

Where's My Whiteboard? The Challenge of Moving Active-learning Mathematics Classes Online

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Introduction

This work-in-progress paper describes the challenges that mathematics faculty and graduate teaching assistants (GTAs) faced when moving active and collaborative learning (ACL) in calculus courses from in-person to virtual instruction in Spring 2020. Understanding these challenges will help us create better support for GTAs and instructors moving to ACL in both online and face-to-face environments.

The change efforts discussed in this paper are part of an NSF-supported project that aims to make ACL the default method of instruction in highly enrolled gateway STEM courses across a large public Research-1 university. Active learning has been shown to improve both retention and understanding in STEM [1]. The theoretical framework for the project builds on existing work of grassroots change in higher education [2] to study the effect of communities of practice on changing teaching culture. In this project, instructors supported by GTAs and undergraduate learning assistants (LAs) formed communities of practice [3] focused on targeted courses. These communities of practice are informed by the findings of the Science Education Initiative (SEI), which identified academic departments and science education specialists as essential in supporting department change [4].

As part of this pedagogical change project, the mathematics department at the institution began transitioning calculus courses to an ACL format in Fall 2019. The effort focused on changing the format of the calculus recitations. In the new format, GTAs, with the support of LAs, used collaborative worksheets designed to guide student groups in solving problems and to increase student engagement and collaboration. The students worked on the problems on whiteboards while GTAs and LAs facilitated discussion. Students articulated their understanding of the problems and worked together to build understanding. GTAs and LAs could watch and listen to students' thought processes and provide immediate feedback.

This effort to change the mode of instruction in calculus was supported by weekly meetings of faculty engaged in the project, bi-weekly meetings of GTAs, and weekly seminars for LAs. When COVID-19 forced the rapid and unexpected transition to online teaching, these ACL efforts faced an array of challenges, particularly given their emphasis on student collaboration in shared physical spaces. Faculty and GTA reflections on the changes to teaching and learning due to the online pivot provide insight into support that can be provided to help instructional staff facilitate implementation of ACL across various modes of instruction. The guiding question for the current study was: How did the rapid shift to online instruction due to COVID-19 affect adoption of ACL in calculus courses?

Methods

This paper describes insights from interviews with faculty and GTAs who were teaching and supporting Calculus I and Calculus II courses in the Spring 2020 semester. All faculty and GTAs involved in these courses and additional faculty involved in the course-based community of practice were invited by email to participate in virtual semi-structured interviews. In total, six faculty and five GTAs responded to the invitation. They were interviewed during the final month of the Spring 2020 semester and during the summer months that followed to accommodate

varying schedules. All participants were asked 11 questions; in keeping with the semi-structured interview format, the interviewer probed more deeply on points related to the move to online instruction.

Interview questions focused on faculty and GTA experiences implementing ACL during the rapid transition to online teaching. Specifically, interviewees were asked 1) to describe the challenges they faced in implementing ACL as they moved their instruction online; 2) for their perceptions of how students responded to the shift to ACL online; 3) how technology helped/hindered the transition; 4) what role LAs played in ACL in an online format; and 5) how the transition to online learning impacted the larger change efforts toward ACL in the department. An open coding scheme [5] was used to identify common themes in the challenges faced by faculty and GTAs as they moved online. Sample questions included: 1) What challenges have you encountered in implementing active learning in your class/teaching as you move online? 2) What has been easy? and 3) How has technology helped or hindered the change efforts related to implementing active learning broadly in your department?

Results

Before COVID-19, efforts to increase the use of ACL in calculus classes focused on getting students to engage in collaborative work in physical spaces, using whiteboards to display their thinking. Discussions in faculty, GTA, and LA meetings focused on understanding the techniques that could be used to work within the physical environments that supported such activities. In an online setting, creating an environment that allowed students to engage with their peers and to articulate their thought processes as they solved problems was difficult and the rapid transition offered little time to think about how to reframe the goals in light of what the online environment can offer. Faculty and GTA interviews revealed several common themes in the challenges faced in the rapid transition to teaching calculus online. In the following, we organize the discussion in terms of perceived challenges for students, challenges for instructional staff (faculty and GTAs), and responses to those challenges.

Perceived Challenges for Students

Instructional staff's experiences in their courses suggested that students faced a variety of challenges when calculus courses moved online. Some of the most prominent challenges were related to technology. Connectivity was perceived to be a serious issue for some students, limiting their ability to attend class regularly and to participate in class activities. Students also appeared to struggle to embrace online communication modalities. Students appeared to be very reluctant to use video or audio, if they had them, making collaborative learning virtually impossible. One faculty member shared that the online environment made it more difficult for students to engage socially and that they were less willing to take risks.

Communicating written math in an online environment was another major challenge, particularly in a course in which that kind of communication was central to its design. The majority of students did not have the ability to write math symbols easily. One GTA noted that students were discouraged by the inability to write freely and that their enthusiasm for group work was lost.

