Interdisciplinarity and peer evaluation as tools for enhancing graduate student teaching training

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Abstract

Graduate student instructors (GSIs) play a critical role in higher education, serving as instructors of record for a substantial portion of courses at research universities. This study evaluates the structure and processes of Duke University Graduate School's Teaching Triangles (TT) program, an interdisciplinary peer observation and feedback process designed to prepare graduate students for academic careers. Guided by the framework of communities of practice (CoP), this study explores how TT fosters pedagogical development, interdisciplinary learning, and professional preparation for GSIs. Utilizing a mixed-methods approach, the study analyzes 694 reflections from GSIs who participated in TT between Fall 2011 and Summer 2022. The findings indicate that TT effectively fosters a supportive environment for GSIs, promoting pedagogical self-reflection, confidence growth, and the adoption of improved teaching practices. Female GSIs, in particular, reported notable confidence gains, aligning with existing literature on gender and teaching self-efficacy. GSIs also valued the interdisciplinary nature of the program, which broadened their perspectives on teaching across various disciplines. Additionally, peer evaluation emerged as a key strength, allowing GSIs to experiment with new strategies in a non-hierarchical, low-stakes setting. This study provides recommendations for enhancing the TT program, such as modifying discussion formats to encourage timely feedback, expanding opportunities for long-term peer

engagement, and developing a framework for continued evaluation. The findings emphasize the effectiveness of pedagogical training rooted in the CoP framework, demonstrating how peer observation programs can cultivate professional growth among graduate student instructors while fostering interdisciplinary collaboration in higher education.

Keywords: graduate student teaching, peer evaluation, faculty development, university teaching

Graduate student instructors (GSIs) are an integral part of the higher education workforce, acting as the instructors of record and teaching assistants for a sizable portion of courses offered at research universities. A 2015 study found that GSIs are instructors for at least 20% of classes at five major research institutions (Friedman, 2017). With many universities facing budget constraints and prioritizing research over teaching, there has been an increasing reliance on graduate students and adjunct faculty to handle instructional duties (Figlio & Schapiro, 2021; Rossol-Allison & Alleman Beyers, 2011). With this increased reliance, the impact of GSIs has become even more pronounced, as evidenced by the disruptions caused by graduate student union strikes demanding better pay and working conditions (Quinn, 2023; Alonso, 2024; Hawks, 2024).

Duke University, an R1 university located in Durham, North Carolina, USA, is home to one of the nation's graduate student pedagogical development programs: the Certificate in College Teaching (CCT). CCT, housed inside Duke's Graduate School, is an optional program that prepares graduate students for faculty positions post-graduation. PhD students in any discipline are eligible to participate in CCT. Master of Fine Art (MFA) students are also permitted, as an MFA is a terminal degree in the field. While most students plan on entering academia following their graduation, any student who meets the eligibility requirements can participate.

To receive an official CCT certificate on their diploma, students must complete three parts: coursework, Teaching Triangles (TT), and

an online teaching portfolio. These requirements take around a year to complete. For this study, we focused on the TT section of the CCT. A total of 694 GSIs in TT submitted end-of-semester reflections from Fall 2011 to Summer 2022.

Program Overview

Before the conclusion of CCT, participants must successfully complete two credit-bearing courses in college teaching. These courses can be any combination of graduate school or discipline-specific pedagogy courses. The graduate school has eight course offerings total, though this number fluctuates depending on the semester and instructor availability. Topics range from college teaching and course design to digital pedagogy and special topics courses. In Fall 2024, the special topics course covered the role of generative AI in college teaching.

Either during or after the coursework, GSIs begin the TT process. TT consists of four parts:

1) **Grouping:** GSIs assemble into groups of three, preferably each from different disciplines.
2) **Peer Observation:** Each GSI is then required to observe the courses of the other two members of their group and, in turn, have their own course observed.
3) **Group Reflection:** The group later meets either one-on-one or together to discuss the observations and identify consistent points of improvement. Ideally, these conversations occur shortly after the observations when schedules permit.
4) **Individual Reflection:** The semester concludes with a brief written reflection on the TT process to gather feedback for future program improvements. Students upload their reflections to the CCT page within the university's learning management software (LMS), where it can be viewed by the program director.

To participate in TT, GSIs must have a teaching role. There are three ways this requirement can be met:

1) GSI is the instructor of record (IOR) of a course.
2) GSI is a teaching assistant (TA) who leads a discussion, lab, or recitation section that meets regularly (at least four times) throughout the semester as the primary leader/facilitator of those meetings.
3) GSI is a guest lecturer on at least four separate sessions, each at least an hour long, in the same term or semester and working with that course's instructor of record.

GSIs are responsible for seeking their own teaching positions. Most GSIs teach at Duke, but some teach at nearby research universities, liberal arts colleges, and community colleges.

