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A Community of Grassroots Leaders: Leveraging Faculty Networks to Create Change

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ABSTRACT
Our department is in the early stages of a multi-year effort to nurture a culture that values active learning. We focus on the change process, including specific, pragmatic ideas from the literature on grassroots leadership and systemic change. We briefly review Wenger's work on cultivating communities of practice and use Wenger's evaluation of communities to substantiate the value of our community at present. This lens sheds light on the progress made so far and documents the early value small communities of practice can generate during initiatives to diffuse active learning more broadly to their departments. Connecting the narrative of our efforts to literature allows other departments to think about navigating power dynamics and cultivating change on their own campuses. The literature helps to structure the narrative and provides research-based guidance for others.

KEYWORDS
Active learning; learning assistants; precalculus; calculus; recitations; grassroots leadership; communities of practice

1. INTRODUCTION

A small group of faculty in the George Mason University (GMU) math department is engaged in a multi-year project aimed at cultivating a departmental culture that values active learning [4, 8, 9]. We conceptualize the major change initiative as occurring in a small faculty community of practice [10]. This community serves as a supportive network of grassroots leaders within the department. As part of our efforts to diffuse active learning to a larger portion of our department, we have changed all of our Calculus I and Calculus II recitations to active-learning recitations. This change to Calculus I and II serves as a group initiative that brings cohesion and common purpose to our community. In the work that follows, we describe our efforts at this early stage of departmental change. First, we provide a brief review of the literature on grassroots leadership and communities of practice which we use to structure our narrative and connect it to theories of systemic change. Second, we describe university and departmental factors that influenced our planning. Third, we describe the initial change process through the lens of beginning a faculty community of practice. In that discussion, we describe, in more detail, the ways in which we navigated institutional and departmental power structures, cultivated university

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and departmental buy-in and leveraged the expertise of our department in order to make a set of initial changes. We are still a long way from understanding what parts of this initiative are working as-is, which need to be adjusted and how this will translate to student gains, so in the last part of this paper, we explore the ways our community has already brought value to our department through the lens of communities of practice [19].

2. THEORIES OF CHANGE

2.1. Grassroots Leadership

University pedagogical initiatives are routinely led by individuals or small groups of faculty which Kezar and Lester described as *grassroots leaders*: "Individuals who do not have formal positions of authority, are operating from the bottom up, and are interested in and pursue organizational changes that often challenge the status quo of the institution" [7, p. 8]. Successful grassroots leaders: (1) leverage the power of institutionally recognized discourses to argue for their initiative; (2) perceive power as multi-locational; and (3) as a result, build networks of support, seek out help from influential administrators and cultivate relationships to bring about change at the university [7]. Grassroots leaders who engaged in these practices were more successful and experienced less burnout than faculty who were unaware of power dynamics, or who viewed power as strictly hierarchical. Successful grassroots leaders refrained from confrontational approaches and instead engaged with power dynamics intentionally and strategically.

2.2. Communities of Practice

Creating a faculty Community of Practice (CoP) has served two purposes. First, the CoP serves as a network of grassroots leaders that supports the changes we have initiated. Second, we regard the faculty CoP as the primary mechanism through which departmental culture change will happen [10, 12, 14, 17]. CoPs are groups of people who gather (either loosely or in more organized ways) around a common set of values, goals or interests. In CoPs, knowledge is both shared amongst members and also co-created by members as the community matures. Under a CoP lens, as new members move to more central forms of participation, they feel greater sense of belonging to the community, develop a group-based identity, and align more strongly with community values, leading to cultural diffusion [10].

There are five stages of intentional CoP development [18]. The first stage is the potential stage which begins with a loosely connected social group. One person suggests making the group more formally organized, and potential participants begin to envision the new group. Four key issues face a potential community: identifying the core coalescing ideas of the community, identifying possible participants, helping participants understand the value of the community, and identifying the practical needs of the community. The second stage is the coalescing stage where

