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Enhancing STEM Graduate Student Teaching: The Cultivation of Teaching Skills and Identity among Graduate Students

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Abstract

This study investigates the development of Graduate Teaching Assistants' (GTAs') teaching identity through professional development (PD) activities and hands-on teaching experiences. While previous research has predominantly focused on how PD programs enhance teaching practices [1], less attention has been paid to their impact on the formation of a cohesive teaching identity.

Understanding the evolution of GTAs' teaching identities is crucial for creating PD programs that can support them and enhance their teaching effectiveness. This research addresses these issues by exploring how structured PD programs, such as pre-semester workshops, and classroom experience shape GTAs' sense of identity in classroom instruction and student engagement.

Data were collected through seven focus groups involving 33 GTAs, conducted immediately following a two-day pre-semester workshop held in August 2023. To gain further insights, we conducted one-on-one semi-structured interviews with 20 GTAs throughout the academic year, followed by a follow-up interview in the summer 2024, with 10 participants. The interviews addressed the techniques GTAs use in the classroom, their perceptions of their instructional role, and how these experiences shape their teaching identity over time. Using open and axial coding methods, the analysis identified key themes related to the development of teaching identity, and the difficulties GTAs encounter as they grow into their instructional roles.

Our findings show a notable evolution in GTAs' teaching perspectives over time. Initially, they approached their roles with limited views of their responsibilities. However, with experience and PD, their self-perceptions shifted. They began to develop a deeper, more holistic understanding of teaching and build their pedagogical practices on learning from professional development, experiences as students, individual skills, and experience in the classroom. These changes reflect the broader development of their teaching identity, emphasizing the importance of tailored PD programs that not only equip GTAs with effective teaching strategies but also help them use their skills and prior experience to integrate research-based pedagogies into their teaching. By understanding how GTA identities evolve, this study contributes to the creation of more effective PD programs that support GTAs as they transition into skilled educators.

Introduction

Graduate Teaching Assistants (GTAs) play a pivotal role in undergraduate STEM education, serving as instructors in laboratories and recitation sections of large introductory courses. GTAs not only deliver instructional content but also support student engagement and foster active learning strategies that are vital for effective education. Structured professional development (PD) programs, such as pre-semester workshops, are often implemented to help GTAs navigate their teaching responsibilities, improve their instructional practices, and learn about research-based pedagogies. Prior teaching experience, PD, and time in the classroom all contribute to the

development of these instructional practices which in turn influence the development of GTAs' teaching identity.

This research seeks to examine the dynamic process of teaching identity formation, using Carlone and Johnson's framework [2] as a guiding model. This framework describes identity through the dimensions of competence, performance, and recognition to explore how GTAs grow in their self-concept as educators. Carlone and Johnson [2] also note that external factors including racial, ethnic, and gender identities shape all aspects of identity formation. For the GTAs, language, background culture, and the cultural and institutional contexts in which they are teaching can have an impact on identity formation. Recent work by Magar et al. [3] highlighted the challenges international GTAs (IGTAs) face in communicating with their students outside of their native language and how that translates and their concern about their ability to perform the jobs as instructors because of the language barrier.

Formal PD programs have been shown to significantly influence the adoption of research-based practices in the classroom by GTAs, faculty, and high school teachers [1,4,5,6] and can reinforce teaching identity by fostering a sense of community and belonging [7]. Teacher professional development is also important for building instructor's confidence in their ability to teach effectively and positively influence student learning, which are important for the development of teaching identity. For GTAs, PD has been shown to improve teaching skills, but less work has been done on understanding how PD, experience, and background knowledge come together in developing teaching strategies and identity and how those evolve over time.

This study investigates the formation and evolution of GTAs' teaching identity. Specifically, the research addresses the following questions:

1. How do various factors, including structured PD programs and teaching experiences, influence the development of GTAs' teaching competence, performance, and recognition?
2. How do GTAs' teaching identities evolve over time?

Literature Review

Teaching identity for GTAs refers to their self-concept as teachers and their understanding of their role as educators. Teaching identity is built on GTA's beliefs about effective teaching, their responsibilities in supporting student learning, and their confidence in their instructional abilities. For GTAs, teaching identity evolves through experiences such as classroom interactions, mentorship from faculty, and PD experiences.

