GTAs' Experiences of Switching to Remote and Online Teaching and Tutoring during the Start of the Covid-19 Pandemic

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The abrupt switch from in-person instruction and tutoring to remote or online instruction and tutoring as a result of the COVID-19 pandemic in March 2020 was difficult for even the most experienced instructor. In this paper, we explore how graduate teaching assistants (GTAs) at three different institutions responded to and experienced this change. Data was collected from surveys and focus groups conducted with graduate teaching assistants at each institution, as part of our ongoing collaborative NSF-funded project focusing on equipping mathematical sciences GTAs to become better teachers. In their responses, the graduate teaching assistants discussed topics ranging from what they did in their remote classrooms to the challenges they faced and supports they received from their department, university, and fellow classmates and faculty.

Keywords: graduate teacher training, remote instruction and tutoring, teaching assistants

Much of the undergraduate instruction in mathematics and statistics is provided by graduate teaching assistants (GTAs), who often have only limited training and experience in teaching (Blair et al., 2015; Ellis, 2014; Speer et al., 2005; Speer & Wagner, 2009). Responding to this need, Promoting Success in Undergraduate Mathematics Through Graduate Teaching Assistant Training (PSUM-GTT) is a multi-institution National Science Foundation-funded program that supports GTAs in developing knowledge, skills, resources, and mindsets to become effective instructors. The goal of PSUM-GTT is to improve academic outcomes of undergraduates in mathematical sciences courses by strengthening teaching capabilities of GTAs. PSUM-GTT aims to provide immediate benefits for the undergraduate students that GTAs currently teach. In addition, because many of today's GTAs are the "faculty of the future" (Saxe & Braddy, 2015, p. 27), we expect the program will provide lasting benefits to the post-secondary students current PSUM-GTT participants will teach for decades to come.

While there is extensive literature related to instructional practices and professional development for online teaching, Hodges et al. (2020) and Ho, Cheong, & Weldon (2021) distinguish between emergency remote teaching due to an emergency or crisis and extended planning for online learning, which might be a 6–9-month process. While some recent work in mathematics education has focused on remote and online instruction and tutoring practices during emergency remote teaching necessitated by the Covid-19 pandemic (Dumbaugh & McCallum, 2021; Johns & Mills, 2021), these studies focused on best practices, not the lived experiences of mathematical experiences GTAs and the training and support they received to support the sudden transition to remote teaching and learning in March 2020. This study aims to address this need by examining the experiences of mathematics and statistics GTAs at the three

institutions where PSUM-GTT operates, leading to the three research questions that guided this study.

1. How did the rapid transition to remote learning and instruction impact and change the instruction of GTAs and their approach to teaching?
2. What challenges did the GTAs face during the transition to remote learning and instruction?
3. What supports did the GTAs receive during the transition to remote learning and instruction?

Theoretical Framework

The theoretical foundations of communities of practice (Lave & Wenger, 1991; Wenger, 1998) have become a model for growth and change in higher education (McDonald & Cater-Steel, 2017) and have been studied in mathematics and mathematics education faculty (Sack et al., 2016). Recent work has included a focus on infusing active learning into foundational science, technology, engineering, and mathematics (STEM) courses (Tomkin et al., 2019) through communities of practice. The elements of the PSUM-GTT program (described below) interact to foster an instructional community of practice among the mathematical sciences GTAs in the program.

Study Context: The PSUM-GTT Program

PSUM-GTT is a multi-faceted approach to supporting GTAs' growth as mathematical sciences educators. It was launched at one institution in 2015 and was expanded to two other institutions in 2019. At all three institutions, beginning GTAs are expected or encouraged to participate in PSUM-GTT. The program includes a seminar on teaching, held weekly for PSUM-GTT participants in their first year of the program, which examines best practices in classroom instruction and assessment, equity and inclusion, active learning, and student engagement. A Critical Issues in Undergraduate STEM Education seminar series features scholars and practitioners for seminars which provide deep dives on significant topics. Additionally, each GTA in the first two years of the program (mentee) is paired with an experienced GTA or faculty member who serves as a mentor, and one GTA at each institution serves as a TA coach to provide additional non-evaluative support to all GTAs. Finally, PSUM-GTT participants learn about the K-12 mathematics pipeline by visiting local middle or secondary schools or volunteering in STEM programs for students hosted at the university campus or in the community.

Method

Data Collection

The PSUM-GTT project includes data collection at the end of each semester for the purpose of program refinement and broadly relevant research. At the end of the Spring 2020 semester, all 67 of the GTAs in the program across the three universities completed an online survey via Qualtrics. The survey included matrix-formatted items that asked GTAs to indicate (from a provided list) which instructional techniques they employed before and after the switch to remote learning and instruction. Open-ended survey items asked the GTAs to report the challenges they faced, and the support they received**.** Additionally, 35 GTAs agreed to participate in focus groups to further discuss their teaching experiences that semester.

