How Should Teaching Assistants Teach? Differences in Student Perspectives by Gender, Race/Ethnicity, and Country of Origin

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Abstract

Teaching Assistants (TAs) are a critical part of many engineering programs, particularly at larger institutions. However, there is a lack of comprehensive understanding of how TAs can effectively support students, particularly in comparison to the extensive knowledge available on how faculty can do so. This paper reduces this gap by not only identifying what engineering undergraduates want from TAs but by exploring how these preferences for TA support vary across gender, race/ethnicity, country of origin, and time. Understanding these demographic differences as well as if and how they vary over time can assist TAs in their efforts to equitably serve a diverse student population. Qualitative research methods were applied to over 1,600 student responses and over 1,800 student preferences for TA support across three major time periods: (a) traditional classroom teaching prior to the COVID-19 pandemic; (b) emergency remote learning (ERT) during the peak of the pandemic; and (c) subsequent return to in-person teaching post-pandemic. Thematic analyses of student responses revealed three primary themes in the data: best teaching practices, teacher preparation, and hospitality. Secondary themes within these primary themes were also identified. Within teaching practice, the most common secondary themes included TA-student contact and TA-student feedback. Within teacher preparation, diverse, well-prepared examples and knowledgeable review of course concepts were popular among student respondents. The analysis of both primary and secondary themes indicated that different demographic groups have different preferences for TA support which evolve over time and that such preferences are not uniform across student demographics. This dynamic landscape of what students expect from their TAs suggests that techniques for exploring student expectations at the start of a course can make a valuable addition to TA professional development programs. Understanding this dynamic landscape can also enable TAs to target their teaching efforts for maximum and equitable effectiveness across both underrepresented and majority student populations.

Introduction

In terms of gender, race, and ethnicity, engineering has a diversity problem that has persisted for a very long time. In 2022, women accounted for less than a quarter (24.2%) of engineering bachelor's degrees in the U.S., marking a significant increase from the 17.8% recorded in 2010 [1]. However, this growth has not been reflected in the workplace. Between 2001 and 2019, the number of women engineers in the workforce only rose from about 10% to 14% [2]. The underrepresentation of women is particularly pronounced in mechanical, electrical, and computer engineering, with only 17.5%, 15.6%, and 20.4% of bachelor's degrees in these fields awarded to

women [1]. Furthermore, women represent only 9%, 10%, and 12% of working engineers in these respective fields [3].

For underrepresented minorities, the statistics are even more dismal. Bachelor's degrees in engineering awarded to Black or African American individuals have risen only slightly from 4.5% in 2010 to 4.7% in 2021 [1]. Hispanics now earn about 13.6% of bachelor's degrees in engineering up from 7.0% in 2010 [1] but the Hispanic population in the U.S. has increased over that same time period from a little over 35 million individuals (12.2% of the U.S. population) to over 62 million (18.8% of the general population) [4].

The underrepresentation problem is not just about how many individuals from underrepresented groups (URGs) pursue engineering degrees but also about how many drop out along the way toward a degree and career in their chosen discipline. Many studies have investigated the leaky pipeline in engineering and other STEM fields and found that the drop-out rate among women and minorities leads to disproportionate losses in URGs compared to majority populations. For example, an estimated 40% of women who earn engineering degrees either quit early in their careers or never enter the engineering profession altogether [5]. Among underrepresented minorities (URMs), leaks in the pipeline are equally dismal. In STEM, an estimated 37% of Latinx and 40% of Black students switch majors as undergraduates, compared with 29% of white students. Latinx and Black STEM students also drop out of college altogether far more often than white STEM students; while only 13% of white students majoring in STEM disciplines drop out, 20% and 26% of Latinx and Black students do so respectively [6].

At the time in their career trajectory when women and URMs are enrolled in engineering programs in college, faculty and other instructors have a valuable opportunity to reduce these exits. Yet, by the very nature of the feedback instructors receive regarding their teaching, they may be inadvertently contributing to drop-out. Feedback almost ubiquitously comes in the form of student evaluations of teaching (SETs) [7]. In addition to being biased against underrepresented faculty [8], [9], SETs also fail to adequately represent the voices of underrepresented students. Not only are SETs poorly correlated to teaching effectiveness, but since they do not disclose distributions nor demographics, they can misdirect teaching improvements and essentially minimize or silence the voices of minorities in favor of the more numerous voices in the fray. As importantly, when students provide suggestions for improved teaching via short answer questions on SETs, faculty who act on these suggestions may inadvertently favor majority groups at the expense of URGs by zeroing in on the most frequent themes emerging from short answer data.

But what if, regardless of ethnicity, gender, race, or other demographics, all students want basically the same proven teaching practices and preparation from their instructors, thereby making the underrepresentation of URG voices in the SET feedback process irrelevant? While unlikely, this is one of the possibilities that our study seeks to investigate. Rather than situate this question in the relatively crowded space of faculty support literature, however, our study instead focuses on teaching assistants (TAs). In the context of TA support of students, this study seeks to

understand whether or not race, ethnicity, gender, country of origin, or even time of enrollment make a difference in what engineering students want most from their teachers. Knowing whether and where these differences exist is essential to nourishing diversity in the engineering classroom by including all voices, whether over- or under- represented, in efforts to improve teaching.

Background

Postsecondary Teaching Assistants (hereafter referred to as TAs) play a significant role in higher education in the United States. Not surprisingly, colleges, universities, and professional schools employ the highest level of TAs at 115,990 or 3.84% of their overall workforce [10]. Among state or government owned institutions, the proportion is even higher. 77,880 individuals are employed as TAs, making up 4.64% of the total workforce of 1,679,110 [11]. TAs are especially prevalent in science and engineering at research universities with one survey indicating that 91% of all biology labs and 70% of life and physical science labs are taught by TAs rather than faculty [12]. Since most degrees in engineering are awarded at research universities [13, Table 5] most undergraduates in these disciplines receive a disproportionate amount of their education from TAs compared to other disciplines.

TAs make contributions to undergraduate education that are distinct from those made by faculty. They often have a broader range of responsibilities than others involved in undergraduate instruction. These responsibilities can include but are not limited to lecturing, leading review sessions, guiding laboratory work, helping students troubleshoot, proctoring exams, engaging students in group discussions, organizing and leading recitation or quiz sections, and providing technology support. In part because of their diverse and numerous responsibilities, TAs also tend to have much more frequent interactions with students than faculty do. Particularly in large, introductory courses at the freshman and sophomore levels, this means that TAs are often more visible to undergraduate students than faculty. In these and other similar contexts, TAs can have a strong influence on the perceived effectiveness of instruction. Yet, despite the ubiquity of TAs in science and engineering programs, “this group of teachers is almost invisible in the academic machinery that drives educational programs at large universities” [14].

