understands and point them to particular areas for further study. One student worked a derivative problem beautifully but could not evaluate $\sin(\pi)$ at the end. I looked at the list of oral quizzes, which ended at 5:30. I responded along the lines of "you just did beautiful, sophisticated work that showed a solid understanding of how a derivative works and what it tells us about the function. Your last calculation hinges on a solid understanding of an important trig function, $f(x) = \sin x$. I'm going to schedule you for a follow-up discussion at 5:30. I'd like for you to have learned the graph of $f(x) = \sin x$ by then and use it to evaluate some basic x-values." At 5:30, the student reappeared on Zoom with a solid understanding of the $\sin x$.

Harnessing the Power of Oral Exams Elsewhere in the Classroom

The success of the sample oral quizzes and exams led to the creation of an entirely new approach to studying for the final exam. I assigned individual students one important problem to prepare for the final exam. I met with them over Zoom and recorded each student working their problem. I collected these individual videos in a folder on our Blackboard site titled "Video Final Exam Review." I encouraged students to utilize even three minutes of free time to view one of the videos and work through a problem that would help prepare them for the final. Students absolutely loved this collection of problems and reported that, indeed, in the moments before dinner, or right before bed, or in an afternoon lull, they would go the folder, click on a video, and work a problem. "Sometimes I watched the same video a few times just so I could get down all the steps," one student commented.

What Faculty Gain from Oral Exams

1. First and foremost, faculty gain an accurate assessment of what your student knows (and does not know) about the material. It only takes five or ten minutes to gain insight into a student's understanding of mathematics. Students cannot hide in an oral exam.
2. More efficient grading. You can grade on the spot. (No electronic grading!) I purchased a large stack of legal pads. I wrote out the problems on the paper and used the margin to keep track of assessment. I used a similar sort of grading rubric as I did for written exams. For example, for a Calculus problem worth 10 points that asks where a function has a horizontal tangent line, I would allocate three points for translating the problem into a question about derivatives, four points for doing the calculation, and three points for determining where the derivative equals zero. This allowed students to earn some or all of the possible points, as with a written exam. I generally did not interrupt students, even if they were moderately off track. If they were well into a problem and completely headed in an unfruitful direction, I might suggest they begin the problem again

with a different approach and then subtract some points for this "tip." I made all of my oral quizzes worth 10 points. For tests with five problems, I made each problem worth 10 points and doubled the score.

3. **Joy.** I had struggled to find the same delight in the remote setting of a classroom consisting of 1×2 inch rectangles on my computer screen as I did when teaching in a "normal" semester. An oral exam with each student reminded me of why I got into this business in the first place—to build and strengthen lives through mathematics.

Realistic Outcomes for the Future

Taken together, these experiences suggest that the restrictions of the pandemic present an opportunity to give thought to new and, perhaps, improved ways to teach mathematics. To be sure, there is confusion and anxiety in the current moment. Maybe now is not the best time to completely revamp teaching styles. But now may be the best time to reconsider seemingly tried and true techniques from a fresh perspective. The lessons we gather now could inform meaningful changes for the future.
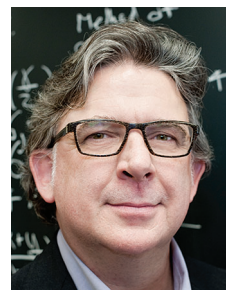
Della Dumbaugh   William McCallum

Credits

Photo of Della Dumbaugh used by permission of the University of Richmond.

Photo of William McCallum is courtesy of the author.

Building Equity-minded Online Programs

Justin Lanier and Marissa Kawehi Loving

So you want to start a program to help build and serve the mathematical community. And you want your program

Justin Lanier is an NSF postdoctoral fellow in the Department of Mathematics at the University of Chicago. His email address is `jlanier8@uchicago.edu`.

Marissa Kawehi Loving is an NSF postdoctoral fellow in the School of Mathematics at Georgia Tech. Her email address is `mloving6@gatech.edu`.

to be effective, inclusive, and equitable—and these days, probably online. What should you do?