PD programs aiming to improve instructional practices are common for K-12 teachers, university faculty, and GTAs. Overall, these programs are found to improve instructional practice. Goldberg et al. [4] examined the impact of PD programs for STEM graduate students and postdoctoral fellows that combined massive open online courses (MOOCs) with structured face-to-face learning communities. They found that these programs enhanced participants' adoption of evidence-based instructional practices and contributed to the development of their teaching identity. Cho et al. [1] explored how structured support programs improve GTAs' instructional practices by addressing their teaching concerns and helping them refine classroom management, time management, and communication skills while developing strategies for balancing their roles as both students and

teachers. Gardner et al. [5] investigated the effects of STEM PD on teachers' knowledge, self-efficacy, and classroom practices and found that participants implemented more productive teaching strategies, although significant gains in content knowledge were not observed.

While the implementation of research-based pedagogies in the classroom (performance) is an important aspect of teaching identity, how instructors see themselves in that role is more complex, with their understanding of pedagogical practices (competence) and how they are viewed by others (recognition) also playing important roles. Francis [6] explored the impact of pedagogy courses focused on evidence-based instructional practices on STEM GTAs' teaching identities. The study concluded that such courses are valuable in helping GTAs reflect on their roles as educators and integrate teaching into their professional identities. Weinberg et al. [7] found that participation in collaborative PD activities helped STEM teacher educators, those responsible for preparing and supporting preservice and in-service teachers, develop a sense of belonging and reinforced their identity as teachers. Kajfez and Matusovich [8] explored teaching identities among GTAs in large first-year engineering programs, categorizing them into three profiles: strong, transitional, and weak. These profiles were based on the GTAs' self-perceptions, which were measured using a Likert scale. Their findings revealed a connection between the GTAs' self-perceptions of their teaching identities and their career aspirations. Specifically, those with strong teaching identities were more likely to aspire to teaching-focused careers, while those with weak or transitional identities often leaned toward non-teaching career paths. Together, these studies demonstrate that formal PD programs, whether focused on individual reflection, flexible learning formats, or collaborative engagement, can play an important role in influencing the development of teaching identity.

Teaching self-efficacy refers to an instructor's confidence in their ability to teach effectively and positively influences student learning. Teaching self-efficacy reinforces and strengthens teaching identity, as increased confidence in instructional abilities enables GTAs to take ownership of their roles as educators [9, 10]. DeChenne et al. [9] developed and validated the STEM GTA Teaching Self-Efficacy Scale (STEM GTA-TSES), a tool specifically designed to measure teaching self-efficacy among STEM GTAs. Their research indicates that self-efficacy, as measured by the STEM GTA-TSES, is strongly correlated with the quality and extent of PD programs and teaching experiences, underscoring the critical role of high-quality PD programs. Zhou et al. [10] conducted a meta-analysis examining the effectiveness of PD training for in-service K-12 STEM teachers' self-efficacy. The analysis included data from 21 articles and 1,412 teachers. The findings demonstrated a significant positive effect of PD on teachers' self-efficacy, indicating that PD programs substantially enhance STEM teachers' confidence in their instructional abilities.

Conceptual Framework

The Carlone and Johnson model [2] provides a framework for understanding identity development by emphasizing the three interrelated constructs of competence, performance, and recognition. We adapt the model to conceptualize how GTAs develop their teaching identities based on the same key constructs. Our model, adapted from Carlone and Johnson, is shown in Figure 1.

Performance in this model is the "doing" part of teaching and involves the delivery of lessons, managing classroom dynamics, the use of tools in instruction, and the execution of innovative

teaching approaches in the classroom. Because communication with students is a key piece of the performance aspect of this model, the ability (or lack thereof) to communicate in the language of instruction feeds directly into performance for IGTAs.

Competence refers to the understanding of pedagogical strategies. Content knowledge for the class(es) being taught can also be an important component of competence but it is not one we investigated. All the GTAs in this study were teaching introductory-level physics, math, and CS so we assumed that they had sufficient knowledge and understanding of the subject content.