Impacts of TAs:

As a natural consequence of their relative invisibility compared to faculty, much less is known regarding how TAs affect the undergraduate experience compared to the impacts of faculty on students. However, as agents assigned to carry out the teaching and learning objectives of the faculty member, TAs are often the “first line of defense” [15, p. 89] in undergraduate instruction and what they do directly affects the perceived quality of the faculty member’s teaching as well as the overall quality of the curriculum in the department [15]. In a quantitative study of engineering students, the instructional support provided by TAs was found to positively and significantly predict multiple measures of behavioral engagement in engineering courses [16]. Interactions between students and TAs were also significantly and positively linked to both student effort and participation [16]. In another study of interactions between TAs and students in physics labs, positive student evaluations were correlated with both the total interactions students had with the TA and the percentage of those interactions initiated by the TA [17]. Positive affect or demeanor on the part of TAs also predicted student enjoyment and satisfaction

with their laboratories [17]. TAs are in a unique position to create a positive lab atmosphere and in so doing to improve the learning experiences and intentions to remain in or pursue science majors [18]. TA influence on students' experience, however, extends beyond affect, engagement, and satisfaction. Higher content knowledge among TAs has been positively correlated to higher, end-of-semester content knowledge among the students that these TAs taught [19]. Students who perceived these same TAs to be more supportive also reported that they had learned more content [19]. While most studies of TAs have been conducted at large institutions where TAs are used in significant numbers, these positive impacts also extend to smaller institutions. For example, a qualitative study of computer science students at a small college has shown that TAs help to engage students and to create a classroom environment that is more relaxed and more open to students asking questions [20].

*Perceptions of TAs***:**
While it may seem that the positive impacts that quality TAs bring to the student experience are similar to the affective and learning benefits that faculty bring to the table, it is not necessarily the case that students perceive TAs the same way they perceive faculty, even within the same course. Kendall and Schussler [21] explored this possibility and found that "regardless of type of class, professors were perceived as being confident, in control, organized, experienced, knowledgeable, distant, formal, strict, hard, boring, and respected." [21, p. 187]. On the other hand, TAs were perceived as "…uncertain, hesitant, nervous, relaxed, laid-back, engaging, interactive, relatable, understanding, and able to personalize teaching" [21, p. 187]. These results are not surprising considering that compared to faculty, TAs are more likely be similar in social status and age to the undergraduates they teach, thus leading students to connect with them as more of a peer than a person of authority. However, these similarities are likely to vary based on the gender, race, ethnicity, and other social characteristics of students. Previous research has supported the influence of student demographics in the TA-student relationship by demonstrating significant interaction effects between some demographics and independent variables such as TA support and TA-student interactions [16].

Expectations for TAs:
While research shows that TAs believe that content knowledge is the sole key to being an effective teacher [14], students have a much different idea of what TAs should bring to the table. In a study of seven laboratory and lecture courses in environmental and water resources engineering, students were asked to rank what makes an effective TA from 17 categories of intellectual excitement and interpersonal rapport developed by the American Society of Civil Engineers Body of Knowledge (ASCE-BOK) to describe effective teaching [22]. 21.3% of students ranked fair grading practices as their first choice for what makes for an effective TA followed by explaining difficult concepts well (14.9%), coming to the classroom or laboratory prepared (13.3%), communicating clearly (12.9%), being available outside of class (7.2%), and treating all students with respect (6.0%). Being an expert in the content area was ranked as the first choice for effective TA teaching by only 6.0% of students in this study, underscoring the fact that what TAs think they should be doing may be very different from what students expect them to do.

This Study:
This study seeks to expand upon existing knowledge regarding what engineering students expect from TAs in four different ways: (a) by exploring TA support in courses within two popular engineering disciplines (mechanical and electrical engineering); (b) by using open-ended, short answer questions rather than close-ended Likert scale questions to allow students to fully explore their preferences for TA teaching methods; and (c) by applying qualitative research methods to analyze student responses over a large student population in order to (d) understand gender and racial differences in student expectations for TA practice. With these four goals in mind, our study seeks to give a voice to minority opinions regarding what TAs should do – perspectives that may not be represented in existing frameworks of effective teaching.

Conceptual Framework

The model for institutional departure developed by Vincent Tinto [23] posits that the college experience consists of two major systems. The academic system predicts academic integration while the social system predicts social integration into the campus community. Both forms of integration as well as incoming goals and commitments predict future goals and commitments, both internal and external to the college or university. These ultimately determine whether a student drops out of college or university. TAs contribute to the formal academic systems by providing logistical and pedagogical support to faculty-driven learning outcomes. They also provide substantial support to the social system by engaging with students at an affective and relational level that puts them more into the role of peer rather than authority figure. Because of the dual roles that TAs play (peer and teacher), we expect that students will have expectations for TAs that cover both the formal academic spaces as well as the more informal social spaces that make up the college experience.

Research Questions

This study explores student expectations for TA support among engineering undergraduates via two primary research questions:

Research Question #1 (RQ1): What do students expect from TAs?

This research question is explored using an open-ended, short answer survey question that does not restrict students to a preconceived framework for effective TA teaching. Assessment of this question across a large population of students can potentially provide meaningful recommendations for TA teaching that may or may not be represented in current models for professional development or effective teaching for TAs.

Research Question #2 (RQ2): Do demographic differences emerge in students' expectations?

This research question provides insight into whether following the opinions of the majority may inadvertently disenfranchise or marginalize the needs of underrepresented groups (URGs) in engineering. RQ2 can also provide insight into how to modify instructional support for URGs in order to provide greater equity in student learning.

Methods

This study is part of a larger, single-institution research project, which used a survey to investigate the connections between different forms of support (from faculty, TAs, and peers) and various dimensions of course-level engagement (including attention, participation, effort, and emotional engagement) in multiple learning contexts. The survey also included several short answer questions, one of which is analyzed in this study:

> "What one action can your TAs at <this institution> take to best support you in your classes (please be as specific as possible)?"

This question was posed to students in traditional classroom settings prior to the COVID-19 pandemic (pre-COVID), to students taught using emergency remote teaching (ERT) during the peak of the COVID-19 pandemic, and after the peak of the pandemic had passed (post-COVID).

Participant Demographics

Across pre-COVID, ERT, and post-COVID settings, a total of 1,678 students completed the short answer questions on the survey associated with this study. Most students were male (*n* = 1,241, 74.0%) and either Asian (*n* = 733, 43.7%) or White (*n* = 610, 36.4%). Most student respondents were US citizens or permanent residents (*n* = 1,400, 83.4%) but nearly all the international students who reported their race were Asian (*n* = 246, 92.8%). Those races where representation was less than ten individuals in the entire dataset including Native American, Pacific Islander, and most mixed races were combined into a single category labeled "other URM." A detailed breakdown of student demographics is provided in Table 1. Since some students did not respond to certain demographic questions, the total number of students in each demographic category does not always add up to the total population sample.