Two years ago we were in this exact position. We knew how isolating the start of grad school can be, and we wanted to start a program to help connect first-year grad students online to combat this isolation. And we knew that this experience of isolation can be especially acute for students belonging to groups historically excluded from our mathematical communities.

The resulting work-in-progress is the SUBgroups program, now in its second year (`www.gradsubgroups.org`). We'd like to share with you the lessons we learned and the toolkit we developed as we worked to design an online program that serves its entire audience—a task that requires meeting the particular needs of minoritized participants. We hope our experiences can be useful to you as you plan and organize your own initiative.

A Year of Change

Two seismic shifts have hit the world this year. In May, police officers killed George Floyd. The inequalities entrenched in our institutions came into sharp focus during the national Black Lives Matter protests that followed his killing. In the wake of the uprising, many mathematicians are reckoning with the racism pervading our academic institutions and are being energized to effect change within their departments and research groups. We want to get involved to make change, to do something!

This renewed focus on racial justice takes place against the backdrop of a global pandemic that has upended our lives. We have shifted so many of our academic activities online in an unprecedented way: teaching, conferences, seminars, research meetings, thesis defenses, and more. This collective move of our professional lives to an online setting, combined with an increased need for virtual connection to combat physical isolation, has stoked interest in creating new programs, forums, and opportunities.

In this moment, there is a great possibility for positive change, but our efforts must be accompanied with care and foresight. Whenever an activity is moved online or a new online initiative is started, there is a real danger of recapitulating the inequitable and harmful structures that often already exist in our departments and fields. Heightening this danger is the speed at which our mathematical lives have shifted to online settings. The ease of starting new online programs can bring with it a "move fast and break things" ethos; this can lead to harm, especially to the well-being and professional lives of our most precarious community members. We must take steps to create mathematical programs and communities that serve all mathematicians.

A Toolkit

Building a new program of whatever size is a long-term process. It involves choosing a need to address, designing the structure of your program, and then carrying out your plans. It is important to bring the same care and judgment to designing your "broader impacts" that you use to craft your research program: we must choose which problems to work on, understand the literature, and find some initial insight on how to tackle the problem—an "edge."

Here are a few items to reflect on as you get started. Some of them we had in hand when we began our work together, while others are lessons that we learned along the way. We hope you'll find them to be useful tools for building online programs with equity in mind. In the next section we'll use SUBgroups as a case study to give examples of how to use this toolkit in practice.

1. **Don't just do "something."** The first step in starting a new initiative, online or not, is to pause and think critically about what you are trying to accomplish. Who are you trying to serve? What explicit need are you attempting to address? What experience are you aiming for your participants to have? Remember, your intentions aren't what drive outcomes—your decisions are what drive outcomes. Beliefs need to be turned into working structures. Because of a sense of urgency, it is understandable to want to put your first ideas into action. But it's important to pace it out and think about what individuals will be served by your program, and how. You need an intentional plan—an "if you build it, they will come" mentality will not suffice!

   One pitfall is addressing problems only superficially, rather than at their root. Or providing a resource but not thinking through how individuals will be able to access it. Another pitfall is letting the professional pressure to obtain funding shape your approach. While funding, prestige, and advancement are all interconnected—and this can be a challenge to navigate—there are often many ways of addressing a problem that require little or no funding. Don't ignore these!

2. **Do your homework**. It's possible and even likely that other people have previously worked to meet the same need that you wish to address in the math community. Find out what structures are currently in place. Can you borrow ideas or structures from these programs? Are there aspects of the problem that existing structures don't yet address? Just as when you are doing math research, understanding the landscape of a problem can help you to define and refine your goals and plan of action. It's also important to build relationships with individuals who can give you input based on their experiences and expertise; they might also become a part of your team. It can also be useful to search for programs or approaches that address similar needs in other STEM fields.