Recognition in this model is the acknowledgment of a GTA's teaching efforts by students, faculty, or peers. This recognition by others can significantly impact GTAs' confidence and motivation. Positive feedback and validation reinforce GTA identity as effective educators, while well-delivered constructive criticism promotes growth by encouraging reflection and refinement of teaching methods [11]. As Carless [12] highlights, clear and constructive communication is crucial to ensuring that feedback and recognition are perceived as meaningful and actionable. This approach not only validates educators' contributions but also strengthens their confidence and effectiveness in their roles, further supporting their professional growth.

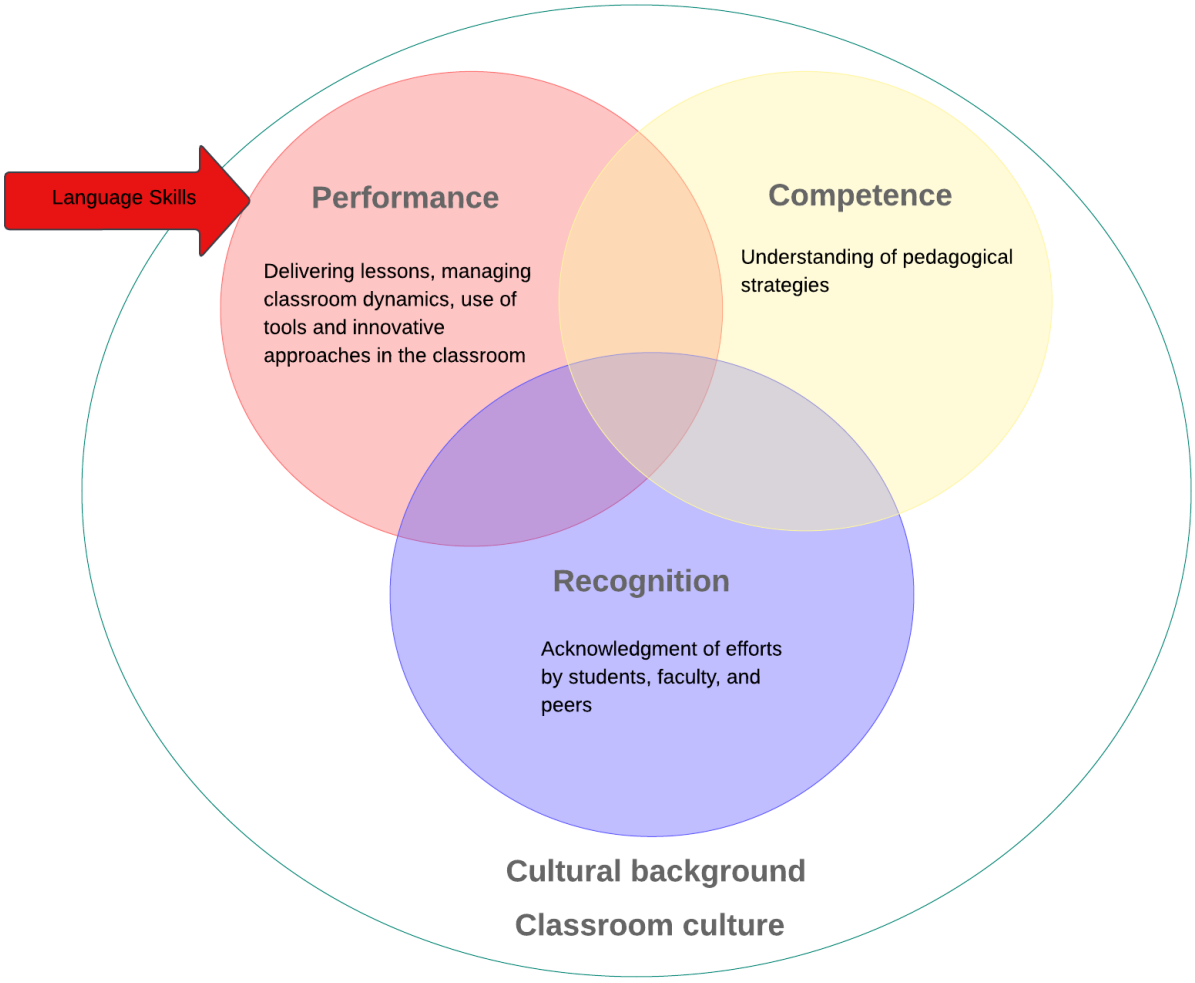

Figure 1: Adapted from the Carlone and Johnson Model [2], this framework incorporates the influence of GTA background culture and classroom culture on all aspects of GTA teaching identity. It highlights the interplay between competence, performance, and recognition and expresses how classroom culture and language skills impact all three constructs for IGTAs.

