

Impact of COVID-19 on a Community of Practice of First Year Mathematics Instructors

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The COVID-19 pandemic has had unprecedented ramifications on higher education. In this paper we describe how the pandemic impacted a community of practice of instructors involved in the instruction of first year mathematics courses. In particular, we use qualitative data from interviews and open-ended survey responses to describe how members of this community responded to the changes in instruction brought about by the pandemic, and in what ways the community adapted to support instructors in engaging in this new instructional format in order to sustain itself through this transition.

Keywords: Community of practice, Graduate Teaching Assistant, COVID-19

Student experiences in introductory mathematics courses play a significant role in retention at U.S. institutions. These courses often act as a barrier for STEM-intending students, resulting in many students switching from a STEM major to a non-STEM major, or failing to matriculate at all. Such impacts are more pronounced with students from historically-underrepresented populations (Ellis et al., 2016; Griffith, 2010; Laursen, 2019; PCAST, 2012). In response to the concerning impacts of these courses, numerous mathematics departments have started initiatives to restructure their introductory mathematics courses. In particular, several departments are embracing the use of student-centered practices as a way to engage students in the learning process and support increased student success. Since such practices are often novel to instructors, these efforts necessitate a parallel initiative to increase the level of support instructors receive for enacting such practices. Research suggests that a community of practice model may be valuable in helping instructors use these practices (e.g., Thompson et al., 2015; Viskovic, 2006). By engaging in a community of practice, instructors can access communal sources of knowledge and resources that enable them to make changes to their instruction.

Unfortunately, like many change efforts, these communities of practice can devolve if members do not actively work to sustain the community. Sustainability may be especially tenuous given the unprecedented ramifications of COVID-19 on higher education. Over time, these communities have established ways of operating and visions for instruction that COVID-19 rapidly disrupted. Moreover, the pandemic has exacerbated existing socioeconomic inequalities at the collegiate level. In one survey of students at a large public institution, lower-income students were reportedly 55% more likely to delay graduation because of COVID-19 than other students (Aucejo et al., 2020). Given that many departments are relying on communities of practice to increase equitable teaching and therefore improve equitable student experiences, it is crucial that the field learns how such communities may have responded to, and sustained themselves, after this major disruption in their practice. In this paper, we report on how one community of practice within University X's mathematics department adapted in response to the sudden transition to remote learning in Spring 2020.

Theoretical Framework

A community of practice consists of three fundamental elements: “a *domain* of knowledge, which defines a set of issues; a *community* of people who care about this domain; and the shared *practice* that they are developing to be effective in their domain” (Wenger et al., 2002, p. 27).

The *domain* of a community of practice is “what gives a group its identity and distinguishes it from a club of friends or a network of connections between people” (Smith, Hayes, & Shea, 2017, p. 211). A domain “consists of key issues or problems that members commonly experience” (Wenger et al., 2002, p. 32). It also creates a shared sense of accountability and contributes to the development of a practice. While the domain is the broad topic that the community focuses on, the *practice* is “the specific knowledge the community develops, shares, and maintains” (Wenger et al., 2002, p. 29). The practice involves a set of common approaches and shared standards that evolves as a “collective product” (p. 39). The *community* refers to the group of people brought together by the domain, as well as “the quality of the relationships that bind members” (Snyder & Wenger, 2010, p. 110). By interacting with one another, members of the community of practice “learn together, build relationships, and in the process develop a sense of belonging and mutual commitment” (Wenger et al., 2002, p. 34). Moreover, a strong community “encourages a willingness to share ideas, expose one’s ignorance, ask difficult questions, and listen carefully” (p. 28), thus creating a “social learning system that goes beyond the sum of its parts” (p. 34).

The First Year Mathematics Community of Practice

In this paper, we focus on a community of practice whose shared *domain* contains two key components: a desire to improve undergraduate mathematics education, specifically through increased student engagement and learning in first year mathematics courses, as well as a related focus on creating robust formal and informal professional development which “inspires members to contribute and participate, guides their learning, and gives meaning to their actions” (Wenger et al., 2002, p. 28).