the community can start holding events and organizing meetings. During that time CoPs need to establish the value of the community, develop relationships, and understand what communal knowledge should be shared within the community. We are currently at the coalescing stage, and this narrative documents our progress through the potential and coalescing stages. The third stage is maturation where the CoP may experience growth beyond its initial scope which may challenge the community. The CoP reaches another state of institutionalization and must understand its relationship to other institutions that it interacts with. Stage 4 is stewardship in which the community may experience a lull in interest from its members. The CoP needs to focus on creating value for its members, perhaps through new energy, new ideas, new members, or new leadership. The final stage is transformation in which a community may experience a radical change, which can be a result of a significant number of new members, new ideas or new leadership, but can also be a sign of community dissolution. It is important to allow communities to change, grow, and develop organically, which is one of the fundamental differences between CoPs and committees under university structures [18]. Because our main goal is to cultivate a culture that values active learning in our department, because CoPs offer a way to operationalize a shift in cultural values and because evaluating early stages of success in systemic change is difficult, we evaluate our work under the framing of CoPs to understand the value this initiative has already created in our department, and how our community of active learning faculty is creating systemic change.

3. CONTEXT

3.1. George Mason University

GMU is a large public research university (27,000 undergraduate students in fall 2019), in Virginia, just outside Washington, DC, with a diverse student population in terms of race, ethnicity, and nationality. The university has recently been categorized as a Carnegie Research I institution. In 2019, 28% of our undergraduate students were first generation college students and the most recent US News Rankings rated GMU high on its diversity index. There is a large transfer population, primarily from the local community college system. The university has seen an increase in enrollment of 6300 students over the last 10 years which has not been paired with new tenure or instructional lines. The most recent accreditation review featured a Self-Improvement Plan centered on Student Scholarship, including Undergraduate Research growth as a key component. In 2019, Virginia designated new funding for improved recruiting, retention, advising, and progress-to-degree in STEM disciplines.

3.1.1. Facilities and Training

Dating back to before 2013, under the leadership of the director of the GMU's Teaching and Learning Center, Kim Eby, and others, the university has intentionally nurtured a culture that values active learning and a number of Active Learning

Classrooms (ALCs) were built. In the summer of 2013, after a Project Kaleidoscope planning process, GMU constructed a 72-seat room with 8 round tables of 9 students each, a monitor for each table, microphones, and whiteboards on all remaining wall space. Other ALCs have been built and GMU now has 20 ALCs, ranging in size from 24 to 72 seats. In 2021, a new building project will be completed that includes 27 more ALCs, ranging in size from 27 seats to 120 seats. When the 72 seat room was created, the teaching and learning center organized a nearly 2-year long faculty learning cohort for instructors that several members of our CoP participated in. The center continues to run workshops, organizes a 1-day yearly teaching conference, offers in-class consultations, and oversees a number of other active learning resources including a robust website, faculty learning communities and course redesign workshops.

3.1.2. Faculty Networks

This administrative support we receive through the teaching and learning center is magnified through positive relationships with faculty in other departments on campus who are also interested in active learning. As we outline below, this project is part of a larger NSF Improving Undergraduate STEM Education (IUSE) grant to study how to cultivate culture change around active learning in multiple STEM disciplines. The larger initiative involves Science, Engineering, and Higher Education faculty and central administration. The project is supported by our STEM Accelerator, which is an interdisciplinary unit, with faculty from mathematics, biology, physics, and astronomy, forensic sciences, geology, and chemistry. The Accelerator trains and mentors Undergraduate Learning Assistants (ULAs) who are essential to this project. The ULA program is almost 8 years old. It has grown dramatically, particularly in mathematics; in fall 2018, approximately 60 students helped in and out of class. Our project hired an additional 30 ULAs to support the calculus recitations and the infrastructure of STEM Accelerator allowed us to scale-up this initiative quickly.

3.2. Our Department

The mathematics department consists of roughly 26 tenure-line professors, 13 full-time instructional professors, and 13 adjunct professors. Statistics, mathematics education, and operations research are housed in separate colleges. Our adjunct faculty pool has grown considerably in recent years, along with modest growth in instructional faculty and almost no growth in tenure-line faculty. We offer BA, BS, MS, and PhD degrees in mathematics. Enrollment in mathematics courses has grown in recent years which has increased faculty teaching and service loads, particularly in STEM service courses. Because enrollment increases have outpaced both increases in faculty positions and facility construction, staffing all of our courses and scheduling classroom spaces has become difficult in recent years. These constraints, along with other important departmental factors have impacted our choices around active learning. We discuss some of these in the next few sections.