Table 1: Demographics of Study Population*

	All Time Periods		Pre-COVID		ERT		Post-COVID	
	n	%	*n*	%	*n*	%	*n*	%
Demographic								
All	1,678	100%	534	31.8%	766	45.7%	378	22.5%
Gender								
Male	1,241	74.0%	403	75.5%	559	73.0%	279	73.8%
Female	413	24.6%	128	24.0%	197	25.7%	88	23.3%
Other	12	0.720%	2	0.370%	6	0.780%	4	1.06%
Race/Ethnicity								
Black	34	2.03%	10	1.87%	16	2.09%	8	2.12%
Latino	66	3.93%	16	3.00%	30	3.92%	20	5.29%
Other URM	120	7.15%	42	7.87%	49	6.40%	29	7.67%
Asian	733	43.7%	209	39.1%	340	44.4%	184	48.7%
White	610	36.4%	226	42.3%	273	35.6%	111	29.4%
Asian/White	79	4.71%	24	4.49%	40	5.22%	15	3.97%
U.S. Status								
Domestic	1400	83.4%	454	85.0%	630	82.3%	316	83.6%
International	265	15.8%	79	14.8%	130	17.0%	56	14.8%

*Numbers do not necessarily add up to 100% due to non-responses

Course Demographics

The 43 courses surveyed in mechanical and electrical and computer engineering are summarized in Table 2. Eight courses including 32.2% of all surveys were collected before the COVID-19 pandemic took hold in spring of 2020. 27 courses including 48.7% of all surveys were collected during ERT between spring 2020 and spring 2021 inclusive, and the remaining 8 courses (19.1%) of surveys were collected after classes returned to in-person learning in summer 2021. The student response rate ranged from 7% to 100% across all 43 courses, but the overall response rate was 67% of all enrolled students in the courses studied. Some students completed the survey multiple times; duplicates were removed for this study, resulting in 1,678 unique responses.

Table 2. Courses Studied

Time Period	Participation		Student response rate			
	n (%) Surveys	*n* (%) Courses	Overall	Min	Mean	Max
Pre-COVID	754 (32.2%)	8 (18.6%)	78.2%	29.0%	73.8%	92.7%
ERT	1142 (48.7%)	27 (62.8%)	65.4%	9.52%	66.1%	100%
Post-COVID	448 (19.1%)	8 (18.6%)	56.7%	6.67%	63.7%	100%
Total	2344 (100%)	43 (100%)	67.0%	6.67%	67.1%	100%

Procedures

IRB (Internal Review Board) approval was obtained to recruit and survey undergraduate students. Instructors were asked to offer the survey to their students within two to three weeks of the end of the term in which the course was offered. Instructors offered an incentive to students to complete the survey, with a nominal amount of extra credit being the most popular choice; extra credit has been shown to be a highly effective motivator for college students [24]. For all but one class in the pre-COVID and ERT time periods, the survey was hosted by an institution-specific survey tool (Catalyst WebQ) and students accessed and completed the survey via a link in the learning management system for the course (Canvas) within one to three weeks of the instructors publishing the survey. In the remaining course (a 2016 pre-COVID offering), students completed a paper version of the survey in class. In the post-COVID period, student responses were collected using either Catalyst WebQ (2022) or Google Forms (2023). Instructors were not provided with any survey responses but instead the researchers provided the names and percentage of questions completed by each student so that grades could be adjusted according to the incentive offered to students. All participation was voluntary, and students were offered credit regardless of whether they granted consent for their responses to be used in the research because institutional IRB required that students who did not consent to the survey not be excluded. Less than 5% did not offer consent and were eliminated from the dataset.

Data Analysis

Textual responses to the short answer question (hereafter referred to as the dataset) regarding TA support examined in this study were analyzed using thematic analysis. Thematic analysis [25] is

a method of qualitative data analysis which requires reading through a dataset and identifying patterns in the data to extract themes. The flexibility of thematic analysis makes it accessible to a wide range of researchers and readers and is well suited to qualitative educational research. Thematic analysis is distinct from content analysis in that it seeks a wide, birds-eye view of the data while content analysis focuses on capturing more detailed information such as the frequency of certain words contained in the data. Since the process of coding (identifying patterns) and assigning themes to data is highly subjective and conducive to multiple approaches to interpreting the data, thematic analysis is also highly vulnerable to researcher bias. Therefore, in any thematic analysis, it is important for the individual(s) involved in thematic analysis to engage in a phase of reflexivity [26] after the data have been classified. Reflexivity involves questioning the assumptions made during coding of the data to identify potential biases in the coding and ultimately in the conclusions drawn from the data. Potential reflexivity bias is explored in the Limitations section of this manuscript.

In this study, thematic analysis was initially applied to identify broad themes in the data. After initial patterns in the data were identified, one or more of these broad (primary) themes were assigned to each student response. Once the dataset was broken down into this primary set of themes, responses within each theme were re-examined to determine whether secondary themes were appropriate to describe the data. Responses that were not classified into any of the primary themes were coded as "other" (student responded but the response was not a good fit to any of the primary themes), no response (student did not answer the question), or no suggestion (student did not think TAs needed to do anything differently).

Results

An initial reading of student responses to the TA support question revealed three primary patterns or themes in the data. The first theme focused on teaching *practice* and a subsequent breakdown of this theme resulted in five possible secondary themes that corresponded to five of the seven principles of good teaching outlined by Chickering and Gamson [27]:

- *Contact:* Frequent contact between teacher and student is "…the most important factor in student motivation and involvement." [27, p. 3] and can include office hours and supplemental review sessions as well as informal conversation.
- *Collaboration:* Teachers can facilitate both formal and informal groups of students to take advantage of the fact that student learning is higher when it is collaborative or social in nature.
- *Active Learning:* Team projects, peer critiques, challenging discussions, and structured problem-solving exercises all serve to move learning away from being a spectator sport into a process in which students are actively engaged.
- *Feedback:* Frequent feedback from teachers whether through formal, graded assignments or more informally through prompt responses to questions posed by students is a critical part of academic performance and learning.
- *Diversity:* Bringing diverse ways to solve problems, complete labs, or excel in classes respects differences among students in their individual talents and ways of learning.

Among all codes assigned to student responses, 697 or 39.7% called for TAs to make it a priority to engage in at least one of these five practices of good teaching (Table 3). Of the five secondary themes identified within teaching practice, students most frequently called for more *contact* (interactions) with TAs (63.0%) and better *feedback* from TAs (27.0%).