This *community* is formed by those involved in the instruction of first year mathematics courses, primarily including graduate students and faculty coordinators. We use the phrase first year mathematics courses to refer to all precalculus courses, calculus, and a first-year liberal arts mathematics course. The majority of instruction of first year mathematics courses at University X is provided by graduate students, either as recitation instructors in large lecture coordinated calculus courses, or as instructors of record (e.g., most precalculus courses are taught by graduate students as instructors of record). For the remainder of this paper we use the term graduate teaching assistants (GTAs) to refer to individuals who are either instructors of record or recitation instructors. GTAs also play a critical role in the leadership of first-year courses. Calculus recitation instructors are overseen by an experienced GTA who conducts regular meetings and observations of recitations. Similarly, precalculus courses are coordinated by a GTA whose main responsibilities include leading regular course meetings, writing assessments, and conducting observations; they also typically teach the course they are coordinating. All GTAs have shared offices in the same building - encouraging interactions about teaching and learning. First year GTAs are all placed in a large office so that they can build personal and professional relationships more easily. The university has also hired dedicated faculty members to support this community of practice - their main roles include providing professional support for GTAs and overseeing the coordination of these courses. Since their main role is to support GTAs’ growth as instructors, and ultimately the success of these courses, these faculty members have offices on the same floor as most instructors who teach first year courses.

The *practice* of this community includes pedagogical knowledge that is used to support student learning in first year mathematics courses, curriculum development, assessment methods, and other activities related to teaching first year mathematics courses. The practice involves a set of common approaches and shared standards that evolves as a “collective product” (p. 39). For

example, all these first-year courses are taught using active learning methods. Further, GTAs are given explicit opportunities to shape this collective product. As an example, the department has employed GTAs on numerous projects to improve first year courses (e.g., writing open-access online textbooks for these courses, developing online homework problems, and contributing to a shared wikispace of detailed lesson plans).

Purpose and Research Question

This research is part of a mixed-methods study to understand how this first year mathematics community of practice adapted to support GTAs and students in first year mathematics courses that were impacted by the transition to remote instruction brought about by the COVID-19 pandemic. For this paper we analyze qualitative data collected as part of this study to examine how GTAs influenced and interacted with the community of practice as it evolved, and to what extent the community was able to sustain itself. To this end, we ask the following research question: *How was the first year mathematics community of practice impacted by the transition to remote instruction due to COVID-19, and how was it able to sustain itself through this transition?*

Methods

We gathered data in Summer 2020 by conducting 45–60 minute semi-structured interviews with 12 GTAs (four of whom were coordinators) who were involved in teaching first year mathematics courses. We also interviewed four faculty members who were actively involved in mentoring or overseeing the GTAs who were involved in these courses. These faculty members served as either course coordinators and/or program directors of the first year courses. Our research questions and interview questions were informed by prior attempts at categorizing this institution's community of practice, as well as literature on communities of practice and departmental and institutional change. Interview questions focused on how key dimensions relevant to a community of practice may have changed from the participant's perspective, including: norms for and ways of engaging with other members of the community, instructional resources, and instructional practices. Recordings of the interviews were transcribed and analyzed in Dedoose. An initial coding scheme of theory-driven codes was developed based on our previous work analyzing departmental change as well as the communities of practice literature (DeCuir-Gunby et al., 2011). Researchers used an iterative process to refine this coding scheme. Once the coding scheme was stable, each researcher used this scheme to independently code 11 of the interviews, and reconcile in groups of at least three researchers (Creswell & Poth, 2018). Based on this analysis the researchers believed that data saturation was achieved, and moved onto a second level of analysis. Individual researchers were assigned codes (e.g., communication) to summarize in a report that included emerging themes and supporting evidence (e.g., quotes, contextual data, etc.). Researchers specifically sought out competing pieces of evidence when developing themes related to each code (Stake, 1995).

Once we generated this report, we read through it to understand how each dimension of the community of practice (domain, community, and practice) may have been impacted by the transition. The report was then modified to include this analysis. In addition, we triangulated the interview data with open-ended responses from a climate and culture survey that was administered to all graduate students at the beginning of Summer 2020. These open-ended response questions asked GTAs to comment on how COVID-19 had impacted their interactions with members of the department in terms of who they go to for advice, who they go to for instructional materials, and who they go to in order to discuss teaching. GTAs were also

prompted to describe how the change to an all-online teaching environment had impacted the community of practice of GTAs in the mathematics department at University X. The response rate for this survey was high amongst GTAs involved in first year mathematics courses (87%) and the majority of the open-ended response questions from this group were filled out (ranging from 69% - 82%). We read these open-ended responses and the remaining interviews for any evidence that supported or contradicted emerging themes.

Findings

Our findings are structured into two main sections: what changed in the community of practice and what did not change due to the transition to remote instruction. For each section, we describe overarching themes that emerged from our analysis of the interview and survey data and provide evidence of how the community of practice was impacted by changes due to COVID-19.