The final requirement to complete the CCT is an online teaching portfolio containing a CV, teaching statement, and anything else desired by the GSI—typically information about their research.

Literature Review

Graduate Students Instructors and Their Roles

GSIs are effective educators, with studies suggesting they are nearly equivalent in effectiveness to senior instructors for tutorial courses (Feld et al., 2019). Bettinger et al. (2016) observed that undergraduates are twice as likely to major in a subject if their first course in that field is taught by a graduate student. This finding highlights the influence GSIs can have on shaping students' academic trajectories and interests. GSIs' passion for their discipline and ability to relate to undergraduates can compensate for their lack of teaching experience (Tuckman, 1975).

Teaching experience is beneficial for GSIs themselves. Those who teach courses are often more successful in their academic progress,

being more likely to graduate early and land a full-time faculty position following graduation (Bettinger et al., 2016). This observation suggests that teaching experience can enhance GSIs' professional development and future career prospects. Some hiring committees for tenure-track positions value teaching ability comparably to or even over publication records (Walsh et al., 2022). As some universities emphasize teaching effectiveness in faculty hiring decisions, GSIs with strong pedagogical skills may have a competitive advantage. Despite the additional commitment, graduate students can maintain their ability to conduct research while teaching (Shortlidge & Eddy, 2018). In fact, Feldon et al. (2011) found that STEM graduate students with teaching experience developed stronger methodological research skills than those without it. This finding challenges the perception that teaching detracts from research productivity and suggests that the two activities are complementary. However, novice teachers are more likely to report that their teaching interferes with their research commitments than more experienced faculty (Murtonen & Vilppu, 2020), reinforcing the need for support and training to help GSIs balance these competing demands effectively.

Importance of Pedagogical Training for GSIs

Unlike many faculty members, GSIs are often new to teaching, highlighting the importance of supporting their development as educators. Beers et al. (2020) discuss the value of programs like Ohio State University's "community of practice" program, which aims to build a support network for GSIs. Such support networks can provide GSIs with mentorship, resources, and opportunities to collaborate with peers, facilitating their growth as teachers. The demands of teaching compound the already high levels of stress and academic burnout faced by graduate students (Allen et al., 2021). Pedagogical training programs can equip GSIs with strategies for managing their workload and mitigating stress, promoting their overall well-being and academic success. Training university teachers benefits

outcomes for both students and instructors (Gibbs & Coffey, 2004; Rifkin et al., 2023). By improving GSIs' teaching skills, these programs can enhance instruction and learning experiences for undergraduate students.

Several studies emphasize the importance of adopting pedagogical training within an increasingly research-intensive university culture (Laiho et al., 2022; McCune, 2021; Myllykoski-Laine et al., 2023). As these universities prioritize research productivity, there is a risk that teaching responsibilities may be overlooked or undervalued. Institutionalizing pedagogical training programs can help counterbalance this trend and ensure that teaching remains a priority. There is a well-documented connection between pedagogical training and instructor confidence (Fabriz et al., 2021; Ödalen et al., 2019; Weurlander & Stenfors-Hayes, 2008; Yu & Ying, 2024). Yu and Ying (2024) note that instructors who are more confident in their teaching abilities are less likely to experience burnout, consequently creating an environment conducive to student success. By enhancing GSIs' confidence in their teaching abilities, pedagogical training programs can contribute to a more positive and productive learning environment for both instructors and students. Despite the well-documented benefits of pedagogical training for GSIs (Fabriz et al., 2021; Yu & Ying, 2024), many universities struggle to institutionalize such initiatives (Cassuto, 2023; Flaherty, 2019). A research brief from the Center for the Integration of Research, Teaching, and Learning (CIRTL) notes that these programs frequently encounter resistance in research-intensive institutions, where teaching is often undervalued (Hill et al., 2018). Additionally, CIRTL identifies logistical barriers—including funding constraints and the decentralized nature of graduate education—that threaten the long-term sustainability of such initiatives. These challenges highlight a missed opportunity for universities to invest in the professional development of their future faculty, ensuring high standards of teaching excellence while preparing graduate students for academic careers.

Role of Peer Mentorship and Communities of Practice

The value of peer and near-peer mentorship for faculty has been researched at length, especially for women and other underrepresented groups within academia (Chesler et al., 2003; Schwartz, 2023; Thomas et al., 2015; Varkey et al., 2012; Yun et al., 2016). Peer mentorship can provide emotional support, guidance, and a sense of community, which can be particularly beneficial for individuals facing systemic barriers or marginalization. Brownell and Tanner (2012) identified "tensions with professional identity" as one of the barriers preventing science faculty from modifying pedagogical behaviors, along with minimal time and incentives to learn, particularly in research-intensive universities. Peer observation of teaching (PoT) fosters professional conversations that enable GSIs to critically reflect on their teaching practices, rethink pedagogical approaches, and develop confidence in their instructional abilities (O'Keeffe et al., 2021). By nurturing a culture that values and rewards teaching excellence, universities can help mitigate these barriers and encourage faculty to prioritize their professional development as educators.