3.2.1. Departmental Culture

The mathematics department values independence and autonomy which significantly impacts our approach, and led to the adoption of a CoP model. Tenure-line, instructional, and adjunct faculty are all generally free to run their courses as they determine. Some departmental coordination occurs around common textbooks for large enrollment courses, like the calculus sequence, but even this amount of coordination does not occur for some large enrollment courses for which the instructors routinely make individual book selections. This has both benefits and drawbacks for our project, because faculty generally are content to be allowed to operate their courses without much departmental interference. Since the calculus recitations have not previously been coordinated under a cohesive departmental structure, they were an ideal location to try to initiate a broader departmental change without needing to cultivate immediate faculty buy-in from a significant portion of teaching faculty. It would be very difficult, for example, for our department to change all calculus lectures prescriptively and uniformly to active learning approaches because of the number of faculty involved in teaching those courses, and because of this history of independence and autonomy around course instruction. However, the department generally is open to active learning approaches. For instance, we have faculty who were Project NExT Fellows or who taught calculus previously at institutions who had implemented active learning on a larger scale, such as the University of Michigan. We also have a number of faculty committed to undergraduate research, which cultivates an environment valuing student inquiry outside the CoP.

3.2.2. Active Learning Experience and Teaching Expertise

This initiative benefits from the leadership of Bob Sachs and Mary Nelson, who both have extensive experience teaching in active learning classrooms and navigating administrative labyrinths. Further, our CoP benefits from the expertise of several other faculty with a broad range of experiences around teaching and who currently are central to the department through their service commitments. We briefly discuss specific experience and teaching expertise that informs the work that the CoP is doing.

Integrated Precalculus/Calculus I course. GMU, relying on the expertise of Mary Nelson, began an Integrated Precalculus/Calculus I sequence in 2013 that covers Calculus I in two semesters with Precalculus integrated through just-in-time approaches. This active learning course (36 students each; 3 credit hours; no recitation) relies on ULAs to facilitate small group discussions. Incoming freshmen with scores of 3 on the Advanced Placement Calculus AB (AP/AB) exam are given credit for the first semester of the sequence. We also offer a drop-down section of the first semester that begins in week 6; students who are struggling in a traditional Calculus I course can elect to drop-down to this Precalculus/Calculus I course without penalty. We offer four sections of this course with a fifth, dropdown section. We plan to increase that number of sections over the next year. Classroom and faculty constraints greatly impact how many of these courses we can offer.

Pilots in large lecture calculus. Two faculty (Bob Sachs and Mary Nelson) piloted active learning in large lecture calculus courses. In that iteration, Bob and Mary would switch classrooms each week to allow some lecture time in a large ALC. We were not able to repeat this project because of room constraints, but a second pilot with two sections of Calculus I and two sections of Calculus II is planned for spring of 2020.

Expertise in the CoP. Several faculty members in our community have histories of individual efforts towards inquiry and active learning in their classrooms: four faculty have taught in large ALC rooms; five have been involved in the integrated Precalculus/Calculus I course; others have experience teaching online, in flipped models; implementing group-work and using project-based learning. All faculty in this community have experience integrating the expertise of ULAs into their courses.

3.2.3. Traditional Calculus I and II

Historically, there were 8 large sections (90 students; 4 credit hours; 1 hour of weekly recitation) of Calculus I and 6 sections of Calculus II in the fall, with similar numbers in the spring. This amounted to approximately 1200 students in Calculus I and II each fall and spring. Calculus lectures are taught by tenure-line, instructional, and adjunct faculty. A typical 90-person lecture was associated with three 30-person recitations, though class size varied slightly. Recitations were led by Graduate Teaching Assistants (GTAs) who were typically responsible for leading six total recitations. The lecture classes were held in a traditional lecture hall, most with immovable seating and desks. Recitations were held in rooms with desks, and sometimes, with a large amount of whiteboard space, though it is unclear how many GTAs were utilizing whiteboards during recitation prior to our initiative.