Table 3: Students who desire better Teaching Practice from TAs

Demographic	Percentage of overall responses within a particular time period							
	All Time Periods		Pre-COVID		ERT		Post-COVID	
	N	%	*N*	%	*N*	%	*N*	%
All Responses	697	39.7%	150	25.0%	399	47.8%	148	35.7%
Gender								
Male	501	37.4%	104	23.6%	285	50.0%	112	36.8%
Female	186	38.3%	45	25.9%	109	47.6%	32	31.7%
Other	6	40.0%	1	33.3%	3	37.5%	2	50.0%
Race/Ethnicity								
Black	13	36.1%	3	30.0%	8	44.4%	2	25.0%
Latino	21	29.2%	4	21.2%	12	37.5%	5	23.8%
Other URM	58	38.4%	14	29.8%	31	59.6%	13	37.1%
Asian	307	38.1%	59	25.9%	175	46.9%	73	35.6%
White	253	37.5%	64	24.6%	145	45.0%	44	36.7%
Asian/White	32	34.8%	5	16.7%	18	39.1%	9	56.3%
U. S. Status								
Domestic	598	38.0%	130	25.2%	338	49.1%	130	37.1%
International	95	33.5%	20	24.1%	59	41.8%	16	26.7%

The second primary theme that emerged from the dataset focused on teacher *preparation* rather than teaching practice and revealed secondary themes corresponding to (a) *review* of concepts covered by faculty in the main lecture including a call for TAs to remain synchronized and informed about what the course professor was doing; (b) a focus on providing *examples* of problems related to lecture content, homework, or future exams; (c) clarifying *expectations* for grading and learning and ensuring that these expectations remained consistent for all students; (d) providing *follow-up* after student sessions including video recordings and copies of TA-led sessions; (e) using *technology* appropriately; and (f) providing professional and polished *delivery* in the classroom.

Moving beyond teaching practice, another 42.3% of students called for some form of improvement in teaching preparation (Table 4). Of these students, a majority asked that TAs provide more examples (25.8%; $n = 202$) or focus on relevant review of concepts introduced by faculty in lecture (26.2%; $n = 205$).

The last primary theme that emerged from the data is that of *hospitality* where "… teaching with hospitality refers to the ability of the professor to provide a nurturing, conducive learning environment" [28, p. 10.376.8]. Hospitality includes …" listening with respect, receptiveness to other opinions, and requiring the same level of interaction and courtesy from all students." [28, p. 10.376.8]. Students reflecting on a need for hospitality in the classroom referred to seeking

TAs who were understanding, caring, flexible, enthusiastic, and interested (among other descriptors) in their teaching practice.

Among all student responses to TA support preferences, 7.24% called for some form of improvement in TA hospitality (Table 5).

Table 4: Students who desire better Teacher Preparation from TAs

Demographic	Percentage of overall responses within a particular time period							
	All Time Periods		Pre-COVID		ERT		Post-COVID	
	N	%	*N*	%	*N*	%	*N*	%
All Responses	783	42.3%	319	53.1%	292	35.0%	172	41.5%
Gender								
Male	557	41.6%	236	53.5%	199	33.5%	122	40.1%
Female	219	45.1%	82	52.6%	90	39.3%	47	46.5%
Other	5	33.3%	1	33.3%	3	37.5%	1	25.0%
Race/Ethnicity								
Black	14	38.9%	4	40.0%	7	38.9%	3	37.5%
Latino	35	48.6%	11	57.9%	15	46.9%	9	42.9%
Other URM	48	31.8%	21	44.7%	15	28.9%	12	34.3%
Asian	336	41.7%	121	53.1%	130	34.9%	85	41.5%
White	293	43.4%	142	54.6%	99	30.8%	52	43.3%
Asian/White	47	51.1%	19	63.3%	45	45.7%	7	43.8%
U. S. Status								
Domestic	682	43.3%	277	53.6%	242	35.2%	143	40.9%
International	117	41.2%	42	50.6%	48	34.0%	27	45.0%

Table 5: Students who desire Hospitality from TAs

Demographic	Percentage of overall responses within a particular time period							
	All Time Periods		Pre-COVID		ERT		Post-COVID	
	N	%	*N*	%	*N*	%	*N*	%
All Responses	134	7.24%	60	9.98%	37	4.44%	37	8.92%
Gender								
Male	93	6.95%	45	10.2%	26	4.38%	22	7.24%
Female	37	7.61%	15	9.62%	9	3.93%	13	12.9%
Other	2	13.3%	0	0.00%	1	12.5%	1	25.0%
Race/Ethnicity								
Black	2	5.56%	1	10.0%	1	5.56%	0	0.00%
Latino	8	11.1%	2	10.5%	2	6.25%	1	4.76%
Other URM	15	11.2%	5	10.6%	3	5.57%	7	20.0%
Asian	52	6.45%	23	10.1%	15	4.02%	14	6.83%
White	47	6.96%	23	8.85%	13	4.04%	11	9.17%
Asian/White	7	7.61%	4	13.3%	3	6.52%	0	0.00%
U. S. Status								
Domestic	119	7.65%	53	10.3%	33	4.80%	33	9.43%
International	15	5.28%	7	8.43%	4	2.84%	4	6.67%

Shifts in student preferences for TA support were evident over the three time periods studied (Figure 1). Over half of students (53.1%) desired improved *teacher preparation* from TAs before the pandemic began, while those numbers dropped during ERT (35.0%) and recovered somewhat after ERT ended (41.5%). Almost half of students (47.8%) called for better *teaching practice* during the ERT phase of the COVID-19 pandemic while far fewer prioritized *teaching practice* before the pandemic began (25.0%) and after ERT ended (35.7%). Responses regarding TA support were very similar across gender with 37.4% of male respondents and 38.3% of female respondents calling for improved *teaching practice* and 41.6% of male respondents and 45.1% of female respondents calling for improved *teaching preparation*. Across race and ethnicity, however, some differences emerged among student responses (Figure 2).