What Changed

Structure of courses. The abrupt transition to remote instruction necessitated rapid and significant structural changes to the department's first year mathematics courses. The most immediate change was that all introductory courses were to follow an asynchronous model, as mandated by university leadership. This model was chosen, in part, because of concerns about varying levels of student access to technology. This gave department members two weeks to re-envision how to preserve the active learning and student engagement that had been happening in these courses, while following the asynchronous requirement. Prior to the transition, all precalculus courses, as well as the first-year liberal arts mathematics course, were designed to support small group work on problems contained in a course packet, with small lectures interspersed throughout the class as necessary to guide students as they worked through these problems. In calculus, a similar model was followed in recitation sections. To replace this model most courses chose to implement discussion boards in an effort to engage students in peer conversations about mathematics. The discussion boards were based on content that was in the course packets, with the videos based on content that would normally be lectured on in the precalculus courses. Exams were also re-imagined to be distributed by online platforms. A precalculus coordinator shared, "we made our exams shorter in question length and we changed the type of questions we asked too. We tried to ask things [that] were more open-ended so they couldn't just steal it off of Chegg," with similar changes made in other courses.

To enact these plans, GTAs and coordinators shared the task of developing the new curricular materials to cover the remaining course content under the guidance of the faculty members who oversaw all coordination efforts. Some GTAs relied on community developed instructional resources, most notably the shared wikispace, to support their new role as curriculum designer. For example, one GTA shared that they "used the [wikispace] more after the transition while preparing the videos that I made. I found it helpful to use the structure of the lesson plans provided for structuring my lecture videos." To support student engagement, course instructors also took on the new role of managing and encouraging online discussions, rather than facilitating in-person discussions.

With the changing roles and responsibilities that followed the transition to remote instruction, so did the power structure in making course decisions. One GTA shared that in developing new curriculum materials to use across all sections, they lost control over individual instructional decisions. As one GTA described, before the transition,

I had full control over how I'm going to present this material, how I'm going to utilize my [learning assistant], how I'm going to interact with students, but after the transition,

especially because like--I mean I'm thankful that I didn't have to create material for every single section, but like I didn't really have much control on how the students are getting this information.

Communication. After the transition, the ways GTAs communicated with other members of the community of practice changed dramatically. GTAs at University X had previously relied on informal, convenient interactions in hallways and shared offices to exchange teaching ideas and build personal relationships. Since this was no longer possible, the majority of GTAs reported interacting with fewer of their peers after the transition. One GTA explained that, “the move online has shifted us from a community of GTAs to various bubbles based on course.” Another GTA stated that the community of practice had gotten “more segmented. We don't interact regularly with people outside of our immediate social spheres the way we would in-person.” Overall, this led to a sense of isolation among many GTAs. As one GTA described,

Well it has become a whole lot more isolating. Before, I would run into random people and casually have a discussion about instruction, or other GTAs would pop into my office and have a chat with me. Now I only have these discussions with a few close friends in the department.

Informal ways of communicating were often replaced with more formal, less convenient modes of communication (e.g., emails, regular Zoom meetings). As one GTA coordinator described, communication became more scheduled, and “less impromptu. I feel like more people emailed me after than usual because you can always drop a quick email, kind of like how you can always just drop by an office.” While the number of emails may have increased, there is evidence that the lack of convenient ways of communicating meant that some people were less likely to seek advice unless they felt they had to. As one participant said,

I haven't had the opportunity to drop by anyone's office, so I only contact them for advice if I have something I really need to ask; things can't come up in casual conversation and I'm more hesitant to email someone than drop by their office.

That said, it seems that overall GTAs felt supported by the community, in part due to regular, weekly formal communication in coordination meetings and emails. For most of the courses, the weekly meetings played an essential role in keeping instructors connected to each other. Several instructors mentioned that these meetings became longer and were more important after the transition to remote learning. However, Calculus did not continue regular meetings for recitation leaders. The GTA coordinator of this course noted how interactions between recitation leaders notably decreased and suggested that these weekly meetings should be reinstated for future semesters to check in with recitation leaders and support their instruction. Recitation instructors expressed how this decrease in interaction hindered their ability to learn from each other, “in my experience, I have interacted with fellow GTAs much less frequently after the transition. That is a bad thing as it prevents discussion about things that work and things that don't.”

Identity. Another major component that changed after the transition to remote learning was how graduate students viewed their identities as teachers. Due to the university requirement that courses be held asynchronously, graduate students were no longer meeting with their students on a regular basis. As one GTA stated, “another thing...with asynchronous courses is it takes away, kind of like the feeling that I am actually teaching them because even if I produce some of the material, I don't see them learning or how they're using it.” Moreover, under the coordination structure, GTAs shared the responsibility of course development tasks such as creating course videos and writing discussion board questions. In some courses, GTAs split into groups with some focusing on course videos, while others focused solely on writing exams. This distribution

of curriculum development led some GTAs to view themselves as more of a content manager, rather than a teacher. As another GTA stated,

GTAs teaching convened courses have really been hurt by this transition from an experience perspective. The role of each individual GTA in teaching their students has gone from being of central importance to having almost no impact, since most lessons are now other GTAs teaching the material.

