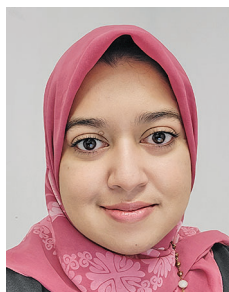


At Math Corps, math is just the beginning. It is the foundation of our camp family, and the building blocks of what we do. But we also nurture kindness, integrity, and courage because we believe that perseverance is greater than perfection. We ask nothing less of middle and high school kids than to change the world. And while it may seem lofty, we know their inner resilience. Hence, we show them love in every way, every day. Because love is exponential. Love grows up and comes back to give love again. Love sets an example and knows that to be it, you have to see it. With love, care, and support, every kid can find their inner greatness, they just need someone to believe in them. At Math Corps, we believe in them, and you should believe in all the kids, students, and people in your life too.



Mobashira Farooqi

Credits

Photo of Mobashira Farooqi is courtesy of Mobashira Farooqi.

Supporting First-Year Mathematics Graduate Students

Benjamin Braun, Uwe Nagel, and Erica Whitaker

Introduction

Graduate school is a challenging time, and the first year is particularly difficult for many students. Over the past six years, faculty and graduate students in the University of Kentucky Mathematics Department (UK Math) have collaborated to develop, implement, and interconnect activities

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and resources to support graduate students with special emphasis on supporting first-year students. When we have discussed these activities and resources at workshops and conferences, we have been surprised by the level of interest from other departments in some of these programs. So, our goal for this article is to share the structure and design of these programs along with several challenges we face in our mission to support graduate students. This article is intended as inspiration rather than prescription, since every department will have different needs and resources.

We have focused on the following three areas: (i) academic support, (ii) training and professional development in teaching, and (iii) social-emotional well-being. A critical ingredient for this work has been collaboration among faculty and graduate students. Without this collaborative spirit, this work would not have been possible! For anyone wanting to improve support for graduate students, we recommend working with a team (each of our efforts started with a small, focused team). Also, our efforts fall within a larger context of university-wide initiatives from the Graduate School, Counseling Center, the Center for Support and Intervention, the Violence Intervention and Prevention Center, the Center for Graduate and Professional Diversity Initiatives, and others. It is important to seek out and connect with existing resources at your university. For professional development in teaching, it also helped to collaborate with faculty at other institutions. We sent teams to two of the MAA CoMInDS workshops on College Teaching, and found the community, discussion, and resources there very helpful.

Another recommendation arising from our work is to formally involve graduate students in providing input on decision-making processes for the department. The Math Graduate Student Council (GSC) is the student organization officially recognized by the UK Math Rules of Procedure¹ as representing the graduate students. Our Rules of Procedure require that the GSC provide a statement of views for all promotion and tenure cases, that input from the GSC will be solicited regarding matters of academic policy related to graduate students, and that a representative of the GSC will be invited to faculty meetings. These practices are incredibly important for the health of our department.

Also, it can be helpful to seek external funding to initiate programs; from 2014–2021, UK Math had an NSF S-STEM award² to support our “Graduate Scholars in Mathematics” program. Several of the activities and projects described in this article started through this grant and have subsequently been incorporated into our regular graduate program structure.

¹<http://www.ms.uky.edu/~chair/DeptDocs/rules-191008.pdf>

²DUE-1356253

Early Orientation

What are the *first things* that we want graduate students to have the opportunity to experience when they arrive in our department? We believe this should be more than just passively listening to general orientation information about policies and procedures. Instead, we want students to (1) meet other new graduate students in our program, (2) practice and receive informal feedback about mathematical collaboration skills, (3) learn productive and effective ways to define and self-assess “success” in grad school, (4) develop useful language for discussing struggles and failures, (5) practice and receive feedback about independently reading mathematics, (6) learn about good places to work on campus, and (7) review fundamental ideas in linear algebra. To make this happen, we have developed an Early Orientation³ program for new students. This is an optional three-day program consisting of six three-hour sessions that occurs a few days before the university-wide TA orientation. Most of our new graduate students participate.

In the first session of the Early Orientation, students discuss these seven goals and get to know each other through icebreaker activities. The remaining five sessions are dedicated to coached collaborative readings of one or two articles from the *American Mathematical Monthly*, focused on topics from linear algebra. Students are assigned to different groups for each session and work together to read and make sense of the articles. Productive collaboration strategies are introduced and as students work, they are provided with feedback on how they are collaborating and on ways to make their collaboration more effective. Students are also led through moderated group discussions where they discuss the emotional challenge of doing difficult mathematical work, and of managing the common feeling that you are failing when others around you are succeeding. By normalizing and making open for discussion ordinary emotional responses to the stress of graduate school, we hope to accomplish two goals. First, we hope to reduce anxiety, depression, and other mental health challenges commonly experienced by graduate students⁴ by encouraging students to talk with others about challenges they are facing. Second, we want students to view campus resources such as the UK Counseling Center and the UK Center for Support and Intervention as useful resources that are valued by our department community.