Our Calculus I and II lecture sections use Thomas' Calculus as a textbook [16]. Because of our large transfer population as well as the impact of AP testing, we have organized the content in the calculus sequence in line with national norms. Calculus I covers the first five chapters of the book: limits, derivatives, integrals, and the Fundamental Theorem. Calculus II deals with applications of integrals, techniques of integration, differential equations, sequences and series, power series, and typically covers Chapters 6–11. Many of our current Calculus I students (roughly 75–80%) have had a prior experience in calculus, in line with national statistics [3].

4. AN ACTIVE LEARNING COMMUNITY OF PRACTICE

In the following section, we describe our process of beginning a CoP committed to active learning and held together through commitment to a centralized departmental project. Throughout the narrative in the next section, we comment on the ways we leveraged the power of recognized university discourses, built and relied on networks of support and created value for our department. Our hope is that linking our narrative to these bodies of the literature will help other departments who are striving to cultivate change within their departments.

4.1. Funding a Potential Community of Practice

A potential CoP has existed in our department even before the 2013 construction of GMU's first active learning classroom, but we begin this narrative with our proposal for funding during Phase 2 of the SEMINAL grant. The SEMINAL project (Student Engagement in Mathematics through an Institutional Network for Active Learning) is an NSF-funded grant aimed at building a network of large institutions sharing materials and solutions to common problems. During that grant proposal process, several department-wide conversations were held. A smaller group of five faculty members engaged in more detailed planning, about which the department chair was highly supportive. Though our initial attempts for funding via SEMINAL were not successful, we were later funded under a separate NSF IUSE grant proposal to study how to cultivate culture change around active learning in university departments. The NSF IUSE grant involves four departments at GMU: Mathematics, Physics/Astronomy, Computer Science and Biology. Mathematics was the first department to begin a change effort.

During this grant proposal process, we were engaged in a lot of initial thinking about changes we envisioned, and we describe in more detail conversations after the grant process in the next section. Funding allowed our CoP to move from a potential stage to a coalescing stage. In our early planning under the NSF IUSE grant, there was intentional and extended consideration given to institutional barriers to implementation of active learning and best practices about how to generate productive change.

4.2. A Potential Community

We have progressed through the first two stages of cultivating a CoP. In the first stage, the potential stage, participants begin to envision the new group and work on identifying the core coalescing ideas of the community, identifying possible participants, helping participants understand the value of the community and identifying the practical needs of the community. In the second (coalescing) stage, the community starts holding events, organizing meetings and become a start-up community. During this time, the community needs to establish the value of the community, develop relationships, and understand what communal knowledge should be shared within the community. During fall of 2018 to spring of 2019, our community progressed from a potential community to a coalescing community. Incorporating ideas from the grassroots literature, we needed to be sure our community was creating a supportive network of faculty that was conscious of navigating departmental power dynamics as the project got underway.

Our official planning began in fall of 2018 with a small group of invested faculty, including several mathematics faculty and the co-PI team of the IUSE grant. During that time, a workshop event for early the following spring was planned and implemented. Several facilitators from our administrative, mathematical, and faculty networks were recruited to help lead sessions. The department chair was

briefed on our plans. We also engaged in conversations with experts in the broader mathematics community about our ideas and plans.

In February of 2019, we organized a full 1-day workshop event to begin on those priorities for our potential CoP: identifying core ideas, possible participants and establishing value. This kickoff event was organized into two sessions. We wanted to be as inclusive as possible, so the morning session was open to graduate students and all tenure-line, instructional, and adjunct faculty. Only full-time faculty were involved in the more detailed planning and discussion that took place in the afternoon. A brief outline of that day's events follows:

Teaching discussion led by our Associate Provost. Our Associate Provost, Kim Eby, who formerly led GMU 's teaching and Learning Center facilitated a 1-hour session on teaching. She is highly respected across the campus, and an excellent facilitator of teaching discussions. Several adjunct faculty members and GTAs were part of this discussion. Kim Eby's presence served as a highly visible sign of support from the administration. Further, in coalescing communities, events that are well-attended by people from diverse groups is a sign that faculty found the event itself of immediate value, an early indicator of value created by the community for our department more broadly.