The framework presented in Figure 1, adapted from the Carlone and Johnson Model [2], illustrates how GTA teaching identity is shaped by the interplay between competence, performance, and recognition, with an added focus on the influence of GTA background culture and classroom culture. Language skills are a critical factor, particularly for IGTAs, as they directly affect the performance aspect. Hazari et al. [13] examined the role of self-efficacy within the context of physics identity, positioning it at the intersection of competence and performance. In this model, self-efficacy translates into the confidence to perform well in teaching roles (performance). For IGTAs, the intersection of self-efficacy and performance is particularly influenced by language skills, as difficulties in communication can undermine confidence and hinder effective teaching practices. By addressing these factors, the model highlights the importance of both cultural and individual factors in shaping teaching identity.

Methodology

Data Collection

This study is part of the Gateway2STEM project, an effort aimed at making active and collaborative learning the default method of instruction in large introductory courses in Physics, Mathematics, and CS at a public R1 university in the mid-Atlantic region of the United States. As part of the project, graduate students serving as first time GTAs in these three departments attended a two-day workshop before the start of the Fall 2023 semester. The goal of the workshop was to provide preparation before the GTAs, most of whom had no formal teaching experience, entered the classroom for the first time. The workshop included 6 GTAs from Physics, 10 from Mathematics, and 44 from CS. Most of the participants were first-year graduate students at the university. At the end of the workshop, we conducted seven focus groups, each consisting of 4–5 GTAs, for a total of 33 participants. Additionally, we carried out hour-long follow-up interviews with 20 GTAs and conducted a second round of follow-up interviews with 10 GTAs. The first round of interviews took place at the end of the participants' first semester, and the second follow-up interview was conducted near the end of their second semester. These interviews focused specifically on GTAs who were teaching labs and recitations, excluding those whose primary responsibilities were limited to grading or holding office hours without direct classroom interaction. The semi-structured interviews, conducted approximately one semester apart, adhered to protocols approved by the university's Institutional Review Board (IRB). To value participants' time and encourage their involvement, we provided $40 Amazon gift cards as incentives for completing each of the interviews. These interviews explored various facets of the GTAs' experiences, such as the teaching techniques they employed in the classroom, their perceptions of their roles as instructors, how their teaching practices reflected their personal experiences as students, and their participation in PD activities related to teaching. The full interview protocol is provided in the Appendix. Appendix A includes the interview protocol for the focus group, while Appendix B and Appendix C provides the protocol for the first round and second round of follow-up interviews.

In this paper we use data from focus groups and the interviews with the 10 GTAs who participated in both rounds of interviews. Pseudonyms are used to represent the selected participants. These participants represent all three departments involved in the project. Among the participants, six were IGTAs from various parts of Asia, while four were local Domestic GTAs (DGTAs). This mix provides a diverse set of perspectives, allowing for a nuanced understanding of the experiences of both IGTAs and DGTAs. Additionally, the group consists of seven male and three female participants.

Pseudonym	Department	Status	Gender	Previous Teaching Experience	Year in PhD program
Yan	CS	IGTA	Male	TA during Master's program in the US	First
Caiyu	CS	IGTA	Male	TA during Master's program in the US	First
Mokbul	CS	IGTA	Male	Private tutor (informal teaching experience)	First
Purny	CS	IGTA	Female	TA during part of PhD program	Third or beyond
Ajay	Math	IGTA	Male	Taught during Master's program in home country	First
Jack	Math	DGTA	Male	TA during part of PhD program	Third or beyond
Patricia	Physics	DGTA	Female	No teaching experience	First
Ray	Physics	DGTA	Male	No teaching experience	First
Julia	Physics	DGTA	Female	Skating coach, student tutor in high school, and private tutor during college	Second
Arman	Physics	IGTA	Male	Part time instructor in home country	First

Data Analysis

We systematically analyzed the transcripts using open and axial coding methods, following the guidelines for qualitative inquiry outlined by Saldaña [14]. The coding process involved developing codes based on existing literature. Specifically, we created codes grounded in the theoretical framework provided by the Carlone and Johnson Model [2], focusing on key concepts such as performance, competence, and recognition. Two or three individuals independently coded

the data using Dedoose software. To ensure consistency, we reconciled differences in the coding through collaborative discussions and reached consensus on their application. Based on the finalized codes, we identified preliminary themes, which are detailed in the findings section.