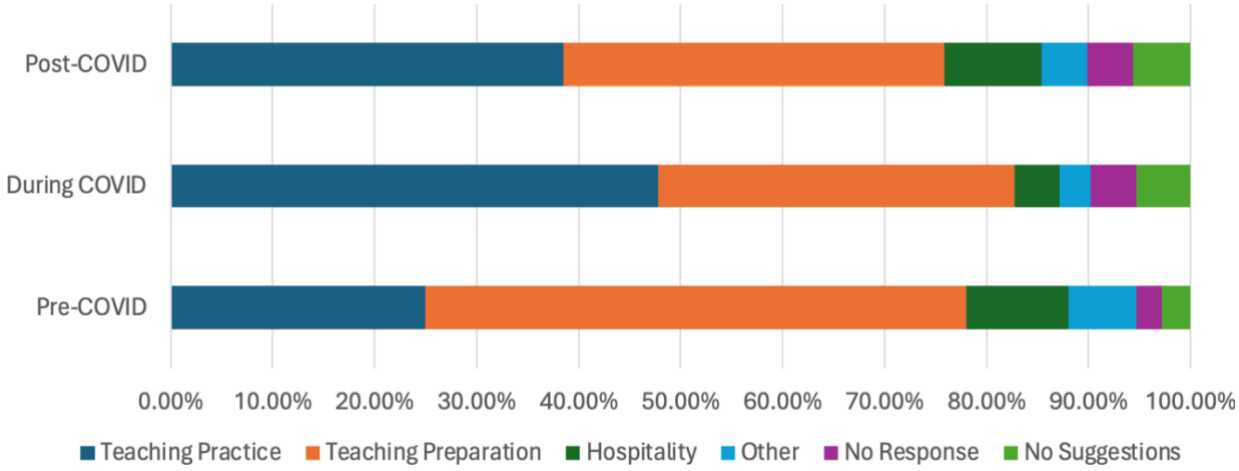

Figure 1: Student Preferences for TA Support before, during, and after ERT/COVID

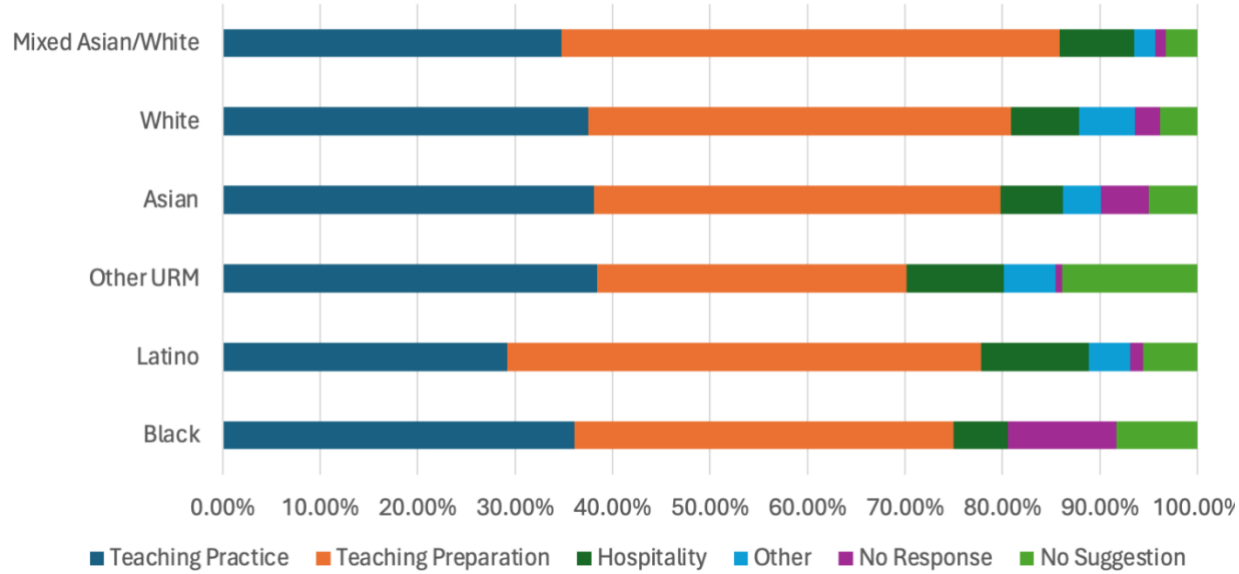

Figure 2: Race/Ethnicity Differences in TA Support Preferences

Expectations for improved teaching preparation were highest among Latino students (48.6%) and Asian/White students (51.1%) and over 5% more so than their Asian (41.4%) and White (43.4%) peers who made up the majority of the student population studied. Notably, over 11% of Latino and almost 10% of other URM students asked that TAs be more hospitable in their teaching while all other races called for improved hospitality at frequencies less than 8%. And, over 8% of Black and other URM students had no suggestions for TA improvement while less than 6% of Asian, White, and Asian/White students thought TAs were doing well enough as is (i.e., also responded with no suggestions).

When comparing American (domestic) and international students (Figure 3), domestic and international students called for improvements in *teaching preparation* at about the same proportion of their overall demographic (43.3% and 41.2% respectively). In contrast, domestic students raised the issues concerning *teaching practice* more frequently (38.0%) than did international students (33.5%). Among international student responses regarding teaching practice, 48 (of 284 total responses) prioritized *contact* with the TAs in their responses and 36 prioritized meaningful *feedback* from TAs. Among domestic students, 385 and 152 (of 1,555 total responses) prioritized *contact* and *feedback* respectively. Interestingly, a larger proportion of international students (9.51%) compared to domestic students (2.64%) chose not to respond to the question regarding TA support altogether.

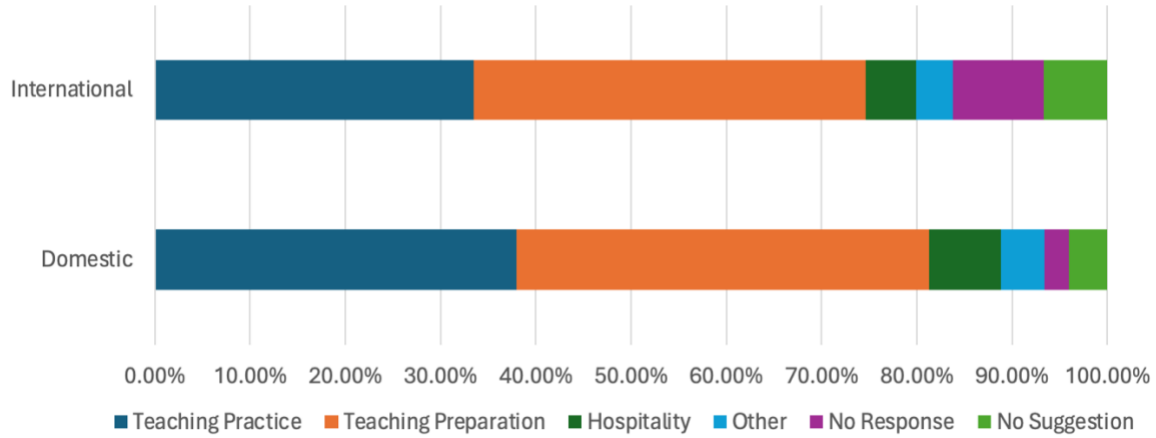

Figure 3: TA Support Preferences among U.S. and International Students

Discussion and Implications

RQ1: *What do students expect from TAs?*

Students most frequently cite *teaching practice* and *teacher preparation* as high priority areas for TAs to emphasize in supporting their learning.

