On the Unique Benefits and Challenges of Mathematics Graduate Student Instructors Providing Teaching Feedback to their Peers

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In this paper, we compare the types of teaching feedback that graduate student instructors provide their peers in comparison to more senior faculty at a large research-oriented university. Additionally, we consider the challenges and benefits that graduate student instructors report concerning providing teaching feedback to a peer. Our results reveal that graduate student instructors and faculty contribute distinct perspectives on teacher growth and together can form a strong support system for first-time graduate student instructors. Additionally, while observing a peer does pose real challenges, we found that graduate student instructors develop strategies to overcome these and report more benefits than difficulties.

Keywords: graduate student instructors, feedback, teaching observation, peer mentoring

At many research universities, graduate students in the Mathematical Sciences become instructors of record for one or more undergraduate courses (Eller, 2017; Justice, Zieffler, & Garfield, 2017); we will call these educators graduate student instructors (GSIs). Oftentimes, GSIs have little to no assistance on the front-end in preparing to teach; however, departments across the country have begun to implement training programs for GSIs with the aim of both improving GSIs teaching abilities and improving the learning experience for their undergraduate students (Speer, et al., 2005; Ellis, 2014). One promising training component that can support GSIs in developing student-centered teaching practices is providing them with feedback from a teaching observation conducted by a more experienced educator (Yee et al., 2022). Within a mathematics department, this feedback can come from a faculty member or a more experienced graduate student instructor. In this paper, we explore the following research questions:

Research Questions

1) What types of teaching feedback do peers give to other graduate student instructors and how does it compare to the feedback provided by more senior faculty?

2) What are the challenges or benefits that graduate student instructors report concerning providing teaching feedback to a peer?

Theoretical Perspectives

Concerning feedback. We frame feedback using Kluger and DeNisi's (1996) Feedback Intervention Theory (FIT). This framework has previously been leveraged in the K-12 setting (Khachatryan, 2015) as well as in the setting of graduate student instructor professional development (Yee et al., 2022). We define feedback as action taken by an observer to provide information concerning aspects of the graduate student instructor's teaching performance. We categorize the components of feedback using three levels or scopes: (Whole) comments on the task of teaching as a whole, (Part) focused details within the task of teaching, and (Individual) comments concerning the affect, motivation, or skill of the instructor.

Because we are discussing feedback for novice instructors, who may not have particular knowledge of aspects of teaching, we expand our framework to categorize whole and part scoped

components as description, feedback, or feedforward. While feedback focuses on what is effective or not in the present, feedforward focuses on the future by offering particular suggestions. It is important to track the scope of feedback because Yee et al. (2022) found that feedback that includes specific context and focal events (what we call part-type feedback) is more effective at promoting change in graduate student instructor's teaching behaviors than feedback that lacked this contextualization. Additionally, FIT suggests that comments focused on the individual are the least effective in motivating a change in performance (Kluger & DeNisi, 1996). Accordingly, we track individual scoped comments and categorize them as positive (a compliment) or negative (a criticism).

Concerning dimensions of mathematical teaching. To facilitate classification of the content of teaching feedback, we used the topics covered in the Mathematical Association of America's Instructional Practices Guide (Abell et al., 2017). This comprehensive resource operationalizes leading research concerning learning in the undergraduate mathematics classroom.

Methods

Context & Data

All data collection was done in the Department of Mathematics and Statistics at a large land-grant university in the United States. In a typical semester, 30 to 40 faculty members, the majority of which are research-oriented, participate in conducting a teaching observation of each graduate student instructor of record.In addition to this faculty-provided teaching observation, a peer conducts a teaching observation for each first time graduate student instructor. Each graduate student instructor who observed a first-time instructor also completed a reflection about the process. We analyzed 35 of these peer observations and the observer's corresponding reflection, from Fall 2020 — which was a planned remote semester due to the COVID-19 pandemic — ranging to Fall 2022 — which was a standard in-person semester.

For comparison purposes, we will share our analysis of 170 faculty observations of graduate student instructors conducted in the same time range. Please note that our reported analysis of faculty-generated observation data is a subset of an analysis conducted for a larger project focused on how mathematics faculty engage with teaching observation protocols; our analysis of the graduate student instructor-generated observation data and the corresponding reflections is novel and only appears in this report.