Another component of the Early Orientation is a strong emphasis on developing metacognitive skills, asking questions such as: “Where am I in this? What am I doing? Why? What standards am I holding myself to, and are they realistic/reasonable?” There is an explicit emphasis

³<https://math.as.uky.edu/sites/default/files/early%20orientation%20schedule%202021.pdf>

⁴E. N. Satinsky, T. Kimura, M. V. Kiang, et al., Systematic review and meta-analysis of depression, anxiety, and suicidal ideation among PhD students, *Sci Rep* **11**, 14370 (2021), <https://doi.org/10.1038/s41598-021-93687-7>.

on engagement and persistence, rather than achievement. For many students and faculty, our broader culture has trained us to view normal progress toward deep learning as repeated failures, and the Early Orientation is an opportunity to subvert this message before classes begin. We emphasize to students that it is important to define success as a measure of yourself against yourself, not against other people, and ask students to reflect on and discuss their personal goalposts for success in the coming semester. By working with students to help them develop clear personal expectations, they can begin their coursework with more confidence about their approach, and with an established, supportive peer group.

The Early Orientation requires one faculty volunteer to run the program. When funding has been available, the department has also paid one or more senior graduate students to serve as assistants for the sessions. As we will discuss at the end of this article, we believe it is important to pay graduate students for their work, and to avoid relying on unpaid graduate student labor (though living up to this aspiration can be challenging, for a variety of reasons).

After the Early Orientation, all new graduate students participate in a university-wide orientation and a UK Math Orientation. At the university-wide orientation, organized by the UK Graduate School, students receive general information about UK and participate in a two-day “Microteaching” experience. The goal of the Microteaching program is for all new TAs at UK to receive training and practice on how to effectively give presentations to students. The UK Math Orientation is a general introduction to the department that includes faculty presentations about our research groups, several Q&A with current graduate students about different aspects of the graduate student experience, an introduction to TA expectations, and academic advising meetings.

Bridge Courses and Prelim Coaching

It is important that graduate programs “meet students where they are at” in their mathematical development. There are many ways to do this, for example bridge courses and peer coaching.

Our graduate program admits students with a wide range of academic backgrounds. Most of our incoming graduate students start by taking Principles of Analysis, Modern Algebra 1, and Linear Algebra. The role of Principles of Analysis and Linear Algebra is to be a bridge between the typical undergraduate experience of our students and the expectations of our graduate courses. It is understood by faculty that these courses should help students develop their proof-writing and mathematical reading skills, in addition to learning mathematical content. Rather than expecting students to have knowledge and skills that we know they typically have not developed, this transition to graduate study is built into our course structure. Students who enter our program with significant amounts of advanced coursework have the option to move directly into more advanced courses.

Graduate students in UK Math are required to pass three written “prelim” exams from a list of six areas; each of these exams is based on one of our course sequences. To provide extra support and guidance to students as they prepare for their prelims, the math department pays senior graduate students to lead coaching sessions for the prelim exam areas that are in highest demand. The funding for this program was originally provided by our Graduate Scholars in Mathematics grant and is currently funded by the Dr. J.C. Eaves Supplemental Support Fund, supported primarily by Jim and Mary Eaves. Each prelim coaching session consists of four study sessions in the weeks prior to the examinations. Each of our prelim coaches creates a set of practice problems for students to work on and provides guidance and advice about problem solving and study strategies.

First-Year Seminar

While the Early Orientation, Orientation, and Bridge Courses provide graduate students with opportunities to interact with and obtain support from faculty, the reality is that many new graduate students are either intimidated by faculty or (understandably) concerned about how faculty perceive them. Thus, for a new graduate student who is struggling with basic proof strategies, or who is having difficulty making sense of their textbook, it is helpful to have an alternative resource. We believe every graduate program should have structures in place to help address this challenge; one of our responses is our First-Year Seminar (FYS).

The FYS is an optional-but-strongly-recommended seminar for first year students. This seminar is not for credit and it is led by a senior graduate student who serves as the FYS leader, which counts as half of their TA load. The seminar meets once per week and follows a syllabus⁵ that has been co-developed by the FYS leaders and faculty since 2018. The specific topics for the FYS include self-explanation training⁶, strategies for exploring definitions, strategies for developing holistic understanding of proofs⁷, collaboration strategies, good question-asking skills, self-reflecting on growth, fixing errors in proofs, and various forms of proof by induction. These topics have been identified by students and faculty as important but likely to be left unaddressed by our curriculum, either because they have not been explicitly taught or because they benefit from revisiting to be fully understood.

The FYS leader is supervised by the Director of Graduate Studies and is in communication with the instructors for the bridge courses to find out which additional topics or issues might need to be addressed. The FYS leader provides an additional feedback loop into our system that allows graduate students to have their concerns relayed to

department leadership, even when the students prefer that their comments be anonymously relayed through the FYS leader. In addition to this feedback loop, the FYS leader is also able to provide some context and reassurance when new graduate students are having a lot of anxiety about their work.