Students' struggles with online communication were perceived to have had a significant impact on group work. As one GTA said, "Group work doesn't work if they don't talk to each other." One faculty observed that group leaders didn't emerge as naturally online, making group communication dynamics more challenging. Another faculty member noted that the lack-of-

confidence some students faced in-person was exacerbated online. While some students worked to motivate and encourage others in person, this was less common online, particularly when motivators had connectivity issues.

Challenges for Instructional Staff

For faculty and GTAs the challenges of pivoting online were similar to those they perceived for their students. Some had similar issues with connectivity and communicating with mathematical symbols online. While most faculty had a tablet with a stylus and were able to use freehand writing, this was not true for many of the GTAs, particularly in the earliest weeks of the shift. Problems remained when faculty and GTAs were able to use a stylus to write because most students did not have access to one, preventing a two-way exchange. One faculty member said, “There’s just something about that, like being able to point to the board, erase something and just that person to person engagement and it’s hard to replace that, no matter how good the technology gets.” Instructional staff found it difficult to gauge students’ levels of understanding and engagement. One faculty member who was using ACL heavily before the pivot mentioned a “lack of discourse” in the online setting, noting that communication and engagement norms that had been established in-person were gone and that new norms were difficult to establish.

On top of communication challenges, faculty and GTAs who were unfamiliar with the university’s learning management system struggled to set up virtual classrooms in Blackboard, structure their virtual classes, develop asynchronous content, and record lectures. For those who had used a classroom response system such as iClickers, new techniques for student engagement and assessment had to be identified. To facilitate group work, many ventured into using breakout rooms, but for some that proved too cumbersome given little or no time to learn the new technology. Some instructional staff abandoned ACL altogether since they reported being overwhelmed with the rapid transition to the online environment.

Response to the Challenges of an Online Pivot

Regardless of their prior experience and efforts to incorporate ACL in their classes, all faculty and GTAs struggled, at some level, to get students to engage online. Some faculty abandoned active learning, moving to an asynchronous model in which lectures were recorded and interaction with the instructor was only via office hours. Others continued with synchronous instruction, striving to reproduce the ACL efforts that they were using in person, sometimes by implementing a flipped classroom. GTAs leading recitations were provided with worksheets and instructions for how to use them. This approach provided structure for moving ACL online, making the process less overwhelming.

For instructional staff who chose to continue with ACL, significant changes were needed as online whiteboards lacked functionality and most students were reluctant to engage outside of the chat feature. For those pushing forward with ACL online, there was a reliance on the trust and community that had been built in their classes before the transition to online and vocal concern about how ACL would fare when classes were online for the entire semester without the ability to develop relationships and ACL expectations in person. As one faculty member remarked, “It also helped that I had a community established in both of my classes, so the students knew what I expected. Even though I didn’t see their faces I recognized a lot of their voices so I could call them by name.” These faculty and GTAs were, in general, more focused on identifying tools to help them implement ACL in the online environment. They knew what they wanted to implement, and the challenge was how to accomplish it in the absence of an easily

shared whiteboard and a physical space for discussion. One instructor commented, “I never lectured this course so it would be harder to go back to lecture.”

Once classes moved online, the focus of faculty learning community meetings moved toward adjusting to a virtual format. These meetings drew a broader group of faculty participants, including adjuncts. Faculty with years of experience in teaching ACL courses struggled during the online transition due to a lack of experience with technology. During weekly teaching conversations, these faculty members felt comfortable sharing their challenges with their colleagues, and other instructional staff offered to help them learn to teach in the online environment. This support included tutorials and regular communication to migrate ACL techniques into learning management systems and online course platforms.

For other faculty the challenges of moving online pushed them back towards traditional lecture, “Once we went online I really didn’t do anything to facilitate active learning in the course format. I was always encouraging students to get together outside of class and work together on stuff.”

Limitations

Findings presented here are drawn from one department in a single institution with a small sample size. Additional findings from other departments, institutions, institutional types, locations, and with larger participant samples would improve generalizability. Additionally, only faculty and GTA perceptions were sought. Future research should attempt to incorporate student perspectives.

Implications

Social networks act as resources for faculty to consult others regarding change [6,7], break isolation, seek support, [7,8], evolve to support growing communities [7], and provide access to social capital [8]. The differences in the challenges faced by faculty depending on their ACL and technical expertise point to the importance of communities that support struggling members while also evolving to support the community’s needs. For experts in ACL, a shift of teaching mode required assistance with technology so that they could adapt their techniques to a new environment. Overall, the help for faculty came largely from peers, highlighting the need to develop a community that works together and trusts one another to shift “teacher” and “learner” roles depending on the circumstances. Interviews with faculty indicate that experts at implementing ACL in person needed to know how to implement the teaching ideas already developed in their minds online, and access to the community of practice provided that. Instructional staff new to ACL needed a more detailed map, which was provided by the community.

Our study also echoes other studies’ findings. Similar to [7], we found that the communities provided opportunities to discuss and reflect on teaching with others. We also found that faculty in the math department shared responsibility and ownership of course design and implementation [9]. We also found that trust between faculty resulted in informal coordination [8], particularly in the assistance provided to members of the community that needed larger levels of support to overcome difficulties in the online teaching environment.

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