Participants

There were 11 graduate student mentors, 12 mentees, and 1 TA coach at Institution A; 8 graduate student mentors, 12 mentees, and 1 TA coach at Institution B; 10 graduate student mentors and 12 mentees at Institution C, all of whom chose to participate in the comprehensive training program. At Institution A, 56.5% of participants identified as male and 43.5% identified as female. Approximately 65.2% of participants were international students. At Institution B, 46.5% of participants identified as male and 43.5% identified as female. Approximately 13.0% of participants were international students. At Institution C, 45.5% of participants were identified as male and 54.5% identified as female. Approximately 40.9% of participants were international students. All participants had some undergraduate teaching experience, either at their current institution or a different institution, prior to the Spring 2020 semester. All three universities are considered to be research-intensive.

When all three schools shifted to remote learning in March 2020 because of the COVID-19 pandemic, 16 participants at Institution A were serving as instructors of record, as were 20 participants at Institution B and 10 participants at Institution C. Of these 46 who were instructors of record, only 6 had taught online previously and 21 had taken a prior online class.

Analysis

Descriptive statistics (e.g., means and percentages) were used to summarize items related to instructional strategies. Thematic analysis (Braun & Clarke, 2006) was used to analyze the open-ended survey items and focus group transcripts.

Results

What Happened During Instructional Time

After the suspension of in-person classes, 39.5% of GTAs who were instructors of record or recitation leaders reported using a synchronous online format that met at the usual class time. Approximately 18.6% reported a mixture of formats that was mostly synchronous, while 16.3% reported a mixture that was mostly asynchronous. Approximately 14% reported using an entirely asynchronous format. The remaining 11% chose "Other", and listed details such as posting recorded videos, using a flipped classroom approach, or live lecturing for those students that could attend and archiving lectures for those who could not attend synchronously.

Instructors were asked to identify the instructional approaches they used before and after the transition to remote instruction. As indicated in Table 1, all active learning instructional techniques were reported being used more frequently when teaching face-to-face compared to teaching remotely. For example, student brainstorming was used by 80.4% of participants for face-to-face instruction but just 43.4% during remote instruction. Similarly, the use of teacher questioning decreased from 87% for face-to-face instruction to 69.6% for remote. Related to teacher questioning, the use of wait time after questions decreased from 89.1% during face-to-face to 65.2% when remote.

The decreased use of active learning and student-focused approaches was also seen in techniques such as jigsaw, students find the teacher's mistake, peer review, informal assessment and student feedback at the end of class. All of these techniques had reported decreases of over 50% with the shift to remote instruction and 45.3% of instructors reported spending less than 20% of class time on active learning. The decrease in student-focused teaching also led to a decline in perceived student engagement with 88.1% of instructors identifying a moderate or great decline in engagement during remote instruction. Finally, the GTAs' perception of their quality of instruction declined with 61% describing their instruction as "not as good" as before

shifting to remote instruction, 34.1% reporting their instruction about the same, and 4.9% indicating better instruction during remote.

Table 1. Instructional Techniques Usage Prior to and During Remote Instruction

Use of Instructional Techniques (n=46)	**Face-to-face**	**Remote**	**Difference**
Direct instruction/lecture	40 (86.9%)	31 (67.4%)	9 (-22.5%)
Students brainstorming	37 (80.4%)	20 (43.4%)	17 (-45.9%)
Peer review of work	22 (47.8%)	6 (13.0%)	16 (-72.3%)
Informal assessment – end of class	19 (41.3%)	5 (10.9%)	14 (-73.7%)
Pop quiz	8 (17.4%)	6 (13.0%)	2 (-25%)
Using wait time after questions	41 (89.1%)	30 (65.2%)	11 (-26.8%)
Students posing questions in class	36 (78.3%)	32 (69.6%)	4 (-11.1%)
Teacher questioning	40 (87.0%)	32 (69.6%)	8 (-20%)
Role playing	5 (10.9%)	4 (8.7%)	1 (-20%)
End of class feedback – (e.g. minute paper)	14 (30.4%)	6 (13.0%)	8 (-57.1%)
Have students find teacher's mistake	29 (63.0%)	16 (34.8%)	13 (-44.8%)
Group quiz	11 (23.9%)	7 (15.2%)	4 (-36.4%)
Students share work on board	23 (50.0%)	5 (10.9%)	18 (-78.3%)
Inquiry-based learning tasks	16 (34.8%)	11 (23.9%)	5 (-31.3%)
Game-based approaches (e.g. Jeopardy)	5 (10.9%)	0 (0.0%)	5 (-100%)
Jigsaw	4 (8.7%)	1 (2.2%)	3 (-75%)
Think-pair-share	22 (47.8%)	3 (6.5%)	19 (-86.4%)
Using clickers or other response options	3 (6.5%)	3 (6.5%)	0 (no change)

Note: In the survey given to GTAs, this item was a multiple response item as GTAs could use multiple different instructional techniques in their courses.