This study draws upon the theory of communities of practice (CoP) (Wenger, 1998) as a conceptual framework for understanding how the Teaching Triangles (TT) program at Duke fosters a supportive environment for GSIs to develop their pedagogical skills and prepare for academic careers. Communities of practice are groups united by a shared domain of interest, where members engage in joint activities, discussions, and the sharing of resources to deepen their knowledge and expertise (Wenger-Trayner & Wenger-Trayner, 2015). The collaborative nature of communities of practice can facilitate peer learning, knowledge sharing, and the development of a shared repertoire of effective practices.

This interdisciplinary triangle design aligns with the principle of "boundary crossing" (Wenger, 1998), where members interact with and learn from individuals outside their immediate field, gaining diverse

perspectives and expanding their repertoire of teaching approaches. Miranda et al. (2021) highlight that interdisciplinary peer observation enables educators to focus on pedagogical techniques rather than content expertise, facilitating a more objective and constructive critique of teaching practices. Similarly, the TT program, through interdisciplinary pairings, allows GSIs to engage in reflective practice and adopt diverse teaching strategies beyond their primary discipline. Such interdisciplinary interactions can advance the integration of varied methods and pedagogical innovations, enhancing the overall educational experience (Miranda et al., 2021). By exposing GSIs to a range of teaching styles and disciplinary contexts, the interdisciplinary nature of TT can broaden their pedagogical horizons and stimulate creativity in their approach to teaching.

Moreover, the peer observation and feedback process cultivates a sense of mutual engagement and joint enterprise (Wenger, 1998), with GSIs collectively striving to improve their teaching practices. This collaborative learning experience facilitates the development of a shared repertoire of resources, experiences, and effective teaching strategies. Nabours (2023) highlights the importance of such collaborative environments for novice educators to develop confidence and competence, while Smith et al. (2016) found success in reducing isolation among faculty members through communities of practice. By building a sense of community and shared purpose, the TT program can help mitigate the isolation and uncertainty that GSIs may experience as they navigate the challenges of teaching for the first time.

Furthermore, the reflective component of TT aligns with the principle of "reification" (Wenger, 1998), where abstract concepts and experiences are given concrete form to be shared and discussed within the community. By reflecting on their TT experiences, GSIs reify their learning and contribute to the collective knowledge and resources. Vescio et al. (2008) emphasize the importance of structured reflection for professional growth among educators. Reflective practice can promote self-awareness, critical thinking, and continuous improvement,

enabling GSIs to identify areas of strength and opportunities for growth in their teaching.

Through this communities of practice lens, the TT program emerges as a supportive learning environment that facilitates GSI professional development by fostering a sense of community, promoting interdisciplinary collaboration, and encouraging the sharing of knowledge and resources related to effective teaching practices. The program's alignment with key principles of communities of practice, such as mutual engagement, joint enterprise, and boundary crossing, suggests that it can provide a conducive environment for GSIs to develop their pedagogical skills and prepare for future academic careers.

Additionally, the literature highlights the importance of institutional support and a culture that values teaching excellence. By investing in programs like TT, universities can signal their commitment to high-quality instruction and create opportunities for GSIs to develop as educators, ultimately benefiting the broader academic community. The interdisciplinary nature of the program also aligns with broader trends in higher education, where interdisciplinary collaboration and cross-pollination of ideas are increasingly valued (Cavadas & Branco, 2023; Holley, 2015; Ramachandran et al., 2024). By exposing GSIs to diverse perspectives and approaches from different disciplines, the TT program can equip them with the skills and mindset necessary to navigate the interdisciplinary landscape of contemporary academia.

While the existing literature provides valuable insights into the role of GSIs, the importance of pedagogical training, and the potential benefits of communities of practice, there is limited research specifically exploring the effectiveness of interdisciplinary peer observation programs like TT. This study contributes to bridging this gap by conducting an in-depth evaluation of the TT program, drawing upon the experiences and reflections of GSIs who have participated in it over an extended period. By analyzing the strengths, challenges, and outcomes of the TT program, this research aims to provide valuable insights and recommendations for institutions seeking to enhance the

professional development of their graduate student instructors and prepare them for successful academic careers.

Purpose

Our study centers on one major question: *How does the TT program foster pedagogical development and interdisciplinary learning among GSIs?*

By conducting an evaluation of the program's structure and processes, our study identifies strategies to better support graduate students striving for tenure-track faculty positions. Universities around the world can replicate the TT model to train their GSIs to implement proper pedagogical strategies and promote student growth as faculty. We begin by discussing our methodology, then present the findings and recommendations, and conclude with a discussion of the implications of this research.