3. **Undo harm**. In setting up structures and norms for your program, it is easier to imagine and scope out the experience of the majority. If you design a program with a "default" user in mind, your program can appear to function well while excluding or harming

individuals with less access, prestige, or privilege. To draw on a familiar aphorism, you may think your rising tide is lifting all boats, but this same tide may be sinking some of your participants. There need to be explicit mechanisms and strategies established to avoid and mitigate harmful hierarchies and power structures within your program. For example, in theory any new platform where anyone can participate and discuss will benefit everyone equally; but in practice it will serve and amplify the voices of those who already have power and privilege unless care is taken in how the platform is structured.

4. **Leverage scale effectively**. Creating a program that will happen online allows for it to scale where the logistics and resources required for in-person programming would be prohibitive. This capacity is why there should be more online activities even in nonpandemic times! If your online initiative is not local to your institution, be prepared to take steps to support a bigger audience, just in terms of logistics, workflow, and technology. Make sure that you are advertising your program in ways that reach the wider audience that this new scaling allows for. On the flip side, the scale of the internet also means that it's important to consider who's listening. The same language and structures that make sense and are welcoming in the "local" setting you are used to might come across as alienating or unwelcoming to the much larger and more diverse audience that life on the internet brings. For example, an all-white panel for graduate students on navigating the job market isn't exclusionary if your department doesn't have any students of color in it, but it sends a clear message about who your panel aims to serve if you advertise more widely.

5. **Actively solicit feedback**. Once your program is up and running, it is important to get feedback about how it's going, especially from the most marginalized people that your initiative aims to serve. It is important to distinguish between feedback that is formative and feedback that is summative—one provides information that can help you to modify your program as you go (candid reactions), the other allows participants to give more holistic feedback as they reflect on their experiences with some distance (considered criticism and deserved praise). It can be useful to solicit them separately. Avoid asking for "anonymous" feedback that also collects demographic information. Again, using multiple feedback instruments can be helpful here. Finally, remember that opportunities for feedback don't have to be uniform, just as the experiences of your participants will not be uniform; without being burdensome or tokenizing, reach out to minoritized participants to better understand their experience of your program.

A Case Study: SUBgroups

SUBgroups is an online peer support program. Each participant is either a first-year math PhD student, a first-year math master's student considering a PhD, or a student in a math post-bacc program. Each SUBgroup is composed of three to five participants. A group meets regularly over the course of a semester or quarter for a video chat that lasts approximately an hour, once every two weeks on a fixed day and at a fixed time. Ahead of these meetings, participants are asked to reflect on their week and to come up with a positive experience, a negative experience, and some math that they've encountered recently and that they might choose to share in their SUBgroups meeting.

In fall of 2019, SUBgroups had 60 students participate from a diverse collection of programs across the country and beyond. As we are writing this, we are just starting our fall 2020 program, helping to support over 200 first-year students in what will certainly be a stressful academic term. This fall we're also excited to share that a group of junior physicists is running a program for first-year physics graduate students that is modeled on SUBgroups, called SU(5).

We now give some examples of how we used the five tools outlined above to help shape SUBgroups.

1. **Addressing isolation through virtual community**. We knew we wanted to address the tough experience of being a first-year grad student—an experience we both encountered first-hand. We chose as a focus the isolation that comes with being a beginning graduate student, when it can feel like no one really understands what you're going through. We knew of lots of ways of finding social connections on a campus or within a department—and we'd heard all the advice about joining an intramural league or going to departmental tea. But the core idea of SUBgroups was that it could be really powerful to put first-year students in touch with each other, in a way that a single department couldn't coordinate on its own.

2. **Programs existed only at the local level**. We knew of attempts to provide support within individual departments, such as pairing beginning and more senior grad students. This can be a positive support, but the fact that it is local leaves a worry that any negative comments or experiences shared with a peer mentor might "get back" to other people in the program. So in surveying what kinds of supports were in place for beginning grad students, we did not find an example of a program like we had envisioned in SUBgroups. At the same time, SUBgroups wasn't designed in a vacuum; we relied on our many experiences in small group facilitation. We built into SUBgroups norms and routines to ensure more equitable participation in discussions, such as prompting participants to do some reflective writing ahead of meetings.