In addition to the surveys, selected GTAs participated in focus groups regarding their remote classrooms. This focus group data provides further insight and information into how GTAs made the transition to remote instruction. Several mentees and mentors converted their course to a flipped classroom, with recorded lectures and synchronous discussion, problem-solving, and collaboration. They used features in their learning management system and breakout rooms in their video-conferencing software to create smaller groups for students. Some GTAs at all three institutions mentioned uploading notes and pre-recorded lectures for students to view prior to class. At Institution B, mentors described how course coordinators for some large service classes had pre-recorded lectures to both assist the GTAs in preparation and provide more uniformity in the instruction across that course. The majority of mentees and mentors across all three sites conducted their courses synchronously, but several GTAs, particularly at Institution A, changed to asynchronous instruction in response to poor student attendance, internet connectivity issues, etc., and reserved class time for problem-solving sessions and active learning activities. Other items mentioned that were used to facilitate instruction included iPads for drawing, computer software such as Desmos and GeoGebra for graph and figure construction, and virtual whiteboards.

The GTAs discussed that during remote instruction they worked to provide appropriate accommodations for students who reported varying "life issues" affecting their performance in the class. Sample accommodations made included GTAs conducting varied office hours for students with work and/or family obligations, flexibility with due dates, and providing extensions where necessary. Several also reported following up with missing students via email or phone. GTAs were also aware of equity issues impacting student participation and performance related to a lack of software, insufficient technology and/or lack of reliable internet. GTAs themselves reported spending more time in the preparation, delivery and grading components of their course.

Challenges and Supports Reported by GTAs

Teaching and learning remotely.

Low attendance and participation. The most common challenge identified by GTAs in focus groups was students not attending class. A number of GTAs also expressed concern about students who logged on but whose audio and video were turned off and who did not participate, so the GTAs could not tell whether or not students were following along with class. In addition, when GTAs did not see their students regularly in the classroom, it was more difficult to follow up with students who were struggling. Several GTAs noted that some students did not respond to their email outreach or that it is harder to communicate effectively via email.

Instructional design and active learning. Many GTAs conveyed a desire to engage their students in active learning, but expressed difficulty doing so in the remote context. For instance, one GTA noted that students were more reluctant in the remote context to share their work, and others noted that active learning activities were more difficult in the remote context. While breakout rooms offered an analogous experience to think-pair-share and group work, GTAs commented that students were less likely to participate in remote learning breakout groups than their in-person equivalent.

Assessment, and recognizing and responding to student understanding. Numerous GTAs expressed concern about formative and summative assessment and responding to student questions during remote instruction. GTAs accustomed to in-person instruction missed the opportunity to circulate the classroom and see students' individual and group work. For instance, one GTA described missing "being able to walk around the classroom and see what's on your paper." Numerous GTAs also lamented not being able to see students' faces so that they could perceive students' confusion, understanding, and "aha! moments."

With less ability to gauge students' understanding, GTAs were less able to adjust their instruction to address student questions or confusion. One GTA explained, "It was just kind of a lot of guessing and hoping like, hey, I'm putting this out there. I think it should be good enough. But I don't really know until they take your test." Another GTA noted it was more intimidating for students to ask questions in the remote context since they had to ask them in front of everyone rather than being able to ask other students sitting near them. When students did use the chat function during class for questions, it was hard for the GTA to notice and respond to them while continuing to lead instruction. A GTA also observed that students were more reluctant to attend office hours via Zoom. Thus, it was more difficult for GTAs to gauge and respond to student understanding in the remote context than in the classroom context.

With regard to tests and exams, many GTAs expressed concern that students were receiving unauthorized aid, whether from web resources or other students. In addition, they described their own and students' concerns about the proctoring services used by the institutions to monitor students while they took their exams.