Observation protocols. The observation protocol used by graduate student instructors is heavily-adapted and pared-down from Rogers and Yee's (2018) Graduate Student Instructor Observation Protocol (GSIOP). We originally aimed to use the GSIOP, but struggled to effectively implement the required training with our graduate student instructors during the COVID-19 emergency. Our protocol opens with 5 likert-type items concerning student engagement followed by the student-centered techniques chart from the GSIOP. To account for the Zoom setting, we added Small Groups/Breakout Rooms, Polling, Chat feature to engage students with content, and use of Google Docs or Spreadsheets for activities/group work to the chart. Our protocol concludes with essay prompts to summarize the observed class, to discuss strengths, and to suggest areas for improvement. The observation protocol used by faculty begins with twelve Likert prompts asking the observer to rank components of the appropriateness of the mathematics, the quality of the instructor's communication, and the level of perceived student engagement. Next, the observer is provided two essay prompts, one requesting details of the observed session and the second requesting suggestions to help the graduate student instructor improve. The primary

difference between the two protocols is that the one used by graduate student instructors has clearly defined notions of student engagement with very specific active learning techniques given. Our faculty, on the other hand, have quite varied notions of effective teaching. Consequently, the observation tool they use is necessarily less concrete.

Pedagogical & mentoring training for graduate student instructors. The graduate student instructors who served as peer mentors received both pedagogical and mentor training prior to conducting observations. The pedagogical training Promoting Success in Undergraduate Mathematics through Graduate Teacher Training (PSUM-GTT) included a teaching seminar during the spring of their first year and fall of their second which focused on modeling active learning strategies and reflecting on journal articles related to teaching and learning. Ongoing professional development was also provided through a critical issues in STEM education seminar facilitated 2-4 times per semester. Mentor training was provided to help clarify the role of a mentor and provide training around communicating effectively, building relationships, setting goals, and conducting classroom observations using an established observation protocol (Manzanares et al., 2023).

Results of First Research Question

Our first question considers what types of teaching feedback do peers give other graduate student instructors and how does this compare to the feedback provided by more senior faculty. We analyzed both the graduate student and faculty observations utilizing *a priori* coding (Saldaña, 2016) with two different code books, one focusing on the types of feedback and the other on the content of the feedback.

Feedback Intervention Theory

Our feedback codes are those types discussed above concerning Feedback Intervention Theory. Table 1 shows the frequency of scopes of feedback in both the graduate student peer observations and the faculty observations. Note that the gray-highlighted rows are the components of the most effective formative feedback, as discussed in theoretical perspectives.

Table 1

Frequency of feedback intervention theory codes in peer vs faculty observations

Scope & Category	Graduate Student Peer Frequency	Faculty Frequency
Whole - Description	0 %	$<$ 1 %
Whole - Feedback	0 %	36 %
Whole - Feedforward	0 %	0 %
Part - Description	100 %	34 %
Part - Feedback	100 %	78 %
Part - Feedforward	100 %	61 %
Individual - Compliment	13 %	38 %
Individual - Criticism	0 %	1 %

Content of Feedback

Table 2 shows the frequency of content codes from the graduate student peer observations and the faculty observations. As briefly mentioned above, our codes concerning dimensions of mathematics teaching were developed from the Instructional Practices Guide.

Classroom community. This code encapsulates students' connections with their GSI, classmates, and university resources. Additionally, it covers classroom norms or atmosphere. For example, one peer observer wrote *"the class was kept at a pace the students can feel comfortable asking questions and I liked the idea of giving thumbs up when something is clear... In general, the class atmosphere was very learner - friendly"*. An example of classroom norms is the feedback:

> *I can tell that you are aware that your classroom is kind of a weird shape. It seems like it makes it hard to make sure everyone can see and participate. Since your room is so big, you could ask your students to all sit closer to the center or pull their tables over towards you. I know that's not the norm for your class since we're so far into the semester, but maybe the next time you teach in a room like that you can anticipate and make them sit closer together.*

Table 2

Frequency of content codes in peer vs faculty observations

Content Code	Graduate Student Peer Frequency	Faculty Frequency
Classroom Community	63 %	12 %
Student Engagement	69 %	41 %
Student Communication	25 %	2 %
Student Questions	38 %	31 %
Instructor Questions	81 %	28 %
Instructor Communication	44 %	35 %
Collaborative Learning	44 %	6 %
Tasks – Intrinsic Appropriateness	94 %	80 %
Tasks – Extrinsic Appropriateness	6 %	31 %
Technology	38 %	1 %

Student engagement or communication. Engagement refers broadly to the observer's perceptions of students actively participating in their learning. The student communication code captures the various modalities for students to communicate their ideas with one another and their instructor. For example, the quoted comment above concerning the use of the thumbs up button in Zoom is also student communication.