Unfortunately, the asynchronous structure provided more opportunities for exam dishonesty. As a result, GTAs felt like they needed to police their students more and be on the lookout for cheating. There were frequent discussions in coordination meetings about how to mitigate cheating and administer exams online. As one GTA noted, “there were a lot of talks about how to properly implement an exam online that would be resistant to cheating.” This shift from a focus on teaching to preventing cheating was a noticeable change for some of the GTAs in terms of their identity as an instructor. As one GTA said,

I also have not really been one to worry about cheating very much in the past because I never felt like I had to due to how the course was set up. Now that there are more opportunities for cheating, I feel like I have to actively do more to prevent it.

While this focus on cheating was overall a negative experience for GTAs, many GTAs expressed that because of the transition, they became more aware of equity issues. As one GTA said, “I believe it's heightened all of our awareness of the inequality in learning resources that our students have simply because of the difficulties some might have in procuring a good Wi-fi connection.” Another GTA mentioned that what he had learned from the transition would impact his practices in the future, saying that he thought Zoom office hours would be helpful in the future in order to encourage more students to attend.

What Stayed the Same

A major commonality throughout many of the interviews was the desire to preserve active learning in these courses. As one faculty member explained,

So the first step was then to look at the University's requirements, and in particular the asynchronous requirement and to think through what it meant to do math asynchronously while prioritizing active learning. So that was sort of our, our motivation was that it's got to be asynchronous and it has to get students active.

Despite this, some GTAs felt that the transition to asynchronous instruction was incongruent with the established values of the community, and department as a whole. As one GTA said, “almost everything is asynchronous. I understand why this is. However, I feel that this goes against the teaching ideas of the department.” Another GTA said that the shift to remote instruction changed the focus of teaching to be on how content should be delivered, rather than focusing on interactions with students. When speaking of challenges brought about by the transition, almost all respondents expressed concerns about student engagement – reflecting their shared desire to continue to engage students in whatever ways they could.

Another theme throughout these interviews was the desire for GTAs to retain some ownership of these courses. During the initial weeks of the pandemic, a faculty taskforce and the faculty coordinators were forced to make radical changes to course structures within a period of two weeks, allowing for little input by GTAs. However, once the general structure of these courses was established, GTA coordinators resumed their roles in the decision-making process to put these structures into place. Many of the GTA coordinators we spoke with expressed that they continued to have quite a bit of agency in directing the course and, in some cases, they felt that their role had expanded. Moreover, coordinators relied heavily on feedback and support from

GTA instructors to make changes throughout the remainder of the semester. As one GTA mentioned, “a lot more of the instructional materials were entrusted to the GTAs.” This underscores the level of trust placed on GTAs to support these courses. Although some GTAs felt like they lost control over individual instructional decisions, as a whole, GTAs retained a significant role in the operation of these courses.

Discussion

Despite the numerous challenges posed by COVID-19, University X’s first year mathematics community of practice continued to operate through the transition to remote instruction, providing support for GTAs as they strove to engage students in an asynchronous environment. Based on the analysis from this study, it is clear the community focused on retaining structures that allowed for increased communication (e.g., regular weekly Zoom meetings), while also engaging GTAs in creation of new materials which allowed GTAs to continue to collaborate with another about teaching, even if the actual face of teaching changed dramatically. Moreover, this situation allowed for some unexpected growth in GTAs as teachers. Many GTAs reported thinking differently (and more often) about equity issues than they had in the past, and some GTAs discussed how these experiences may influence their teaching in the future. Further, GTAs gained experience with online tools to support student engagement, and developed materials that can be used in future semesters (both for in-person and online courses) to support different instructional models. As an example, since these data were collected, these courses have switched to synchronous models that were heavily influenced by instructional insights from Spring 2020. In particular, the instructional videos that were developed in Spring 2020 were used to inform new video development over the summer; these videos are currently being used to support a flipped-classroom model in several of these courses. While we have not conducted a formal study on the community of practice since Spring 2020, there is strong anecdotal evidence that the community is still thriving, despite the challenges it has faced in the last year. One possible factor contributing to the resiliency of this community, that we have not yet touched upon, is that the community had already been formed to accommodate radical changes. In particular, the *community* is always in flux due to GTAs graduating and shifting into new roles within the department on a semester basis. As such, in its original formation the community of practice was forced to accommodate this by developing permanent structures and roles (e.g., the faculty members who oversee coordination of these courses). Future studies should explore this relationship further to better understand how the community is sustained.

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