Results

This study explores the development of GTAs' teaching identities and how it is influenced by their teaching experiences, PD, and personal backgrounds. The findings are examined with respect to the three core dimensions drawn from the Carlone and Johnson [2] framework - performance, competence, and recognition. While race, ethnic, and gender identity are included as important inputs to all aspects of identity development in the Carlone and Johnson model, we do not have the data to probe these influences and do not discuss them here. We do examine briefly how the cultural background and differences in classroom culture factor into identity development for IGTAs. We leave a deeper exploration of these cultural dimensions for later work.

Performance

We find that GTAs adapt, innovate, and use their existing knowledge and personal strengths to engage with students in the classroom. In their interviews, GTAs described performance in the classroom as not simply delivering content. They described strategically using technology and employing creative practices like playing music or using simulations. For instance, Yan emphasized the importance of technology in enhancing instruction:

> "I must draw something on my desktop and show it on the screen. Sometimes it is important to show them some videos about how the program runs. That will be better."

Julia, on the other hand, shared her approach to creating a lively and engaging classroom environment by incorporating music and stickers as rewards. Drawing from her extensive experience as a figure skating coach, a role she began at thirteen and continued throughout college, Julia developed teaching strategies that reflected her background. She used to play music while coaching, a technique she brought into the classroom:

> "I just like to play music in the background. Just quietly, because a silent classroom is boring. And then I also like to give out stickers at the end of the lab. It's fun seeing students build their sticker collections over the semester."

While many GTAs built their classroom practices on their knowledge and experiences, nearly all IGTAs mentioned the need to adapt to different classroom atmospheres than the ones that they had experiences in their home countries. Ajay explained that his teaching style was influenced by the formal classroom environment he experienced during his undergraduate and master's programs, which sometimes made it difficult for him to foster an open, student-centered classroom as he began teaching in the U.S.:

> "In my undergraduate and master's programs, our classroom environment was very formal. That is, we would just speak on the professional part that we are interested in, and we won't engage in any kind of personal conversation."

Language was a common barrier to the delivery of lessons in the classroom for most of the IGTAs. Despite such difficulties, they leveraged their domain-specific expertise and technical vocabulary to compensate for these obstacles, enabling them to communicate essential concepts clearly and ensure students' understanding. Caiyu, an IGTA from the CS department, shared:

> "I feel like still some language problem I mean, for some words, I still cannot explain to students very well because like, English is still not my primary language. Sometimes I may, because I can only use very limited words. But I mean, for CS, I know a lot of words in that field."

In follow-up interviews, several GTAs highlighted that group work was a key strategy they learned during the PD workshop and frequently applied in their labs and recitations. They also described actively engaging with students by walking around and interacting during class. Arman shared his perspective on active learning:

> "When I learned about active learning, I thought it was the best approach. In my classes, I start with a brief introduction and then move around to engage with every group."

We find that with experience, GTAs integrate advanced tools and refine their practices. During follow-up interviews, Ajay described his shift from traditional methods to utilizing modern instructional tools, saying:

> "When I started teaching, I mostly used the whiteboard. This semester, I switched to the doc cam, which had a big impact because students, especially those at the back, could see what I was writing more clearly. It made them more comfortable."

Collectively, GTAs' reflections illustrated their ability to adapt and innovate, group work as strategy learned during PD workshop that they have successfully used in their teaching, addressing obstacles like language barriers and differing classroom atmospheres while fostering growth in both technical proficiency and interpersonal teaching skills.

Competence

Competence, as shown in Figure 1, refers to the understanding of pedagogical strategies. Our data show a clear progression of growth among GTAs. Initially, their understanding of teaching methods and active learning strategies was limited. However, through experience and insights gained from our pre-semester GTA workshop, they developed a deeper understanding of these pedagogical techniques and their value.