Of the five best teaching practices [27] that emerged from student responses in our dataset, *contact* and *feedback* dominated. Students want TAs to be available, to spend time helping them to solve problems, to troubleshoot, and to support their learning. They also want TAs to be active in the TA-student relationship by providing frequent and relevant feedback to them regarding their learning by asking appropriate questions, providing prompt answers to those questions, grading in a timely manner, and reaching out to them when they are struggling. A desire for

frequent and meaningful connections with TAs is consistent with previous studies where TAs are perceived as interactive and relatable partners in the personalization of teaching [21]. These results also underscore the TA's role as a peer in the learning process and as a contributor to the social integration of the student into campus culture [23].

That being said, TAs also play a formal role as teachers in the academic integration of the student into the university. This more formal role is reflected in our study in how frequently students indicated that they expected TAs to be prepared to teach them. When students focused on *teacher preparation* in their responses, they spoke to how important it was for TAs to be synchronized with professors, to be aware of and clarify the expectations that the professor had of them in the course, to provide clear explanations of course content that augment and complement the professor's teaching, and to lead students through examples that empower them to learn and perform well on homework, tests, and other assignments. Interestingly, these expectations align more with perceptions that they be organized, experienced, and knowledgeable, descriptors that in previous research [21] have been connected to professors rather than TAs.

In summary, this study suggests that TAs are expected to be a strong ally and peer to students, while also demonstrating expertise and experience comparable to their supervising professors. TAs are already juggling a myriad of research and student responsibilities along with teaching duties. The broad range of expectations that students place on TAs informed by the results of our analysis may be an unmanageable burden on those TAs, potentially leading to higher burnout and withdrawal from teaching.

RQ2: *Do demographic differences emerge in students' expectations?*
Results from this study do not suggest that male students and female students have substantially different expectations for TAs. However, variations in the responses by race, ethnicity, and country of origin suggest that a "one size fits all" approach to teaching is not any more appropriate for TAs than it is for faculty [29].

Among international students, it often wasn't enough to have TAs be available for them; rather, 37.8% of international students who called for improved *teaching practice* wanted TAs to provide those improvements in the form of frequent and timely feedback to them regarding their learning and performance. Such proactive communication is essential to help international students when they struggle [30]. Previous research has supported the role of faculty in interacting with and engaging with international students to assist in overcoming cultural differences in teaching methods and clearing up misunderstandings in class procedures or in navigating the politics of education in the U.S. [31]. Because TAs play roles both of peer and authority figure, their frequent interactions with and feedback to international students have the potential to play an even more impactful role than faculty on international students' education and well-being.

Interestingly, across different races and ethnicities, some underrepresented minority (URM) groups, such as Latino and Asian/White students, appeared to place a higher value on *teaching preparation* than *teaching practice*, while other URM groups placed a lower value on teaching preparation. In contrast, Black students appeared to value both elements of TA support in

relatively the same proportion. Latinos and other URM students also appeared to value *hospitality* from TAs more than other groups, suggesting that relational connection with TAs is important to their success.

Our data also paint a dynamic picture across time particularly with respect to the COVID-19 pandemic. Prior to the pandemic, a majority of students sought greater *teacher preparation* from their TAs, while in ERT during the pandemic, many students shifted to calling for better *teaching practice*, especially in the form of increased contact with and availability from TAs. While this may be no surprise given how isolating remote learning was during the pandemic, it is surprising that students have not returned to their pre-pandemic opinions regarding support in the post-COVID years. Instead, many more than prior to the pandemic call for better *teaching practices* from TAs while *teacher preparation* appears to be less important to students now than traditional classrooms of the past.

While these differences across race, ethnicity, country of origin, and time seem to paint a complex and intimidating picture to TAs who are seeking to meet the needs of their students, one message from the data is abundantly clear. What students want in terms of support is a dynamic, moving target. Thus, just as fundamental frameworks of learning [32] call for diagnosing student knowledge and skills as a first step in teaching a course, so it seems that engineering instructors should also seek to diagnose or understand what students need from their teachers from the start.

Unfortunately, TAs, particularly at research institutions, often receive ambiguous messages about the importance of their teaching assignments [33] and often doubt their abilities with regard to teaching [34]. In this study, a single question posed to students regarding TA support enabled strides forward in resolving this ambiguity. Thus, the importance of diagnosing expectations in addition to understanding the skill and content knowledge that students bring into the classroom is important to supporting all those invested in teaching in higher education. Further, doing so may be especially important for engineering and related STEM fields where prerequisite skill and knowledge are critical to succeeding in many upper-level classes and beyond. As more and more engineering and other STEM departments make efforts to provide professional development for TAs [35], [36], [37], [38], our hope is that techniques for initially probing and diagnosing student expectations will become more commonplace in teaching novice teachers like TAs how to teach. Doing so can potentially ensure that the classroom outcomes of TA professional development evolve from mixed [39], [40], [41] to more consistently positive.

Limitations

This study draws on textual data from a single research institution. While the relatively large sample size (1,678 unique students; 1,851 primary themes) allows for generalizing conclusions regarding the mechanical, electrical, and computer engineering environments at the institution where the study was conducted, the results may not be generalizable to other engineering and STEM disciplines or other institutions. However, the results of this study indicate that the learning environment is dynamic and student preferences for what instructors do can vary across demographics such as race, gender, and country of origin as well as across different time periods over which students are enrolled. Campus cultures and learning environments within other engineering or related STEM fields are likely to be as dynamic as those described in this study.

Therefore, the main implication of this study (that student preferences for teaching should be diagnosed and evaluated alongside incoming skills and knowledge) is likely to be relevant outside the disciplines and institution studied herein. The main themes emerging from this study (teaching practice, teaching preparation, hospitality) are also likely to emerge from similar studies, surveys, or diagnostics at other institutions.

While qualitative research and data analysis are often more vulnerable to bias than quantitative methods, steps have been taken to minimize both *researcher* and *participant* bias in this study. Self-selection bias is a form of participant bias where individuals with specific viewpoints or interests are more likely to opt into a research study than those who have differing viewpoints. We have endeavored to reduce the likelihood of *self-selection bias* by offering the survey in this study to entire classes of students with appealing incentives (e.g., extra credit) that are likely to attract student participation regardless of individual viewpoints. Offering students the opportunity to privately complete the survey while away from the presence of researchers and faculty also reduced the likelihood of *response bias*. Response bias occurs when respondents feel compelled to provide responses that they deem socially desirable to others. Finally, another form of participant bias, *non-response bias*, has also been minimized in this study because the researchers had access to entire classes of students (indirectly through participating faculty), and strategically chosen incentives reduced the barrier to survey participation.