Peer Mentoring and Student Organizations

Another channel in the feedback loop between first-year students and department leadership is a peer-mentoring program organized by the GSC that pairs each first-year graduate student with an experienced graduate student. The peer mentoring program originated as part of the Graduate Scholars in Mathematics program and was initially organized by faculty; at the request of the GSC officers, organization of the peer-mentoring program was moved to the GSC. The GSC officers send a survey to all the new graduate students asking about their interests; an interest form is also sent to the current graduate students to identify potential mentors. Peer mentors are expected to meet with their mentees every week or two to check in and see how things are going.

One of the strengths of the GSC peer mentoring program is that, like the First-Year Seminar leader, peer mentors can help bring issues to the attention of the GSC officers, who are then able to bring those to the attention of the DGS, while providing anonymity when desired. It is also common for first-year students to seek out faculty support based on the recommendation of their peer mentors when faculty assistance is needed, or to seek out services at the UK Counseling Center. As faculty, we are continually impressed by the ways in which our graduate students support each other.

In addition to the GSC, our department has student chapters of the Association for Women in Mathematics, Spectra, and the Society for Industrial and Applied Mathematics. There is a university-wide chapter of SACNAS that was co-founded by a UK Math graduate student. Faculty and graduate students participate in an interdisciplinary working group on Ethics, Equity, Inclusion, and Justice in the Mathematical Sciences. The GSC organizes a weekly colloquium run by graduate students for graduate students, and both GSC and AWM host weekly department teas. Every spring, faculty in the department organize an Alumni Day at which doctoral alumni from the department return to talk about their careers and share advice on how to prepare for jobs in academia, business, industry, and government. Through this range of opportunities, we hope that new graduate students can find a supportive niche where they feel welcome and included.

Professional Development for Teaching

The majority of graduate students who choose to attend UK are interested in a career where teaching plays a central role. UK Math historically had two primary sources of training for new TAs, both of which are included in our current

⁵https://math.as.uky.edu/sites/default/files/First_Year_Seminar_Syllabus_2020.pdf

⁶<https://www.lboro.ac.uk/departments/mec/research/mathematical-cognition/self-ex-training/>

⁷<http://digitaleditions.walsworthprintgroup.com/publication/?i=298634&page=1&p=33>

training structure: a two-day “Microteaching” experience provided through the Graduate School orientation and a 1-credit hour course titled “MA 601: Teaching College Mathematics,” taught annually by a faculty member in UK Math. Various additional aspects of TA development in the department were addressed through other means. In an effort to unify these activities and make them more coherent, in Spring 2018 a group of faculty gathered to establish our department’s TA Professional Development. This has been good for our department, and we recommend that every department develop a written plan for TA training.

Our TA Plan identifies four general areas of focus for TA training and professional development: classroom practices, assessment practices, tutoring practices, and course design practices. For first-year TA training, the TA Plan assigns responsibilities to faculty in four components. First, there are two presentations and Q&A by faculty at the new graduate student orientation. Second, at the beginning of the semester there is a meeting for all UK Math TAs to review policies and resources such as FERPA, academic honesty, tutoring centers, a reporting chart in case of problems, and the department expectations for TAs. Third, at beginning-of-semester meetings with each course teaching team, the course coordinators lead TAs through practices for managing group work, expectations for course preparation, effective communications practices, and syllabus expectations. Fourth and finally, the TA Plan specifies a curriculum for our MA 601 course that directly reviews and builds on the training new TAs receive in the first three components.

The new graduate students are typically assigned as recitation leaders in either our Calculus I or Pre-Calculus courses. By assigning new TAs into only these two courses when possible, we decrease the number of course coordinators who are responsible for supervising and training new TAs, and we also create natural communities and cohorts for the new TAs as teachers.

Challenges for the Future

While we have made a lot of progress in supporting our first-year graduate students in their transition to graduate studies, various challenges remain. We highlight below four particularly difficult challenges that we think are common across institutions.

1. **Effective communication in the first three weeks:** There is a huge amount of information to convey to new graduate students, and it is understandable that many messages will not stick immediately. We have still not found an optimal way to disseminate information to new graduate students at “just the right time” through the course of their first month in the department.
2. **Supporting students who are minoritized in our department:** While our department has a supportive and vibrant graduate student community, this community is predominantly White, predominantly US citizens, and the majority of our students identify as

men. As a result of this, some of our students of color, international students, and women have not felt fully included and heard in our community. Further, as is the case with almost every university, minoritized students have experienced microaggressions and/or acts of discrimination from people in the department and in the greater university and civic community. It is critical that we continue to work to improve this situation.

3. **Communicating expectations to students while removing barriers to success:** One challenge for graduate programs is to simultaneously (A) communicate to students that graduate school is extremely difficult and (B) remove all unnecessary difficulties for students. In other words, we want the challenges and difficulties that students face to be related to learning mathematics deeply, rather than about navigating complicated bureaucracies, or finding mentors they can trust, or having uneven levels of clarity regarding different expectations, etc. Clearly distinguishing between these and gaining faculty consensus for changes to our program remains a challenge.
4. **Funding:** We want to be able to compensate graduate students for their contributions to the department whenever possible. Typically, these efforts are hindered by a lack of funding sources and by bureaucratic barriers. Given the impact of the covid-19 pandemic on university budgets and enrollments, it is not clear what the future will bring.

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