. https://doi.org/10.17226/24943.

[2] National Center for Science and Engineering Statistics (NCSES), "Diversity and STEM: Women, Minorities, and Persons with Disabilities 2023," Special Report NSF 23-315. Alexandria, VA, National Science Foundation, 2023. Available at https://ncses.nsf.gov/wmpd.

[3] J. de Lima, S. Isaac and H. Kovacs, "Teaching assistants' contributions to creating inclusive and equitable learning spaces in engineering," *European Journal of Engineering Education*, pp. 1-18, 2024.

[4] G. E. Gardner and M. G. Jones, "Pedagogical preparation of the science graduate teaching assistant: Challenges and implications," *Science Educator,* vol. 20, no. 2, pp. 31-41, 2024.

[5] T. D. Reeves, G. Marbach-Ad, K. R. Miller, J. Ridgway, G. E. Gardner, E. E. Schussler, and E. W. Wischusen. "A conceptual framework for graduate teaching assistant professional development evaluation and research," *CBE—Life Sciences Education*, vol. 15, no. 2, 2016. https://doi.org/10.1187/cbe.15-10-0225.

[6] C. Kepple, M. Tilahun, N. Matti, and K. Coble, "Pedagogy training for the development of GTA mindsets and inclusive teaching practices," in *Proceedings of the Physics Education Research Conference, October 2020.* pp. 272-277.

[7] E. E. Schussler, Q. Read, G. Marbach-Ad, K. Miller, and M. Ferzli, "Preparing biology graduate teaching assistants for their roles as instructors: An assessment of institutional approaches," *CBE—Life Sciences Education,* vol. 14, no. 3, 2015.

[8] E. A. Canning, K. Muenks, D. J. Green, and M. C. Murphy, "STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes," *Science Advances,* vol. 5, no. 2, 2019. https://doi.org/10.1126/sciadv.aau4734

[9] L. B. Wheeler, J. L. Maeng, J. L. Chiu, and R. L. Bell. "Do teaching assistants matter? Investigating relationships between teaching assistants and student outcomes in undergraduate science laboratory classes," *Journal of Research in Science Teaching,* vol. 54, no. 4, 2017, pp. 463-492.

[10] National Science Foundation, National Center for Science and Engineering Statistics, "Women, minorities, and persons with disabilities in science and engineering," Alexandria, VA, Special Report NSF 19-304, 2019.

[11] G. Crisp, A. Nora, and A. Taggart, "Student characteristics, pre-college, college, and environmental factors as predictors of majoring in and earning a STEM degree: An analysis of students attending a Hispanic serving institution," *American Educational Research Journal,* vol. 46, no. 4, pp. 924-942, 2009.

[12] National Academies of Sciences, Engineering, and Medicine, "Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce," Washington, DC, The National Academies Press, 2019. https://doi.org/10.17226/25257.

[13] H. K. Ro, S. Aguilar-Smith, S. Y. Anderson, T. Rodriguez, E. J. Ramon, and D. Javier, "Attending to STEM education in servingness at Hispanic-serving institutions: a systematic review of more than a decade of scholarship," *International Journal of STEM Education,* vol. 11, no. 1, 2024.

[14] Student Experience Project. "Increasing equity in college student experience: Findings from a national collaborative," 2022.

[15] C. S. Dweck. *Self-theories: Their role in motivation, personality, and development*. Psychology press, 1999.

[16] S. E. DeChenne, L. G. Enochs, and M. Needham. "Science, technology, engineering, and mathematics graduate teaching assistants teaching self-efficacy," *Journal of the Scholarship of Teaching and Learning,* vol. 12, no. 4, 2012, pp. 102-123.

[17] B. Glaser, and A. Strauss, *Discovery of Grounded Theory: Strategies for Qualitative Research.* New York, Routledge, 1999.

[18] S. E. DeChenne, N. Koziol, M. Needham, and L. Enochs. "Modeling sources of teaching self-efficacy for science, technology, engineering, and mathematics graduate teaching assistants," *CBE—Life Sciences Education,* vol. 14, no. 3, 2015. https://doi.org/:10.1187/cbe.14-09-0153.

[19] G. E. Grant, and J. Parrish. "Biology graduate teaching assistants as novice educators: Are there similarities in teaching ability and practice beliefs between teaching assistants and K–12 teachers?," *Biochemistry and molecular biology education,* vol. 47, no. 1, 2019, pp. 51-57. https://doi.org/10.1002/bmb.21196.

[20] C. R. Smith, D. Menon, A. Wierzbicki, and J. M. Dauer. "Exploring STEM teaching assistants' self-efficacy and its relation to approaches to teaching," *CBE—Life Sciences Education*, vol. 22, no. 1, 2023. https://doi.org/10.1187/cbe.22-06-0115.