Most of our focus group participants commented that they had little to no prior experience with active learning. However, a few exceptions included those IGTAs who had earned master's degrees in the U.S. and some DGTAs who were familiar with using active learning techniques such as group work and iClickers. One GTA from the focus group reflected on their lack of knowledge (competence) and how they needed to build it before being able to use it (perform) in the classroom:

> "I think I need to do some research on active learning before using it in my class because I don't have much knowledge about it. I plan to learn more and then apply it."

In the follow-up interviews, group work emerged as one of the most employed active learning strategies by GTAs, reflecting their efforts to foster collaboration and enhance student engagement. Arman highlighted his understanding of active learning pedagogies and why they are useful:

> "Active learning is engaging each other and learning from each other, that's why I use group work. Make them understand that's how you learn from each other."

During the second follow-up interview, Patricia emphasized the importance of the PD workshop held before the semester in helping GTAs build foundational knowledge and skills in active learning. She highlighted how the workshop played a crucial role in developing their pedagogical competence by introducing effective teaching strategies early in their teaching journey. Patricia shared:

> "I think the workshop on active learning at the beginning was very helpful. That's my take - it was really good to have it at the start of the year."

For IGTAs, understanding active learning pedagogies often required adaptation due to their previous educational experiences which provided their initial understanding of pedagogical practice. Mokbul reflected on the hierarchical nature of classrooms in his home country, stating:

> "You know, we're just afraid of the teacher. Oh, my God, the teacher's going to do something or say something."

This quote illustrates the influence of prior educational environments on IGTAs' initial teaching approaches.

Another common theme observed among Physics GTA interviews was that the weekly physics seminar series had a positive impact on their teaching skills. One notable practice highlighted by the GTAs was peer observation, which provided valuable opportunities to learn from each other. Julia, for example, described how observing her colleagues' classes gave her insights into different teaching styles and classroom environments:

> "One thing we did was observing each other's classes. We're each assigned a peer to observe, and it helps us get ideas on different ways to teach. We also provide feedback things we like and things we think they could improve on. I found this really helpful because it's much less intimidating to be observed by someone you know and who's also a peer."

These findings illustrate that GTAs' growth in pedagogical competence was driven by a combination of targeted workshops, peer learning opportunities, and their ability to adapt to new teaching environments.

Recognition

Most GTAs don't receive formal recognition for their efforts and there was no mention of formal recognition in our interviews. The recognition that we see contributing to GTA teaching identity came from informal acknowledgement by the students. Students' recognition of GTA efforts serves as a motivator and builds confidence and commitment to teaching. Recognition, whether through explicit feedback or subtle gestures of appreciation, strengthened GTAs' dedication to their roles and encouraged continuous refinement of their practices. While this study did not explicitly

examine the evolution of recognition over time, the data consistently highlighted its importance across participants.

Mokbul emphasized the impact of visible student engagement and appreciation, recalling how his follow-up efforts to address a question elicited a heartfelt response:

> "He was very happy. He emailed me, 'Okay, that was good of you. And thank you for the answer."

In contrast, IGTA Yan described difficulties with recognition due to communication barriers. Yan stated:

> "The students keep asking me, 'Do you understand what I mean?"

These findings illustrate how recognition - whether through positive feedback or challenges - shapes GTAs' experiences in the classroom and contributes to their teaching identity.

Discussion

The GTAs began their teaching basing what they did in the classroom on practices that they had experienced elsewhere or knowledge that they had from other domains. Over time they brought other techniques into the classroom illustrating their adaptability and creativity in addressing classroom difficulties. IGTAs mentioned relying on traditional methods, such as lectures or whiteboard, but with experience this evolved into more modern approaches like use of technology, and simulation methods. In contrast, DGTAs adopted innovative methods from the outset, such as incorporating music into their classrooms to enhance engagement.

These adaptations demonstrate GTAs' willingness to experiment and refine their approaches to meet the needs of their students. For IGTAs, however, language barriers and differing classroom expectations sometimes hindered their performance. Participants described leveraging domain-specific expertise to address communication challenges, underscoring the need for institutional support in fostering clear and effective communication. Providing access to instructional tools and resources, alongside encouragement to innovate, can further enhance GTA performance.