Active learning workshop led by experienced active learning expert. The second half of the morning session was led by Amy Ksir, currently at the U.S. Naval Academy, who is active in the Academy of Inquiry Based Learning (AIBL). The facilitator led participants in a discussion of the benefits of active learning for students, described her IBL experience, and facilitated an active learning mathematical activity. This expertise is an example of how we relied on informal networks of faculty in the mathematics community to build a case for active learning at GMU. The presence of outside leadership and expertise brought legitimacy to the pedagogical initiative, and again created immediate value for participants.

Planning retreat. In the afternoon, full-time faculty remained to begin planning the changes we wanted to make in our department. The afternoon session was facilitated by one of the grant co-PIs, Jaime Lester, who is a national expert on institutional change. In the afternoon, our group identified several issues which provided a framework for identifying the core ideas of the CoP. These central ideas helped coalesce our community around a common set of initiatives: (1) we decided to change Calculus I and II recitations to active-learning formats; (2) we would start a biweekly teaching seminar; (3) we would revisit our placement procedures for Precalculus and Calculus I; (4) we would build better teaching support for GTAs; and (5) we would deal broadly with the underpreparation of students for Calculus I.

4.3. A Coalescing Community

After that initial planning session, a smaller group of full-time faculty continued to meet during the spring of 2019, where potential community members discussed ideas in more detail and raised new issues. These early spring meetings included almost all faculty who are currently involved in the CoP and served to formally

coalesce the group into a loose meeting pattern and informal email distribution list. During this time, we connected with other mathematics departments with similar issues and were graciously given access to materials for active learning recitations from San Diego State University (SDSU), again an example of how informal networks with other mathematics departments contributed to the success of our implementation. During these discussions, the group facilitators (Bob Sachs and Mary Nelson) were intentional about creating space for all voices from the department to be heard about possible alternative pedagogical styles for the recitations. It took several sessions to settle on a new model of recitations but the time we used in those discussions created space for all faculty to contribute ideas to the proposed recitation approach, and helped the CoP to navigate potential roadblocks in departmental power dynamics.

The new model involved a comprehensive change to all Calculus I and II recitations to be implemented in fall of 2019. No changes were planned or implemented at scale in Calculus I or II lectures, though we hope to more slowly diffuse active learning to those environments as well. In the new recitations, we changed class size from 30 to 45 students, to be held in ALCs, with whiteboards on all walls. As noted earlier, because this project was funded, because we have broad administrator support and because GMU has made significant effort to build ALCs, we were able to secure use of these spaces. Recitations were led by 1 GTA and 2 Learning Assistants, which created a 15:1 student-to-assistant ratio in the active learning recitations. GTAs, who previously were leading 6 recitations each (covering 2 large lectures), now lead 4 recitations, still covering the same number of students, but with only four hours of time in-class which opened up time for them to participate in teaching training and conversations weekly.

The spring semester proved very busy once the nature of the recitations was envisioned. We adapted materials from SDSU for our recitations. This reliance on the broader mathematical community reduced the curriculum development workload of the project and allowed us to change to active learning recitations without needing to run pilots of curricular materials. We envisioned a new GTA-training model to support our graduate students as they transitioned to active learning methods. Two GTAs were hired and selected to act as peer-leaders for the initiative and help with some curriculum development. We recruited and hired nearly 40 ULAs, a move that was facilitated by our already established learning assistant program and the network of faculty in the STEM Accelerator. The contributions of the 40 additional learning assistants in the Calculus I/II sequence were essential as our GTAs were facing larger classes with active students. The increased size of recitations allowed us to free up some GTA time which in turn was used for planning, writing and meetings.

Work continued over the summer, in particular by Bob Sachs and Mary Nelson who were navigating the intricacies of early implementation. GTAs were introduced to the changes in recitations during a half-day GTA orientation before the fall semester. During the fall, the GTAs used (sometimes with adaptations) the SDSU materials in all recitations for Calculus I and II. GTAs for these courses met biweekly

to discuss upcoming material, share successes and challenges, modify the recitation materials, and most importantly, build a community where they were working together and feeling empowered to teach responsively. Sessions were co-led by two experienced GTAs and Bob Sachs.