Student or instructor questions. Comments about questions posed by students were coded as student questions; Comments about questions posed by the instructor were coded as instructor questions. Many peer observers discussed wait time, or giving students adequate time to think about a question before expecting an answer. For example, one graduate student reflected *"He has a slight tendency when the answer isn't said almost immediately to give them the answers"* and wrote the following feedback on the observation form: *"waiting after asking questions. Gives students some time to internalize and some are shy."*

Mathematical tasks – intrinsic or extrinsic appropriateness. Intrinsic appropriateness concerns the characteristics intrinsic to a task and whether those characteristics support student learning while extrinsic appropriateness takes into account external factors such as classroom architecture or students' motivation. The discussion above of classroom shape making participation

hard is an example of extrinsic appropriateness. The extrinsic appropriateness code only occurred when there was a concern.

Others. Instructor communication skills focused on legibility of handwriting or instructor's speaking volume. Collaborative learning is structured group work managed by the instructor. Technology primarily was comments concerning Zoom during the planned emergency remote semesters, but could be related to any technology in the classroom.

Comparing Peer Feedback to Faculty Feedback

Primarily, if a faculty member discussed an engaged-student learning strategy, it was group work. Our graduate students, on the other hand, leveraged a vast array of techniques coming from the GSIOP, suggesting when and where a strategy could be used; on average, each graduate student peer observer discussed 3.4 strategies. Graduate students 100% of the time employed the components of effective feedback: part description, part feedback, and part feedforward. Many faculty did not provide these components in their observation comments. Additionally, there was a wide difference in the types of topics discussed between graduate student instructors who were observing their peers who were teaching for the first time in the department and the topics covered by faculty observing all graduate student instructors. One might think this is because the first time instructors needed more help, however, we found this to not be the case. Even when a peer observer felt that the instructor they watched was effective, they still described what they noticed and explained why they found it effective. On the other hand, in a similar situation, where the faculty member found the session that they observed to be effective, they were more likely to give whole-type feedback such as "The class went quite well" with no further information about what they noticed.

One area in which faculty greatly outperformed the graduate student observers is their rich and nuanced discussions of mathematical task - intrinsic appropriateness. Our graduate student instructors generally mentioned the mathematical topic of the day and then turned their focus to the other dimensions of classroom instruction. On the other hand, faculty who discussed the mathematical content demonstrated a deep mathematical understanding, for example discussing necessary levels of correctness, alignment of that day's learning outcomes with the course and curriculum more broadly, or presenting the material at an appropriate level for the student population. We believe the differences we observed are primarily due (1) to the graduate student instructors having a tightly formed community of practice while the faculty have no common notions of effective teaching, (2) to graduate student instructors receiving specific training on providing teaching feedback while faculty received none, and (3) to our faculty primarily serving in research-intensive positions with experience teaching a broader range of courses and at an upper level.

Results of Second Research Question

We utilized emergent coding from a grounded perspective (Saldaña, 2016) when working with the 35 reflections. Our aim was to uncover the challenges and benefits that graduate student instructors report after providing teaching feedback to a peer. After individually gaining familiarity with the data, we met as a team to discuss and refine our codes. We met a second time to resolve any discrepancies in our final coding of the data. Importantly, we want to note that in our initial round of coding, we discovered a distinct difference in our perspective as coordinators of teaching professional development versus the perspective of the graduate student instructors. In

particular, they found certain aspects of the experience to be a challenge, while we thought of that struggle as a benefit. Because of this tension in perspectives, we will be very purposeful in indicating *who* is perceiving the benefit or challenge.

Awkward or nervous because it is a peer. Four graduate student instructors felt nervous or awkward giving feedback to a peer, but also expressed a strategy to overcome this challenge. One reflected:

> *I thought our follow-up meeting went well, too. Even though I was still (and probably always will be) a little nervous to make suggestions for improvement, it wasn't awkward and I think we are gaining more rapport with one another to talk through those things.*

Another instructor also felt that developing a relationship over time would make this awkwardness not *"much of an issue"*. The source of one GSIs discomfort was their perfecption that their peer actually had more teaching experience than them, writing, "*I feel a little bit of imposter syndrome about giving her suggestions for strengthening/improving."* The last instructor who felt awkward developed a strategy where *"instead of telling him he was wrong,"* they tried "*asking about certain things and letting him talk through to reach his own conclusion about how effective/ineffective certain things were."*

Developed a feedback strategy. Eleven graduate student instructors discussed the strategies that they had developed for giving feedback to a peer. Three strategies focused on how to approach the feedback conversation, with one GSI explaining "*I approached it just as a conversation where we point out and maybe debate some aspects of each other's teaching style and approaches*", and the other two explaining that they wanted to come across as "*supportive instead of demanding*" and "*there to help and not out of a place of putting him on trial*", respectively.