Methodology

To answer our research question, we conducted a program evaluation, in which we expanded upon a small-scale trial of the TT process conducted by Crumley and James (2009). We analyze 694 reflections from Fall 2011 to Summer 2022. Four questions guided GSI responses for these reflections. These questions originated from a focus group and were modified before the data collection started in 2011.

1) Which was more useful, being observed & getting feedback or being an observer of another instructor? Why?
2) What aspects of your teaching has TT led you to think about?
3) What are you doing/going to do differently now?
4) How would you suggest modifying this system for feedback on teaching?

We began our coding using a deductive framework. The initial code aimed to measure the strength of the findings of the earlier program evaluation on TT (Crumley & James, 2009). They observed four major themes with three sub-themes, detailed below. Rather than coding "Facilitation of Critical Self-Reflection" broadly, we opted to code the three sub-themes separately to gather more specific data. An explanation of each point can be found in italics.

1) Facilitation of Critical Self-Reflection
   a) Interdisciplinarity works [*GSI discusses value of interdisciplinary nature*]
   b) Focus on process, not content [*GSI observes solely pedagogy in classroom, not course content itself*]
   c) Take advantage of being an observer [*GSI describes benefits of their observation process*]
2). Modified Teaching Behaviors & Tangible Outcomes [*GSI sees change in teaching style and its outcomes from before vs. after program*]
3) GSI Recognition of Differences from Modeled Teaching [*GSI notes that they use teaching styles that look different from the norm in their field, i.e., active learning vs. typical lecture style*]
4) Logistical Suggestions for Peer Observation and Feedback [*GSI offers feedback on program improvements*]

As other themes stood out, we later incorporated inductive coding. If an idea arose in roughly 10–20 reflections, we added it to our list of themes. These variables can be found below. Following this inductive coding, we coded each reflection again to ensure we consistently captured all variables.

5) Impact of Observation on Teaching [GSI discusses how being observed impacts their ability to teach, whether through additional nerves or some other way]
6) Role of Discussion in Reflection Process [GSI explains the value of their discussion with other GSIs after observation]

7) Logistical Challenges Limiting Teaching Triangle Accessibility [GSI notes inability to fully complete the program due to pandemic, illness, scheduling conflicts, or another reason]
8) Teaching Triangles' Impact on Confidence [GSI describes confidence boost after completing the program; see below]

The coding framework was informed by Wenger's (1998) CoP framework, particularly in identifying themes related to collaborative learning and reflective practice. The initial deductive coding categories, such as "Facilitation of Critical Self-Reflection" and "Modified Teaching Behaviors & Tangible Outcomes," align with Wenger's concept of mutual engagement and joint enterprise, where GSIs develop shared teaching practices through peer interactions. The inductive themes that emerged, including "Impact of Observation on Teaching" and "Role of Discussion in Reflection Process," reflect the CoP principle of reification, as GSIs translated abstract reflections into actionable teaching improvements. By structuring the coding process around CoP, we were able to analyze how GSIs co-constructed knowledge through the TT program and engaged in disciplinary boundary crossing (Wenger, 1998), reinforcing the interdisciplinary benefits of the program.

Though one researcher was the primary coder throughout the process, a research assistant coded 10% of the reflections in parallel and conducted random spot-checks to ensure inter-rater reliability. We modeled this process after the work of Patton (2015), also adhering to a strict coding approach. For instance, when coding for impact on confidence, we only included instances where 'confidence' was explicitly mentioned to avoid subjective interpretation.

Throughout the TT program, there has been no formal process for collecting demographic information. Consequently, this paper utilized the GSIs' portfolios, online resources, and the text of their reflections to collect demographic information, including field [social sciences, natural sciences, or humanities] and gender [male, female, or non-binary] (see Table 1). Gender data were collected by identifying the preferred pronouns of the GSIs, which were available through their third-person biographies in their

Table 1. GSI Field by Gender, 2011–2022 (n = 687)

	Male	Female	n
STEM	140	266	406
Humanities	61	109	170
Social Sci.	44	67	111
n	245	442	687

Note. Five students do not specify their field of study within their reflection

portfolios and online resources (e.g., articles about their research, conference biographies, etc.). To protect their anonymity, the two non-binary GSIs were not included in the quantitative analysis. For more information about gender demographics, please see the limitations section.

Additionally, some students noted in their reflections that they are not native English speakers. To capture these perspectives, we include takeaways from these students in the findings. However, since not all students mention their native language, we do not conduct a quantitative analysis of these data.

Findings

Finding 1: Noted confidence growth attributed to TT

In this study, the reflections reveal evidence of heightened confidence because of participation in the TT program. Although the reflection questions do not specifically probe confidence growth, GSIs bring up the topic independently. While many GSIs alluded to their development as educators through TT, we coded data only from those explicitly expressing that they had used the word "confident" or "confidence."