While these three forms of bias reduced overall participant bias in this study, we still had to contend with researcher bias. *Selection bias* (the non-random selection of participants) was reduced by inviting entire classes of students across mechanical, electrical, and computer engineering courses to participate. Since a single researcher assigned both primary and secondary themes to the student responses in this study, however, reflexivity bias may be in play in the study results. *Reflexivity bias* occurs when the researcher's personal beliefs and preconceptions may have distorted both the selection and assignment of codes and themes; such bias was partially reduced by relying on established frameworks of good teaching including Chickering and Gamson's best teaching practices [27] and hospitality principles [28]. However, since the primary researcher/coder in this effort was an engineering education practitioner and researcher, this most certainly created some bias in how the data were framed and subsequently coded; future work should include recruiting additional coders to evaluate intercoder reliability [42] and inviting the input of researchers outside of engineering to the analysis and interpretation of the data.

Finally, no additional statistical tests were conducted with the frequencies of student responses. After intercoder reliability is completed, future work will conduct chi-square and similar tests to assess which of the data shown in Tables 3, 4, and 5 reject the null hypothesis that no differences by race, gender, or country of origin were present in the results.

Conclusion

This paper has analyzed almost 1,900 ideas from 1,678 engineering undergraduates regarding how TAs can better support them. The three primary themes of TA support emerging from the

data were related to *teaching practice* (how TAs work directly with students); *teaching preparation* (how TAs acquire content and skill expertise and provide resources accessible to students); and *hospitality* (the methods by which TAs welcome all manner of students into the learning process). Although no substantial gender differences were evident in the frequency of student responses along each of these themes, multiple differences across race, ethnicity, and country of origin as well as across three different time periods (before, during, and after the peak of the COVID-19 pandemic) were evident. These results suggest that underrepresented minorities view the role of TAs differently than Asian and White students and that international students have different expectations of TAs than domestic students. The results also suggest that student calls for TA support are neither constant over time nor have they changed monotonically over the past eight years from pre-COVID-19 to remote learning (ERT) to post-COVID-19 teaching and learning. Instead, at the peak of the pandemic, almost half of the engineering students in our study called for increased contact with and feedback from TAs as well as other student-oriented best teaching practices. As the classroom returned to a traditional setting, student preferences did not return to their pre-pandemic levels. Instead, more students continued to ask for improvements in teaching practice as well as increased hospitality compared to pre-pandemic levels. Taken as a whole, the results of our analysis suggest that what students want from teachers, including TAs, can evolve over time and can vary across demographic differences. This dynamic landscape of expectations for teaching support, in turn, suggests that TAs and other engineering instructors (including faculty) can benefit from beginning their classes by asking students to articulate their preferences for instructional support. Future work in this area will not only look at the impact of collecting student preferences at the start of instruction but also at the effect of including researchers outside of engineering in coding, analyzing, and interpreting short answer data regarding TA support.

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References

[1] American Society for Engineering Education (ASEE). “Engineering and Engineering Technology by the Numbers.” asee.org. [Online]. https://ira.asee.org/wp-content/uploads/2023/12/Engineering-and-Engineering-Technology-by-the-Numbers-2022-1.pdf. [Accessed Jan. 31, 2024].

[2] P. Meiksins, and P. Layne, “Women in Engineering: analyzing 20 years of social science literature,” *Magazine of the Society of Women Engineers*, vol. 70, no. 1, Winter 2024. [Online]. Available: https://magazine.swe.org/lit-review-22/. [Accessed Jan. 31, 2024].

[3] Society of Women Engineers (SWE). “Employment of Women in Engineering.” swe.org. [Online]. Available: https://swe.org/research/2023/employment/. [Accessed Jan. 31, 2024].

[4] C. Funk and M. H. Lopez, “A brief statistical portrait of U.S. Hispanics,” *Pew Research Foundation*, 2022. [Online]. Available: https://www.pewresearch.org/science/2022/06/14/a-brief-statistical-portrait-of-u-s-hispanics/. [Accessed Jan. 30, 2024].

[5] S. S. Silbey, “Why Do So Many Women Who Study Engineering Leave the Field?,” *Harvard Business Review*, 2016. [Online]. Available: https://hbr.org/2016/08/why-do-so-many-women-who-study-engineering-leave-the-field. [Accessed Jan. 30, 2024].

[6] C. Riegle-Crumb, B. King, and Y. Irizarry, “Does STEM stand out? Examining racial/ethnic gaps in persistence across postsecondary fields?,” *Educational Researcher*, vol. 48, no. 3, pp. 133-144, 2019.

[7] American Sociological Association. “Statement on Student Evaluations of teaching.” asanet.org. [Online]. Available: https://www.asanet.org/wp-content/uploads/asa_statement_on_student_evaluations_of_teaching_feb132020.pdf. [Accessed Jan. 15, 2024].

[8] S. A. Basow, “Bias in Student Evaluations,” *PsycEXTRA Dataset. American Psychological Association (APA)*, 2013. doi: 10.1037/e584152013-001.

[9] P. Spooren, B. Brockx, and D. Mortelmans, "On the validity of student evaluation of teaching: The state of the art," *Review of Educational Research*, vol. 83, no. 4, pp. 598-642, 2013).

[10] Bureau of Labor Statistics. “Occupational Employment and Wages.” bls.gov. [Online] Available: https://www.bls.gov/oes/current/oes259044.htm#(3). [Accessed Jan. 2, 2024].

[11] Bureau of Labor Statistics. “National Occupational Employment and Wage Estimates by ownership,” bls.gov. [Online] Available: https://www.bls.gov/oes/current/611300_2.htm. [Accessed Jan. 2, 2024].

[12] M. D. Sundberg, J. E. Armstrong, and E. W. Wischusen, “A Reappraisal of the Status of Introductory Biology Laboratory Education in U.S. Colleges & Universities,” *The American Biology Teacher*, vol. 67, no. 9, pp. 525–529, Nov. 2005, doi: 10.2307/4451904.

[13] American Society for Engineering Education (ASEE). “Engineering and Engineering Technology by the Numbers.” asee.org. [Online]. https://ira.asee.org/wp-content/uploads/2020/09/E-ET-by-the-Numbers-2019.pdf. [Accessed Jan. 31, 2024].

[14] 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, 2011.