Time required for instructional planning, provision of special help, and assessment in remote context. Support from other GTAs and from faculty and staff helped GTAs address the increased time demands of remote/online instruction. GTAs named specific graduate teacher training personnel as providing them with individual support in addition to supporting the larger body of student instructors. GTAs in some highly coordinated courses received substantial support from faculty course coordinators, such as the sharing of videos or loading of content into course management systems, in addition to regular "check-ins" or meetings. GTAs reported other graduate students as a source of support. These peer interactions via email, text and Facebook included discussion of details provided in university and department emails, answering of specific questions related to a class, sharing of resources from those who had taught online before, and assistance with creating assessments, such as writing exam questions.

However, a number of GTAs commented on the increased time demands of online teaching. Indeed, across the three schools, 70% of instructors of record reported spending more or much more time on remote instruction than they previously had for in-person instruction. Focus group respondents identified specific time-consuming activities such as recording and editing videos, preparing for class, grading student work, and responding to student questions.

Technology resources and know-how.

GTA technology know-how. A number of GTAs who had not previously taught online (i.e., asynchronous) or remotely (i.e., online synchronous) reported needing to identify appropriate technology tools that were available to them, learn to use these tools and troubleshoot issues, and determine by "trial and error" which worked best. The mathematical sciences context made it particularly important to find a technology tool to fill the purpose served by a chalkboard or whiteboard in a classroom because instructors wanted students to be able to see them working a problem (as on a chalkboard) at the same time that the instructor was able to see and be seen by the students.

GTA access to technology. Emails from each university and department provided details regarding resources for moving to remote teaching, such as training on Zoom or Bluejeans and course management systems. Additionally, two universities provided some students with university-owned technology for teaching, such as laptops, iPads or tablets, and microphones, or reimbursed them for individual purchases. However, some students indicated that the process for getting this technology was not clear to them, so not all GTAs initially had the technology they needed for remote teaching.

Student access to technology. Numerous GTAs reported that students contended with weak Internet connections and/or a lack of helpful hardware like a camera, microphone, stylus, iPad, or whiteboard.

Pandemic as context.

Practical difficulties faced by GTAs. The pandemic created a number of practical difficulties for GTAs. GTAs who were parents reported difficulty working from home with their young children, and another GTA who is a parent relocated to live with family. A couple of GTAs experienced increased demands in their own academic work, with one describing the workload as "unforgiving." Several also noted that no longer having access to a workspace on campus made it more difficult to focus or to get help from other GTAs or faculty, and one described being "overwhelmed" by the volume of university e-mail.

Personal struggles faced by GTAs. GTAs identified personal struggles they faced as a result of the pandemic, including diminished focus or motivation, mental health challenges, low energy, financial hardship, and not enjoying teaching in the remote context as they had in person.

Obstacles to student participation and learning. In addition to student challenges related to technology and teaching and learning, as described above, a number of GTAs reported that they had students who had difficulty attending class because of changes in their work schedules, the need to care for young children, or time zone differences. GTAs were faced with limiting synchronous interactions or knowing that some students would not be able to participate. One GTA commented that some students had gone home to another country and mused, "is it equitable to ask them to log in at 2am in the morning math class where they're expected to participate?"

Additional support that GTAs wished they had.

When asked what additional support could have helped them, GTAs identified two main areas. In terms of support for teaching, GTAs indicated that they could have used more direction on how to request technology and how to create their own questions in WebAssign, as well as more guidance on how to teach effectively in the remote environment. GTAs without course coordinators noted that they wish they'd had the same level of support as those with highly coordinated classes. In addition to support for teaching, GTAs indicated the need for more support for themselves as students and individuals.

Conclusion and Implications

The training program created a network of support and collegiality among GTAs and between GTAs and PSUM-GTT faculty and staff that was essential for the transition to remote/online instruction. While this support network was beneficial in fostering the community of practice around mathematical sciences instruction and learning, the difference among GTA assignments within departments resulted in GTA reports of varying support levels. Overall, PSUM -GTT faculty, staff, and students at the three institutions came together around a shared commitment to undergraduate education in the mathematical sciences, learned from each other, and contributed to the growing knowledge base of remote teaching and learning (Smith, Hayes, & Shea, 2017).

Active learning, student engagement and equity are foci of the program. Active learning approaches were used less often remotely, and instructors reported declines in student engagement. While many GTAs found different methods of reaching their students and learned to use different technologies that they might not have in a traditional setting, departments can support GTAs in their teaching by providing strategies and resources for active learning, student engagement, and assessment in online and remote courses and tutoring experiences. GTAs attention to equity issues was greater during the pandemic than prior to the transition. GTAs were more likely to make accommodations and follow-up with students.

GTAs were simultaneously contending with increased time related to remote teaching and learning and their own coursework and/or research as necessitated by the remote context. Due to GTAs receiving communication from multiple sources (e.g., dean's office, department chair, course coordinator), streamlining of communication from within the department specifically about resources would have been helpful.

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