Female GSIs more frequently noted confidence growth compared to their male counterparts. This aligns with broader trends in pedagogical development, where female educators often emphasize self-reflection and instructional growth more frequently in peer-reviewed teaching programs. Table 2 presents the percentage of GSIs who reported increased confidence by gender.

Table 2. Percentage of GSIs Observing Confidence Growth by Gender

	Total
Male	11.84%
Female	18.55%
Total	16.14%

GSIs across disciplines noted an increase in self-efficacy, which in turn led to greater enthusiasm for teaching. This finding is particularly notable since graduate students are often required to teach or assist in a classroom setting to secure funding for their PhD program. Additionally, some GSIs attributed their confidence growth to peer validation received during TT, reinforcing the value of structured observation and collaborative feedback in developing effective teaching practices. The reflections indicate that many GSIs valued the validation of their teaching performance, particularly when receiving constructive feedback from peers in other disciplines. An area for further exploration might be the initial confidence levels of GSIs upon entering graduate school.

Additionally, some students voluntarily mentioned in their reflections that they were non-native English speakers and expressed concerns about their ability to communicate effectively in the classroom. While these perspectives were not analyzed quantitatively, their qualitative insights provide valuable context for understanding how TT contributed to their pedagogical development.

One non-native English-speaking GSI reflected on how the TT process alleviated concerns about their communication skills:

Although this was not my first teaching experience, it was the first time I was teaching in English. I was concerned about struggling to communicate with my peers due to my accent as well as some communication characteristic that I carry to when I speak English from my Spanish. I was concerned that the speed in which I spoke would be too fast and combined with my accent would prove challenging for the student to follow what I was saying. Since this was an area of concern, I ask[ed] my Teaching Triangle Peers to evaluate my verbal and

non-verbal presentation style. Based on the comment provided by my peers, these concerns were unfounded. The feedback that they provided indicated that I was capable of enunciating properly as well as I had a proper pace during my teaching. They also noted that my body language was appropriate, and it complemented the discussion of the journal article assigned for that particular session. Both commented on the welcoming and engaging atmosphere generated in the classroom that allow me to interact with the students and facilitate their discussion of the article. Through this experience I was able to gain more confidence in my skill as a teacher and soften my self-criticism.

While a portion of participants reported confidence growth, the rates seem lower than suggested by the general tone of the reflections. Future reflections could incorporate questions such as "I feel more confident because of Teaching Triangles" with a corresponding four-point Likert scale to provide a more precise estimation.

Finding 2: Value of interdisciplinarity

Interdisciplinarity, a fundamental principle of TT, was demonstrated through the program's considerable success in engaging with GSIs from various departments, including English, engineering, dance, and public policy, among others. GSIs reported that interdisciplinary observation broadened their perspective on teaching a range of topics. Specifically, 45.6% of humanities GSIs stated that they benefited from the program's interdisciplinarity, in comparison to 31.5% of social sciences GSIs and 32.7% of STEM GSIs. This holds true even for several humanities GSIs who were teaching courses on fine arts and other subjects not traditionally based in a classroom setting, as GSIs were able to identify commonalities between their own courses and those of their partners. According to one female GSI in STEM:

I was pleasantly surprised by the parallels in teaching among different fields. In particular, one of the instructors I observed teaches a

ballet dance class, while I taught a biomedical engineering electronics lab. We had a very interesting discussion about the parallels of top-down teaching approaches vs more organic, 'create knowledge' types of instruction. Both fields have traditionally been associated with an instructor at the front of the room lecturing to students about the correct methods within the field, but are increasingly moving towards student-led learning—for ballet, more interactive classes & student-led chorography *[sic]*, for engineering, problem-solving-based assignments & labs.

This GSI was not the only one to identify parallels between fine arts and STEM fields. A PhD student in genetics found a similar connection. The GSI in STEM continued:

However, I felt that being an observer was the highlight of the Teaching Triangle experience. Both of my observations were in completely different fields; I teach an undergraduate genetics class, and both of my partners teach fine arts classes, specifically a film class and a dance class. Both of these classes are incredibly immersive, with students creating or performing the entire class. This contrasts starkly with most science classes, which usually involve a lot of lectures. Seeing how my partners used these immersive activities as a teaching tool, how they interacted with the students during these activities, and how the students reacted to the activities inspired me to include more activities into my teaching.