The evolution of competence among GTAs highlights the transformative potential of structured PD. Many participants initially lacked familiarity with active learning strategies, reflecting limited prior exposure. Over time, however, through teaching experiences, they developed a deeper understanding of these pedagogies and their value in promoting student engagement. This progression underscores the importance of sustained mentorship and follow-up support to reinforce the lessons learned in initial training. For example, creating spaces for reflection, such as teaching journals or small-group discussions, could facilitate ongoing growth and encourage GTAs to critically evaluate their teaching practices.

Recognition emerged as a pivotal but uneven factor in shaping GTA teaching identities. Informal acknowledgment from students was particularly impactful, motivating GTAs and reinforcing their commitment to teaching. However, for IGTAs, recognition was often mediated by cultural and linguistic differences, which sometimes led to perceptions of diminished authority or classroom ability. This suggests that recognition must be fostered at multiple levels. While student feedback

plays an important role, institutions should implement formal recognition mechanisms, such as teaching awards, peer evaluations, or mentorship programs, to ensure that all GTAs feel valued and supported.

The findings reveal the importance of discussing the dynamics of the American classroom environment in GTA preparation. For many IGTAs, their prior experiences in formal, hierarchical educational systems created difficulties in adapting to the more collaborative, student-centered approaches commonly emphasized in U.S. classrooms. These cultural dynamics can hinder the adoption of active learning pedagogies, as seen in participants who described discomfort with open classroom dialogue. This suggests that PD programs need to explicitly address cultural differences, providing opportunities for GTAs to reflect on their prior experiences and learn strategies to navigate new teaching contexts. Peer observation and collaborative teaching models could also help IGTAs adapt by exposing them to diverse teaching styles in a supportive environment.

These findings emphasize that GTA teaching identity development is not static but evolves as GTAs navigate pedagogical, institutional, and cultural landscapes. PD programs should adopt a holistic approach, addressing the intersection of competence, performance, and recognition to support GTAs' growth as educators. This includes fostering cultural awareness, promoting reflective teaching practices, and creating systems of equitable recognition. Future research could explore how these dimensions evolve over time, particularly in the context of long-term professional growth and cross-cultural teaching environments.

Limitations

The data was collected from a single institution across three departments during one academic year. Additionally, all participants were PhD students who typically hold GTA positions for a short period before transitioning to research roles, making it difficult to track the long-term development of their teaching identities. Expanding the data collection to include additional departments, multiple institutions, and different academic years would enhance the richness and depth of the dataset.

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Appendix A

The following is the interview protocol used for the focus group interviews.

1. Please begin by telling me your name, department, and the course you will be teaching, if you know.

2. Have you taught before? Who/what/when did you teach? This can include teaching, tutoring, etc.

3. How would you define active learning? What would you say is the role of active learning in the classroom?

4. In what ways do you plan to promote active learning in the classroom?

5. What did you learn at this workshop that you are most looking forward to applying to your teaching? How do you think you will apply for it?

6. What challenges do you anticipate with respect to teaching? Is there anything you are worried about?
    a. Why?
    b. Did this workshop have any impact on your response?

7. What are you most looking forward to with respect to teaching?
    a. Why?
    b. Did this workshop have any impact on your response?

8. Can you describe how you understood the role of an instructor before you came to this workshop?
9. Have your thoughts about the role of an instructor changed based on this workshop?

10. Is there anything else you would like to share with me about implementing active learning in your classroom?

11. Would you be willing to participate in follow-up interviews over the course of the academic year? You will be compensated for your time.

Appendix B

Below is the interview protocol used for the first round of interviews.

1. Please tell me your name, what department you are in, and what classes you are a GTA for this semester?
    a. What is your role in the class you are a GTA for this semester? [probe what this means in terms of the actual work done – do you prepare the assignment, do you grade? Do you develop materials? In what ways do you interact with the students?... try to go deep on this one]

2. What was your undergraduate and prior graduate experience like before you arrived at Mason?
    a. What was the classroom instruction like?
    b. How did the professors/instructors run classes?
    c. Were the classrooms and students within them diverse or homogeneous in terms of backgrounds, languages, cultures, regions, backgrounds, etc?
    d. What was the language of instruction if GTA was not from US?