[15] J. W. Nicklow, S. S. Marikunte, and L. R. Chevalier, “Balancing Pedagogical and Professional Practice Skills in the Training of Graduate Teaching Assistants,” *Journal of Professional Issues in Engineering Education and Practice*, vol. 133, no. 2, pp. 89–93, Apr. 2007, doi: 10.1061/(asce)1052-3928(2007)133:2(89).

[16] D. Wilson, J. Wright, and L. Summers, “The Importance of Teaching Assistant Support and Interactions in Student Engagement,” *Sage Advance*, Aug. 2020 [Online]. Available:

https://advance.sagepub.com/articles/preprint/The_Importance_of_Teaching_Assistant_Support_and_Interactions_in_Student_Engagement/12751475. [Accessed Jan. 15, 2024]. doi: 10.31124/advance.12751475.v1.

[17] Z. Hazari, A. W. Key, and J. Pitre, 'Interactive and affective behaviors of teaching assistants in a first year physics laboratory," *The Electronic Journal for Research in Science & Mathematics Education*, vol. 7, no. 3, 2003.

[18] C. O'Neal, M. Wright, C. Cook, T. Perorazio, and J. Purkiss, "The impact of teaching assistants on student retention in the sciences: Lessons for TA training," *Journal of College Science Teaching*, vol. 36, no. 5, pp. 24-29, 2007.

[19] 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," *J. Res. Sci. Teach.*, vol. 54, no. 4, pp. 463–492, Apr. 2017.

[20] P. E. Dickson, "Using undergraduate teaching assistants in a small college environment," In *Proceedings of the 42nd ACM technical symposium on Computer science education, Dallas, TX, USA, Mar. 9-11,* 2011.

[21] K. D. Kendall and E. E. Schussler, "Does Instructor Type Matter? Undergraduate Student Perception of Graduate Teaching Assistants and Professors," *CBE—Life Sciences Education*, vol. 11, no. 2, pp. 187–199, Jun. 2012, doi: 10.1187/cbe.11-10-0091.

[22] D. Christenson, D. Baldwin, M.M. Brundrett, P. A. Monaco, K.vA. Nguyen, and A. N. Morse, "Student and Teaching Assistant Perspectives on Characteristics of an Effective Teaching Assistant," In *ASEE Annual Conference & Exposition*, Seattle, WA, USA, 2015.

[23] V. Tinto, *Leaving College: Rethinking the Causes and Cures of Student Attrition*. Chicago: University of Chicago Press, 1993.

[24] K. A. Foltz, M. Clements, A. Fallon, and A. Stinson, "Extra Credit and Decision-Making: Understanding College Students' Motivation to Attend On-Campus Events," *Journal of Campus Activities Practice and Scholarship*, vol. 3, no. 2, pp. 5-15, 2021.

[25] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative research in psychology*, vol. 3, no. 2, pp. 77-101, 2006.

[26] D. Byrne, "A worked example of Braun and Clarke's approach to reflexive thematic analysis," *Quality & quantity*, vol. 56, no. 3, pp. 1391-1412, 2022.

[27] A. W. Chickering and Z. F. Gamson, "Seven principles for good practice in undergraduate education," *Biochemical Education*, vol. 17, no. 3, pp. 140–141, Jul. 1989, doi: 10.1016/0307-4412(89)90094-0.

[28] J. Marshall and J. Marshall, "Crucial teaching strategies for engineering educators," In *ASEE Annual Conference & Exposition*, Portland, OR, USA, 2005.

[29] R. M. Felder and R. Brent, “Understanding student differences,” *Journal of engineering education,* vol. 94, no. 1, pp. 57-72, 2005.

[30] A. Mowreader, “Investing in Support for International Students,” *Inside Higher Education,* 2023. [Online]. Available: https://www.insidehighered.com/news/student-success/college-experience/2023/10/17/three-ways-support-international-student-success. [Accessed Jan. 24, 2024].

[31] S. Unruh, “Struggling International Students in the US: Do University Faculty Know How to Help?," *Athens Journal of Education,* vol. 2, no. 2, pp. 99-110, 2015.

[32] J. D. Bransford, A. L. Brown, and R. R. Cocking. *How people learn*. Vol. 11. Washington, DC: National Academy Press, 2000.

[33] J. D. Nyquist, L. Manning, D. H. Wulff, A. E. Austin, J. Sprague, P. K. Fraser, C. Calcagno, and B. Woodford. "On the road to becoming a professor: The graduate student experience." *Change: The Magazine of Higher Learning,* vol. 31, no. 3, pp. 18-27, 1999.

[34] S. Meyers, M. L. Lansu, J. Hundal, S. Lekkos, and L. Prieto, “Preparing New Psychology Instructors to Teach Undergraduates: Developing Confidence and Competence,” *J. Fac. Dev.*, vol. 21, no. 1, pp. 45–54, Jan. 2007.

[35] J. A. Roden, S. Jakob, C. Roehrig, and T. J. Brenner, “Preparing Graduate Student Teaching Assistants in the Sciences: An Intensive Workshop Focused on Active Learning,” *Biochem. Mol. Biol. Educ.*, vol. 46, no. 4, pp. 318–326, Jul. 2018.

[36] J. P. Kurdziel, J. A. Turner, J. A. Luft, and G. H. Roehrig, “Graduate Teaching Assistants and Inquiry-Based Instruction: Implications for Graduate Teaching Assistant Training,” *J. Chem. Educ.*, vol. 80, no. 10, p. 1206, Oct. 2003.

[37] P. C. Wankat and F. S. Oreovicz, “Teaching Prospective Engineering Faculty How to Teach,” *Int. J. Eng. Educ.*, vol. 21, no. 5, pp. 925–930, 2005.

[38] D. T. A. Pinder-Grover, “Active Learning in Engineering: Perspectives from Graduate Student Instructors,” In *ASEE Annual Conference & Exposition*, Atlanta, GA, USA, 2013.

[39] J. W. Rushin, J. De Saix, A. Lumsden, D. P. Streubel, G. Summers, and C. Bernson, “Graduate Teaching Assistant Training: A Basis for Improvement of College Biology Teaching & Faculty Development?,” *Am. Biol. Teach.*, vol. 59, no. 2, pp. 86–90, Feb. 1997.

[40] 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 Sci. Educ.*, vol. 14, no. 3, pp. 1–11, Sep. 2015.

[41] D. A. Torvi, “Engineering Graduate Teaching Assistant Instructional Programs: Training Tomorrow’s Faculty Members,” *J. Eng. Educ.*, vol. 83, no. 4, pp. 376–382, Oct. 1994.

[42] C. O’Connor and H. Joffe, “Intercoder reliability in qualitative research: debates and practical guidelines,” *International journal of qualitative methods* vol. 19, 2020.