The non-judgmental observation also eased the nerves of some GSIs, many of whom say they otherwise dread observation. The TT program is designed to minimize observer influence on regular classroom dynamics by selecting observers who are unfamiliar with the course content. This approach ensures that observations do not disrupt student engagement or alter instructional delivery. One GSI teaching a foreign language course commented on her students' reaction to the observers:

Neither of my guest observers speak the language, which permitted them to ignore content, and focus exclusively on course dynamics, organization, and other structural elements that French speakers might sweep aside because of the temptation to get caught up in the dialogue. While I always tell my students that any observers are there to evaluate me, not them, and that the context is constructive and friendly, I think it was even more reassuring to them to know that the observers couldn't possibly, even subconsciously, judge the quality of their ideas or language skills. This aspect helped to preserve the normal classroom environment as best as possible, even in the presence of a guest. I personally felt more relaxed, as well, since I wasn't preoccupied with the possibility that I might use the wrong word or make some other silly, though minor mistake, as a fluent but non-native speaker.

The GSIs commended the TT program for creating an environment where observers focus exclusively on the instructor's pedagogical methods rather than the subject matter, thereby corroborating the findings of Crumley and James (2009). As peer observers, GSIs assume the role of a student and gain firsthand exposure to different teaching techniques that they can add to their own toolkit. Several GSIs highlighted that their experience with TT marked the first time they were able to sit in a class without the pressure of understanding the content. As one STEM GSI succinctly put it, "If the instructor loses or confuses the untrained observer, they are probably also losing students in the class." Table 3 quantifies the benefits reported by GSIs who observed their peers.

Conversely, some GSIs struggled to appreciate the value of interdisciplinary observation due to the divergence in teaching methods across disciplines. These GSIs suggested a modification to the triangle structure to include one participant from a contrasting discipline and

Table 3. Percentage of GSIs Who Saw Value in Observing Another Course

	STEM	Humanities	Social Sciences
Total	69.78%	67.2%	77.48%

another from a related one. This would still capture the advantages of interdisciplinarity while also providing more nuanced feedback. These GSIs acknowledged that while the random assignment of students is more straightforward, "matching instructors based on, for example, subfields, class category/format, and course level (graduate versus undergraduate) would yield more actionable feedback." For instance, a GSI of a lab-based course may be better positioned to directly apply knowledge gained from observing another lab-based course in a similar field rather than a large lecture or seminar. Concerned about not providing or receiving specific feedback on material, some GSIs plan to rely solely on *intradisciplinary* evaluations in the future. Despite being in the minority, these views advocating for decreased interdisciplinarity are worth considering.

Finding 3: Peer evaluation—a level playing field

Peer evaluation, a crucial component of TT, emerged as the most successful aspect of the program. GSIs overwhelmingly favored peer observation of their teaching over faculty observation. Only 6.7% of GSIs (8.17% of men, 6.11% of women) reported that observation interfered with their ability to teach effectively, often attributing this to nerves or distracted students in a small course. An 'extra set of eyes in the classroom' could benefit GSIs more than overly critical evaluations of their teaching style. Graduate students, often subjected to constant critique in research, coursework, and job applications, may find peer observation a less stressful addition to this cycle of evaluation. One GSI female in humanities said:

> Since deciding to pursue the Certificate in College Teaching, the Teaching Triangles portion of the certificate always felt extremely daunting. I became preoccupied by the anxiety it generated, thinking of the observation portions like a performance review, but in practice, it wasn't nearly as stressful or intimidating as I thought it would be. In fact, it was extremely beneficial. [My partners] were all peers,

not bosses or potential employers evaluating my performance, and as such, the feedback they provided came from an understanding place — and, because of that understanding, I feel their feedback was even more pointed, perceptive, relevant, and helpful.

Observation by fellow graduate students enabled GSIs to experiment with new teaching strategies and take risks they might otherwise avoid. A handful of GSIs reported that the pedagogical techniques they developed during TT improved student learning but contradicted departmental teaching norms. Unfettered by fear of lasting judgment from faculty within their own department, GSIs felt free to implement their recently acquired strategies without fear of backlash. A female GSI in STEM reported:

At the beginning of the semester, I felt like this was something similar to the 'blind leading the blind,' which I still think is partly true, but I found myself finding areas where just an extra set of eyes in the classroom could help point out things to my fellow graduate students. And I think my partners were able to do the same for me. There are things I know I am not the best at, specifically not giving students enough time to give me an answer before I simply tell them the answer, and not only were those picked up on by my observers, but we were able to talk through those with different ideas for helping with that. I really liked the additional time to talk face-to-face with the others. It allowed us to talk through some things we saw in the classroom, and I think that this part of the feedback process should be highly stressed as important for the coming semesters!

GSIs also reported the additional benefit of establishing professional connections within their triangle. Many GSIs found the follow-up discussions to be formative in both understanding their enthusiasm for pedagogy and building relationships with peers. Encouraging discussion among peers allows GSIs to share ideas and expand their teaching repertoire.