One GSI decided to ask their peer if "*there was anything she wanted me to focus on during her observation*", which they felt made the other person "*more open to constructive criticism*". Two GSIs considered how their peer might be more open to suggestions and respectively decided on "*telling him more strengths than weaknesses and always interposing them*" and "*include more positive comments instead of only focusing on where my mentee can improve*". The last GSI also decided to specifically ask their peer what they "*wanted me to keep an eye out for, which allowed her to ask me things she wanted to know about, rather than just what I would say*"

Wrestling with different opinions of "good" teaching. This focusing on another person's perspective and recognizing that there may different ideas of "good" teaching presented a challenge to 3 GSIs. One wrestled with the ways in which different class settings may necessitate different teaching styles, reflecting "*If you have someone teaching finite math and it is active learning versus a calculus class which is lecture based, you do not do things the same way.*" One GSI was concerned that they did not know what the department values, writing:

> *There is not one method or style of teaching that seems to be the "ideal" for the department. It's not clear if the department wants the most effective lecture-style environment, or if they want more active learning, or if they want more in-class assessments, and so on.*

The final GSI wrestled with confronting their own biases and opinions, sharing, "*The thing I find most difficult is the actual assigning of values to her teaching. It is based off my own bias of what I think makes a good teacher and the qualities I identify as important."* We do want to note that we value the fact that our GSIs are considering and reflecting on this issue to be a benefit of our program, even if the students themselves feel that this is a challenge.

Uncertainty in role. Every graduate student instructor reported feeling prepared to con-

duct a teaching observation and to provide feedback except for two students who expressed uncertainty in this new role. The first explained, "*I did not feel prepared going into our follow up meeting. I was unsure of what questions I should ask my mentee especially ones that would really make them examine specifics of my teaching style.*" The other expressed uncertainty in the purpose of the observation in the broader context of the department and the GSI training program explaining, "*I wasn't really sure what my mentee would have to do with regards to observation follow up*" This reveals an opportunity for us to provide additional support for GSIs prior to them conducting their teaching observations.

Providing self-reflection. One GSI valued having this dedicated time to discuss teaching with a peer, explaining, "*I was eagerly looking forward to it.*" Six GSIs explained that this process was an effective self-reflection tool, with one even explaining "*I learned more about my teaching*" and *"This was a good process in general because I feel like it encourages both the person being observed and the observer to reflect on their own teaching and seek how to improve.*"

Two reported a boost in confidence after self-reflecting, "*It was really encouraging to realize that my three semesters of experience made me feel completely confident and qualified to offer advice on my mentee's class.*" and "*It was an encouraging reminder to me that I have been teaching for a couple of years now, and that experience has taught me a lot!*" The last GSI felt the process provided some accountability for their teaching, reflecting, "*I try to bring up her progress in these areas every time we meet to keep her accountable for working on this. Incorporating more active learning is something I also need to work on, so this keeps me accountable as well.*"

One GSI reported understanding her own teaching in relation to others' teaching practices after discussing feedback with a peer, writing, "*I knew that I had a laid-back attitude in my classroom ... but my mentee pointing out how informal my class was made me realize that that is really not the norm for everyone.*" Another GSI also expressed understanding their own teaching better: "*My mentee is very open to getting help and being evaluated, so it made this process easy and eye-opening to things that I could improve on too!*"

Re-conceptualizing teacher growth. Two GSIs thought of growth as a teacher in a new way, with one expressing that this experience made them realize that improving their own teaching will be an ongoing and "*continuous process*" and the other reporting "*I think oftentimes (even in my own teaching) this is something slower to implement. I have tried to emphasize with her that changing teaching style/implementation can and probably should happen slowly. You can't change everything you do overnight.*"

Conclusion

We found that faculty were more effective at giving feedback on mathematical content knowledge while our graduate student instructors were more more effective at giving feedback on pedagogical approaches. This demonstrates that both populations contribute uniquely to teacher growth and together can form a strong support system for first-time graduate student instructors. Although asking graduate student instructors to observe a peer and provide feedback does pose real challenges, such as awkwardness and uncertainty, we found that GSIs develop strategies to overcome these and report many more benefits, such as personal accountability, teaching confidence, and a greater understanding of their own and others' teaching.

Acknowledgments

This project is funded by NSF Award Numbers DUE #1821454, 1821460, and 1821619.

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