The summer also slowed the momentum of the CoP. Once fall started, we failed to meet for the first few weeks of the semester, either due to a lack of coordination or just busy fall schedules. This was one of the major things that we look back on and wish would have gone differently. There were bumps and detours in other areas of this initiative, to be sure, but many of us missed those meetings in early fall 2019. Informal hallway conversations continued during this time and were very valuable to all members. This may point to one of the challenges of non-hierarchical group models. In some ways, this gap in our meetings allowed a faculty member to step into a fuller role in the community, when she began to more formally organize the group meetings. After our first meeting took place in mid-October, we continued to meet biweekly, to discuss both the current state of the Calculus I and II recitations and our plans for future diffusions. As a note, we did begin meeting early in spring of 2019, after this late-start in fall of 2019, learning from our mistake.

4.4. Highlights of the Narrative

Early departmental conversations in fall 2018 and spring 2019, generated departmental good will, connected with the department chair and helped us understand departmental power dynamics. Early faculty participation in the grant process also began to coalesce potential members of our budding community and organically generate conversations around active learning. External funding was essential to undertaking this project and provided valuable resources to our community. The funding proposal process facilitated the creation of a broader community of faculty across the College of Science and Engineering that are now involved in the project, as well as connected us to faculty in Higher Education, and external experts who could not be involved without funding. Beyond providing necessary financial support, funding increased the profile of the initiative in our department and at the university level. Understood in this way, funding is a discourse that carried weight with both the department and university administration, and facilitated the formation of a supportive network in university administration. Because this project was funded, we were able to leverage the visibility of the project to negotiate active learning classrooms for all of our Calculus I and Calculus II recitations, which needed a university committee approval.

We carefully cultivated a CoP around a common project by asking for departmental input early, carefully listening to the concerns of departmental members and developing goals together. Further, we understood the departmental culture well enough to understand where active learning could be quickly implemented in a large number of sections without requiring significant faculty commitment from a department in which innovation and independence are highly valued. Our eventual plan leveraged departmental expertise, an established ULA program and

institutional facilities. Further, the larger project coalesced a network of change agents with other faculty across the university and with other mathematics departments. SEMINAL, the Mathematical Association of America, the Joint Mathematics Meetings, and the Academy of Inquiry Based Learning allowed us to connect with other mathematics faculty for conversations and provided us with valuable resources. We relied on colleagues at SDSU, their *PRIMUS* description of changes in their calculus program [1], and the other articles in that special issue, along with the MAA Calculus Study results [2, 3, 13, 15], to guide our thinking. The AIBL community has also provided resources to us and partnered with us in departmental conversations [11, 20].

For other departments looking to undertake strategic planning for themselves, who may not have internal access to the expertise of Jaime Lester, who guided many of our conversations about this change effort, the University of Kansas has a planning document through their Community Toolbox to help grassroots leaders think through the change effort they are suggesting. In particular, Chapter 8 of that document is a very pragmatic approach to outlining goals, identifying resources and assets, identifying fellow agents of change, and planning strategies and tactics for implementation [5].

5. EVALUATING VALUE OF OUR COMMUNITY OF PRACTICE

Wenger et al. [19] provided a framework to measure value creation in CoPs, which they suggested should be understood through the individual and collective narratives of the community. Questions for narrative reflection on value include (paraphrased here):

Immediate Value. What was the quality and quantity of engagement like?
Potential Value. How has the CoP changed individuals, social relationships or the standing of the CoP in the larger institution?
Applied Value. Where have individuals or the CoP applied the knowledge or social relationships generated in the community?
Realized Value. How has the CoP impacted individual success more broadly?
Reframing Value. How has the CoP led to changes in institutional values, culture or priorities? [19]

In the section below, we reflect on how the CoP has generated value for us as individual practitioners, for our CoP as a group and for our department more broadly. We conclude with a brief description of our plans to intentionally diffuse active learning more broadly.

5.1. Individual Innovators with a Common Goal

As individuals, the CoP brings immediate value to our lives by being a supportive and engaging space for members to come to talk about our own personal efforts in

active learning; the bi-weekly meetings are as much about our own teaching as they are about the calculus recitations. The idea that teaching is challenging is normalized and we routinely reach out to one another when we encounter a teaching issue. More experienced members of our group are as transparent about their struggles and successes as are new active learning practitioners, and this has led us to freely share knowledge across expertise. The community has demonstrated ongoing commitment to support individual CoP members in their own efforts to engage in active learning as well as to support this more unified approach to the calculus sequence. All members of the CoP benefit from the active learning experience of others, all without putting forward a single vision of what active learning is. Like AIBL, we adopt and enact a "large-umbrella" approach to active learning, and we are more flexible practitioners for it.