Table 4. Percentage of Students Who Modified Behaviors with Tangible Benefits

	STEM	Humanities	Social Sciences	Total	n
Male	29.29%	49.18%	38.64%	35.92%	111
Female	28.57%	31.19%	34.33%	30.09%	165
Total	28.75%	37.65%	36.04%	32.17%	276
n	139	89	48	276	

After observing courses and implementing peer feedback, GSIs across all disciplines reported enhanced teaching performance (see Table 4).

Male GSIs in the humanities reported growth most frequently, at 49.18%. Although there is no definitive reason for this rate, it might be attributed to some MFA students who acknowledged that their involvement in TT marked their first teaching semester. While GSIs in STEM trailed their counterparts in humanities and social sciences, nearly 30% of both men and women in STEM observed tangible benefits, including increased student participation, improved quality of work, and enhanced student evaluations. It should be noted that several GSIs reported not having the time to modify their behavior due to late evaluations. Most of these GSIs, however, identified actionable steps for implementation in their next teaching experience. One male GSI in humanities said:

> Inspired by the classes I observed, I also began to incorporate more groupwork activities, where I would split students into breakout rooms and provide each group with a shared Google Doc of a passage that they could edit collectively. Similarly, instead of always discussing material as a class, occasionally I would split the class into groups and ask them to consider a specific part of the reading material. When these groups came back together as a class to discuss their findings, they were able to explain to one another the dimension of the reading that it was their job to focus on specifically. This meant we were able to cover a lot more ground in less time and the students got a better grasp of the concepts because they learnt how to figure it out for themselves (which became evident in the weekly writing assignments).

Recommendations

Recommendation 1: Modify discussion suggestions to adopt tighter timeframe and expand social component

Given the timeframe of the program, it would be beneficial for CCT faculty to encourage discussions immediately following observations. Many GSIs indicated that they forgot key details from the observed class when meetings were held at the semester's end instead of shortly after the observation. GSIs take notes during observation, but immediate feedback would likely provide higher quality insights. Additionally, GSIs valued group meetings over one-on-one sessions, with those in groups reporting fruitful discussions and collectively brainstorming strategies to overcome common challenges, such as the misuse of technology as a distraction. Collaboration is essential for progress, and group meetings, time permitting, can facilitate this.

Some GSIs also desired an informal setting for discussing their teaching experiences outside of structured meetings. Having an initial mass meeting makes sense in terms of time management, but a final meeting could help GSIs use the CCT as a platform for community-building and cross-disciplinary networking; GSIs noted that a very small proportion of people in the world are able to speak passionately about the challenges of teaching and how to tackle them for over an hour, and the true value of this program is bringing GSIs together to talk.

The creation of an informal space for discussing teaching and the possibility of extending the TT process beyond a GSI's semester in CCT could further enhance the program's community-building aspect. A network of graduate students from different disciplines interested in discussing effective teaching methods could benefit all participants.

Recommendation 2: Develop a framework for continued evaluation

GSIs expressed interest in continuing the TT-style peer observation system after the semester's end. A form that allows former TT participants

to schedule more observations with other interested GSIs is a feasible solution. A shared sign-up form would not require additional work from CCT faculty and would allow students to sign up at their convenience. This could be a GSI-led program that provides a support network for those interested in honing their teaching skills after completing their semester in TT.

In doing so, GSIs could receive follow-up feedback on their modified practices to ensure their effectiveness. A long-term structure could create a "legacy" for CCT, with more experienced PhD students, following their time in TT, mentoring less experienced GSIs.

Recommendation 3: Ensure GSIs convey preferred observation priorities before teaching

GSIs seek various types of feedback when observed, including clarity, student engagement, speed, and more. If a GSI aims to evaluate their effectiveness in engaging students, it can be valuable to write down the areas they hope their observers will focus on. The current TT sheet does not provide a specific space for requesting focused observation. Some GSIs reported receiving feedback on areas they already knew were weak because they did not provide specific focus areas for observers. This slight change could allow GSIs to receive more nuanced and tailored feedback rather than an observer's attention being spread thin over several areas.

Discussion

As universities increasingly rely on GSIs to teach courses and the hiring of PhD students slows, it is critical that graduate schools prepare their students for future faculty roles. TT succeeded in supporting GSIs in this preparation, fostering confidence and professional relationships among peers. The core components of TT—interdisciplinarity and peer review—functioned as intended. Among 694 reflections, GSIs

lauded the program for effectively leveraging interdisciplinarity and peer evaluation. Criticisms were sparse and mainly concerned minor logistical adjustments, such as simplifying the process with a single submission form, automating the triangles based on schedules, and recording observed lectures.

This study contributes to the literature on graduate student preparation, demonstrating that interdisciplinary peer evaluation effectively supports GSIs intending to assume faculty roles post-graduation. TT has shown its success in preparing GSIs for interdisciplinary teaching, with potential for wide positive impact on GSIs and higher education in general. It is an inexpensive, logistically manageable program that can be easily replicated, and it boosts the confidence of many graduate students across all disciplines, particularly those from underrepresented backgrounds in academia.