3. **Disrupting isolation through participant-tailored groups**. We recognized that if we just brought students

together and randomly assigned them into small groups we would likely end up reproducing many of the conditions that led them to feeling isolated in their programs to begin with. In particular, some students might once again be the "only one" in their group—the only woman, the only Black student, the only queer student—and this experience is compounded for people with multiple minoritized identities. To address this, we asked for demographic information as part of registration and also asked students if they had any requests regarding the composition of their group. This required extra work and care in order to comply with privacy laws like the EU's GDPR, but we knew that this information would help to make functional and difference-making group dynamics possible.

When deciding on the structure of the SUBgroups, we debated whether to provide each group of first-year students with a more senior grad student mentor to help facilitate the group meetings and answer any big-picture questions about math grad school. Ultimately we decided against doing so since it introduced an unequal power dynamic into the group which we felt would inhibit honest and open sharing of experiences between participants. This decision wasn't without drawbacks. There were a couple of groups that unraveled after their first meeting or two without a senior point person to coordinate meetings and help with rescheduling. This year we are modifying the way that meetings get scheduled to help build agency and responsibility for participants up front to avoid this consequence of our decision about mentors. At the end of the day, there is no way to ensure a perfect outcome. Still, it's important to think critically about the impact that even these (superficially) purely logistical questions can have on meeting your goals.

4. **Advertise! Advertise! Advertise!** We believed we could leverage scale in the online space to help address this collection of problems: isolation felt by graduate students, the claustrophobia of the first-year experience, and the compounding "only one" challenge. Of course, one concern we had during the organizing phase was that we wouldn't have a broad enough swath of students participating to accommodate students' requests for their group composition. Our solution was to advertise as extensively as possible. We reached out directly (with individualized emails) to the graduate directors and chairs at about 200 math graduate programs in the US and Canada. We also advertised in community Facebook groups that are focused on various underrepresented groups in math as well as advertising through the NAM newsletter and the AMS grad student newsletter. This fall we also specifically contacted a number of minority-serving colleges and universities, to raise awareness about SUBgroups among underrepresented minority students who will be starting graduate programs in the next few years.

In addition to far-reaching advertising, we have aimed to make SUBgroups as inclusive as possible while still being focused enough to address the specific needs we outlined. For instance, we've received a number of inquiries about whether applied math students or students who plan to pursue teaching-focused positions can participate in SUBgroups, as well as inquiries about whether our program is a good fit for students in statistics, math education, or bridge-to-PhD programs. We have added language to our website to clarify that all of these are within the program's audience.

5. **Disaggregating student feedback**. Asking for feedback is one area where we definitely still have room to grow in running SUBgroups. We asked for feedback from SUBgroups participants after the first meetings and again at the end of the program. It was all fully anonymous. We did get some good early feedback that reassured us that groups were functioning and that people were generally having positive experiences. The response rate was not as high as we would have liked, however. Our closing survey gave us several choice quotes that felt good to read and were helpful in further advertising the program; it also pointed out places in the program that could use improvement. In addition, since our surveys were anonymous we had no way to ensure that we were hearing from minoritized individuals to better understand how our structures were meeting their needs and expectations. This year we will gather additional feedback from our underrepresented participants on their experiences in SUBgroups.

There are lots of social, human, and structural problems within the math research world that are either unaddressed, or not widely recognized, or not even clearly identified. These problems need to be worked on creatively, energetically, and thoughtfully—and it's never too early (or too late) in your career to get started! We hope that the toolkit we've outlined can help you to think critically about how you develop initiatives to meet these needs.

Justin Lanier

Marissa Kawehi Loving

Credits

Photo of Justin Lanier is courtesy of the author.
Photo of Marissa Kawehi Loving is courtesy of the author.