Given our departmental history of independence and autonomy, the CoP model allowed us to conceptualize and implement a vision for systemic change that could reasonably be diffused without needing to revert to more hierarchical forms of organization. The CoP model has allowed us to carry forward the values of our department and embed them in this project and in our CoP. Even within the coordinated calculus recitations, we cultivate a culture that allows GTAs to adapt, create, and critique the active learning materials we are using, and our practitioner knowledge around active learning grows because of the creativity of our faculty and GTAs. We felt it was particularly important to be responsive to feedback from the GTAs so that all participants could feel heard and acknowledged, but also because we felt that the GTA perspective was important for us to understand what was happening in our department. They are particularly well-positioned to provide valuable feedback, both on what support might be helpful to them, and on student issues in recitations. We view this as a huge success of this early community and a model for how this change may continue to diffuse through our department without creating departmental resistance by running counter to existing culture of independence and autonomy.

The ongoing engagement of 6–7 faculty in a project that is completely voluntary over a 1-year timeframe, we would argue demonstrates the immediate value of this community. Further, our own narrative that this is the community we turn to for advice and ideas around active learning speaks to the quality of that engagement in our coalesced community. Several members of the CoP acknowledged that the community had given them courage to try something new. Gabriela Bulancea spoke to the influence of the CoP on her approach to teaching. Both Joanna Jauchen and Catherine Sausville have taken on more and more expansive departmental service and leadership roles in parallel with their participation in this project. These individual members reflect that it was their participation in the CoP, their commitment to the success of the project, and the support of the other members of the CoP that led to this pursuit of new forms of teaching and service. This example of realized value for particular members of the community also brought into the community new knowledge and skills.

5.2. Leveraging Community During Emergency Online Instruction

"One piece of evidence of how much we want the active learning, is how much we hate doing this online. If all we wanted to do is stand in front of a room of faceless people and lecture, we could be doing that. We'd just be doing that into our iPads and be done." (Patricia Granfield)

During spring of 2020, the world experienced a global pandemic that caused our university to move quickly to online instruction. During that time, two members of the community who were also experienced online educators, Joanna Jauchen and Catherine Sausville collated and created materials for the entire department to utilize to move to online instruction. These just-in-time resources described best practices, technological tools, and assessment strategies that might be a good fit for implementation in mathematics classes in a compact format aimed at math faculty. Those resources were distributed and utilized by the department, along with other resources provided by GMU 's teaching and learning center to quickly allow faculty to pivot to remote teaching. Further, Joanna's work organizing the CoP meetings led her to feel comfortable organizing similar teaching discussions for full-time faculty, adjunct faculty, and GTAs during this emergency time. The first discussion, described to faculty as a conversation about teaching, drew more than 25 participants, all gathering to discuss approaches to remote learning. Teaching conversations continued weekly, and while attendance decreased over the next few weeks to about 10–12 people per week, CoP members are routinely in attendance, along with other faculty members. While these conversations have not centered on active learning, they do demonstrate how the centrality of good teaching to our CoP was leveraged to create broader value for the department with very little notice. In many ways, this demonstrates both the potential and realized value of the CoP to the department during this particular time. Further, these conversations, necessitated by global emergency, revealed that many faculty outside the CoP were interested in approaches that allowed for more student-centric forms of teaching. Conversations included discussions of how to facilitate group work online, what collaborative whiteboard spaces were available and how to continue our Calculus I and II recitations in active learning formats. These questions demonstrate support for more student-centric forms of teaching in the department broadly, but also the idea that our community members and others in the department may have insight into how to continue those teaching strategies, even online.

5.3. Departmental Curiosity and Intentional Diffusion

These glimpses of student-centric teaching that were witnessed in the teaching conversations were echoed by members of the CoP. Several members reported hearing about or being involved in conversations with other faculty who are talking about active learning. One small group was discussing active learning in Calculus III. Another pair of research collaborators were discussing active learning in a hallway chat. One of the CoP members, Patricia Granfield who had been away

from the department for 5 years in the honors college, returned to the department to find "real change" in the departmental curiosity around active learning. She herself acknowledged that she was skeptical at first, asking Mary Nelson "Why would I put them at the boards? It just seems like a waste, but she [Mary Nelson] convinced me."