However, this study was not without limitations. The guiding questions used for the reflections may have influenced responses. A reflection form with a four-point Likert scale would produce more comprehensive and standardized results, facilitating easier progress evaluation. The COVID-19 pandemic limited some GSIs' ability to participate meaningfully in the TT process, affecting data from Fall 2020 and Spring 2021.

Furthermore, collecting demographic information was one of the more complex challenges in this study. In retrospect, distributing a survey would have provided a more systematic and accurate approach to gathering gender identity data. Since gender data were collected from publicly available sources, we acknowledge that they may not fully reflect GSIs' self-identified gender identities. However, given the extensive literature on gender-based challenges in faculty roles (e.g., Aragón et al., 2023; Galvin et al., 2024; Misra et al., 2021), we aimed to analyze the TT program's impact on GSIs while recognizing these limitations. Our findings align with prior research suggesting that structured pedagogical training can help mitigate some of these disparities by fostering confidence and peer support among GSIs.

Additionally, the small sample size of non-binary students limits the extent to which these findings can be generalized to gender-diverse GSIs. Women are overrepresented in the Certificate in College Teaching program, comprising 63.69% of participants compared to 48.97% in Duke's Graduate School. Moving forward, intentional recruitment strategies could support a more gender-diverse representation of GSIs in pedagogical development programs, ensuring inclusivity across various gender identities and academic disciplines.

Implications and Future Research

The TT program at Duke's Graduate School has proven to be a valuable instrument in preparing graduate students for successful careers as faculty members. By harnessing the transformative potential of TT, we can elevate the quality of teaching across higher education. This model not only benefits graduate students but also their students and the institutions they serve by equipping future faculty with a diverse range of pedagogical strategies. These strategies, designed to engage learners and promote academic excellence, are shared in a supportive and collaborative environment. Due to its minimal cost and student-driven nature, TT is a program that graduate schools can integrate into their curriculum or into a voluntary program, such as the Certificate in College Teaching, without imposing a major burden.

The findings highlight how the CoP framework structures graduate student pedagogical training. GSIs' participation in TT reflected key CoP principles—mutual engagement, joint enterprise, and shared repertoire (Wenger, 1998)—as they built trust, engaged in meaningful peer discussions, and adopted new pedagogical strategies across disciplines. The interdisciplinarity of TT enabled GSIs to engage in 'boundary crossing' (Wenger, 1998), broadening their teaching perspectives and fostering innovative approaches. Moreover, the continued informal discussions among GSIs following the structured TT process suggest that peer mentorship programs can cultivate

sustained professional learning communities. Given these findings, institutions seeking to enhance GSI pedagogical development should consider embedding CoP-informed peer observation initiatives into faculty preparation programs.

Future research should assess the effectiveness of graduate student preparation programs at other R1 doctoral institutions. Investigating whether other peer evaluation programs could enhance effectiveness would be a valuable avenue to explore. Additionally, studying institutions that predominantly support graduate students across diverse backgrounds could provide insights into the impact of a peer observation program on GSIs with a larger sample size than this study. A longitudinal study tracking CCT graduates could offer further insights into the long-term benefits of the TT program, particularly regarding their pedagogical development and career trajectories in academia. Understanding how GSIs continue to apply peer observation and interdisciplinary collaboration beyond their graduate education would provide a more comprehensive evaluation of TT's sustained impact.

Conclusion

The TT program at Duke University has demonstrated its effectiveness as a structured, interdisciplinary peer observation program that supports GSIs in developing their teaching skills. By fostering pedagogical self-reflection, interdisciplinary collaboration, and confidence growth, TT equips GSIs with essential competencies for future faculty roles. The findings demonstrate the value of peer-driven learning communities and highlight the role of communities of practice in shaping graduate student pedagogical development.

As higher education continues to rely on GSIs to fulfill instructional responsibilities, institutions must invest in programs like TT that provide structured opportunities for professional growth. The interdisciplinary nature of TT encourages boundary crossing, exposing GSIs to diverse teaching strategies that enhance their adaptability as educators.

Moreover, the emphasis on peer mentorship within TT creates a supportive environment where GSIs can engage in meaningful discussions about teaching, experiment with new pedagogical approaches, and receive constructive feedback in a low-stakes setting.

By embedding CoP-informed pedagogical development programs into graduate education, universities can better prepare future faculty members while fostering a culture that values teaching excellence. The TT model offers a replicable, cost-effective approach to supporting GSIs that can be adapted across institutions, ensuring that graduate students receive the necessary pedagogical training to thrive in academic careers.

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Conflict of Interest Statement

The authors have no conflict of interest.

Data Availability

The data reported in this manuscript are available on request by contacting the corresponding author.

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