3. What is your previous experience teaching or tutoring? Are there instructors or course experiences you want to emulate and incorporate into your own approach to teaching? Ones that you want to avoid?
    a. What aspects of classes/instruction you have had before do you want to incorporate into your own teaching? Why these? Are there some you want to actively avoid? Why those?
    b. Favorite class or instructor? What made that a positive experience?

4. What are the similarities and differences between the classes for which you are a TA and those you took prior to coming to Mason?
    a. What was the instructional approach like at your prior institution?
    b. What was the student body like?
    c. What were the expectations of the students in the classroom? Of the instructor?
    d. How much of this is about language and culture?
    e. How much of this is about institution type?
    f. How much of this is about institution type?
    g. What has surprised you?

5. What has your GTA experience been like so far?
    a. What has your experience working with students been like?
    b. What are some of your highlights so far as GTA?
    c. What challenges have you had to deal with?
    d. Are there things that would make being a GTA easier?
    e. What have you found difficult in working with students?

6. What is your approach to engaging with students and in your role as a GTA?
    a. What factors have influenced your approach?
    b. What surprises have you faced? How did you deal with them?

7. In what ways have you incorporated active learning into your classroom? How has it gone?
    a. How have you used what you learned in the workshop in your classroom?
    b. Have you had any teaching workshops or professional development beyond our pre-semester workshop? How have you used what you learned?
    c. What resources are you using? What resources would you like to have that you don't?
    d. What support have you gotten from faculty in your role as GTA? What additional support do you need?
    e. How have students reacted to active learning?

8. What do you view as your role as a GTA for your course? How has it evolved since the semester began?

9. Is there anything else you would like to add?

Appendix C

The protocol outlined below was utilized for the second round of interviews.

1. Please tell me your name, what department you are in, and what classes you are a GTA for this/last semester.

2. Now that you have some experience, how has your view of the role as a GTA for your course evolved? Can you tell us about a time you did something different in your role this semester than you would have when you started as a GTA?
    a. Do you think you have changed in any ways since you first started as a GTA?

3. Prior to your experience at Mason, how have students addressed the teacher? How do students interact with the teacher/professor?
    a. Do you think this is different here at Mason? How did you adjust to these differences?

4. In your prior educational experience, how did college STEM classrooms look?
    a. How is the physical layout different? How do students interact with each other? With instructors? What sorts of rules are there in the classrooms in each of the cultures you've talked about? [How are the rules communicated in each of these cultures?] for example, what are the expectations of students in the classroom? Are there things that students can or cannot say/do?
    b. Do students feel comfortable asking questions in class or after class? WHY?
    c. For example, if a teacher made a mistake in class, would students correct the teacher?
    d. How would a student approach a teacher if they needed help (or would they)?
    e. How have any differences you have seen in the structure of the classroom and the ways that teachers and students interact impacted you as you move into your role as a GTA?
    f. How have your views of these structures and interactions changed as you have spent more time as a GTA?
    g. How did you adjust to these differences?

5. What motivates you - are you more grade-motivated, knowledge-driven, or something else?
    a. What do you think motivates students more generally?
    b. How has your thinking about these different motivations influenced how you interact and engage with students in the classroom?
    c. Have your ideas on student motivation and how to motivate students changed as you have worked more as a GTA?

6. What are your educational goals? How did you decide on these goals? What influenced the creation of those goals?
    a. Have you noticed differences in the way your students think about their educational goals?

    b. How do you think that the culture you come from influences students' thinking about their educational goals?

7. How have your family and family responsibilities impacted on your education?
    a. How have your friends or colleagues impacted your education?
    b. What is the role of family, friends, and/or colleagues in a student's education in your culture more generally?
    c. How do these influences impact the way you engage with students in the classroom?
    d. In what ways has this changed as you have gotten more experience in the classroom?

8. Can you describe a time when a student was struggling in your class? What did you do to help the student? Would you do the same thing next time?

9. During your class, how do you understand if students are grasping the course material? How have you modified what you are doing to help them understand?

10. Is there anything else you would like to share about your experiences as a GTA?