We are hoping to leverage this curiosity into more widespread diffusion of active learning, possibly through these overlapping, smaller communities within our department to expand the number of active learning practitioners, and active learning sections in the department. We have planned to double the number of lecture sections of the integrated Precalculus/Calculus I course from 5 to 10, which will require a substantial number of additional faculty to engage in some form of active learning for those small sections. We are also actively recruiting faculty to participate in a second pilot of the innovative half collaborative lecture, half active learning lecture for both Calculus I /and II. We secured meeting space for that pilot for fall 2020, but as the global situation has changed, we now plan for that pilot to occur in spring of 2021. Finally, our department is hiring four new instructional faculty for fall of 2020. Two of the members of the CoP are sitting on the hiring committee, and the advertisement included an emphasis on experience with active learning. So we're hoping to expand the number of faculty engaged in active learning in the fall simply through intentional hiring practices.

6. Conclusion

Real systemic change is messy, with challenges both anticipated and not [6]. Top-down initiatives often lack grassroots knowledge and have difficulties sustaining buy-in. This dynamic has sidetracked many K–12 and university reform efforts. Conversely, grassroots leadership often lacks resources that come from more formal positions of power. A multi-layered approach, in which grassroots leadership is combined with supportive networks in administration and faculty, can avoid or mitigate these pitfalls. This requires strategic planning and intentional network building which acknowledges both the constraints and benefits of the cultural environment of the institution. Our goal in this article was to demonstrate how we used such an approach, leveraged the knowledge of individuals in our CoP and created networks of support to create an ongoing change effort and process for the future. It is hoped that others who embark on change efforts will find this account useful in shaping their thinking and actions. The authors are happy to hear from others engaged in this sort of work, share what we have learned, as well as learn from others' experiences.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

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BIOGRAPHICAL SKETCHES

Gabriela Bulancea is a term assistant professor. She also serves as the Director of the GMU Math Learning Center. She has been teaching at GMU for the past 7 years. During this time, she had taught at least one large Calculus lecture each semester. In her lectures, she engages students using group work and student response systems. Each semester she is assisted in class by one or two undergraduate learning assistants, who help with the in-class group work and offer office hours and review sessions outside regular class meeting time.

Patricia Granfield started her career as a lawyer, but her love of math prevailed and she became a faculty member in the Mathematical Sciences Department at George Mason University in 2003. In 2011, she transitioned to a position in the Honors College as an Honors Math instructor and STEM advisor, working with students and faculty across all departments of the College of Science. In 2018, she returned full-time to the Math Department to teach, advise and work on the calculus redesign. As of Spring 2020, she decided to retire and is looking forward to post-Covid traveling with her husband.

Joanna Jauchen has been a math instructor at GMU for 8 years. She was a member of the initial ALC cohort at GMU, and teaches from a feminist perspective through the use of cognitive mentorship. She feels incredibly lucky to be a part of this CoP and is so grateful for all she has learned from the other practitioners.

Jack Love was a term assistant professor at GMU and outreach director for the Mason Experimental Geometry Lab. He left GMU in Summer of 2020 to pursue other passions, and we will miss his thoughtful contributions to the group.

Mary Nelson is Associate Director of the STEM Accelerator and is active internationally in the Learning Assistants Alliance. She created our extended Calculus I with Precalculus course first at CU Boulder during her time there and then upon her return to George Mason. She has won multiple teaching awards at CU and Mason.

Robert Sachs is a professor of mathematics and served 8 years as Department Chair. He is a co-PI on the NSF-IUSE grant and is always actively learning about Active Learning.

Catherine Sausville started her journey at George Mason University as an undergraduate in 2000 and transitioned to a full-time faculty member in the Mathematical Sciences Department in 2010. In addition to her teaching, she also serves as the Director of Undergraduate Studies, Director of Math Placement Testing, Precalculus Coordinator and Faculty Senator for the College of Science. She is currently acclimating to teaching her active learning classes fully online, while her dachshund coworker supervises.