Pathways to a Career Outside of the Academic Silo

Elizabeth Munch

Whether we want to believe it or not, the world is changing. In particular with the rise of data science and high performance computing, there is no longer a single career path to be followed by a person with a Mathematics PhD.

I earned my PhD from a traditional math department in a traditional university. I held a tenure-track position in a traditional math department, and still have a 30% appointment in one. I was expected to do only traditional math research. It was quickly made clear to me in my first years of a tenure-track job that I would need to conform to the template of what those institutions thought of as a “real mathematician,” or I would fail. For me, satisfaction in my career came after my move to a new, interdisciplinary department, with all its freedoms and challenges. For some of you, the tenure-track position in a math department is your personal definition of success. I truly believe there is much good work to be done from that vantage point, and I wish you the best of luck. However, this advice is not for you. I’m writing to offer advice to those looking to make their mark outside of any single academic silo by looking for a career path in an interdisciplinary department, program, or institute.

No advice is unbiased. My advice comes, admittedly, with a heavy dose of survivor bias. Additionally, my axes of privilege, including being white, cis-gender, heterosexual, and having a big-name university attached to my PhD, have yielded a great deal of something-that-looks-like-luck over the course of my career. Finally, I only have experience in the American academic system; what I say may be wildly incorrect outside of the United States. Given these limitations, I invite you to sit with my advice, and if it doesn’t fit for you, I encourage you to simply dismiss it.

Perhaps you are nearing the end of your PhD program in a math department and are working to envision where you can see yourself and your career in the next five years. Perhaps you are excited about the possibility of research in an interdisciplinary setting, but are trying to figure out what that would look like. This advice is for you.

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1Nor was there ever.

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What Options are Available?

An interest in something-other-than-tenure-track-math does not necessitate leaving academia. There has been a steady rise in interdisciplinary departments and institutes inside of academic settings which are not “math departments” or even “applied math departments” per se, but instead are created to foster interdisciplinary collaborations. These fall roughly into two categories. The first, like the Department of Computational Mathematics, Science, and Engineering (CMSE) where I am at Michigan State University, is just that: a department. We have our own faculty, our own undergraduate and graduate students, our own tenure committee, our own self-determination.

Some of our faculty have PhDs in Mathematics, but others have PhDs in Physics, Biology, Statistics, and many flavors of Engineering. For me, a primary appeal of being in our own department is that tenure expectations are tied to measures not usually celebrated in your run-of-the-mill math department. The expectations in my interdisciplinary department naturally align with the goals I have for my own work. I am expected to form interdisciplinary collaborations and publish across boundaries. I am expected to create and share open source code that could make the work we do available to others. I am expected to teach less, but to also bring in more grant funding to support graduate students. I am expected to find ways to communicate mathematics to colleagues without a graduate-level mathematics background. In short, the tenure expectations reflect what I already wanted to do. We are by no means the only such department: other examples include the Halıcıoğlu Data Science Institute at UC San Diego and the Department of Scientific Computing at Florida State University.

A second category of collaborative, interdisciplinary academic settings is that of non-departmental level institutes. Some examples of this include MIDAS at University of Michigan, and the Oden Institute at the University of Texas. However, rather than having tenure-granting status, these institutes bring together interdisciplinary-minded faculty, who are still granted tenure within traditional departments where their primary appointments are. One advantage of this arrangement is that a faculty member can retain a more traditional job title while still accessing a setting that actively fosters interdisciplinary collaboration. One challenge of this arrangement derives from its spread across campus, both in terms of physical office space and in terms of expectations. Then again, now that we live in a Zoom-infested world, the geographic challenges are nowhere near as insurmountable as they may have been even a few years ago. However, issues that should be thought about in advance include regular offering of courses; which department these are associated with; and how students who are spread across many degree programs don’t get to interact with each other as much.

Use any and all resources to see what options are available to someone with a math PhD. Make use of your university’s career office before you need it. They can help you build resumes and career documents long before you are setting them up in panic mode. The earlier in your PhD that you can get a sense of career options, the more time you have to seek out preparation and opportunities that will set you up for those positions. The first options that may come to mind for those trying to find alternatives to the usual career path are things like research positions in industry. Another exciting set of options are government research labs (e.g., Pacific Northwest or Sandia National Laboratories), which offer some potential for a middle ground between an industry and academic setting at the expense of limitations in terms of visa status.2 Having no experience in those settings myself, I can do little more than encourage you to reach out to people in jobs that look like what you want at those places to understand more of what those career options look like.

Preparation Before You Go on the Market

Be active about obtaining experience and skills that will enable you to compete for the kind of job you want. For jobs in interdisciplinary departments or institutes, no amount of coding experience is too much. I won’t wade into the which-language-is-better debate3 because once you learn one computer language and start wrapping your brain around basic algorithmic and data structure tools, transferring your skills to whatever language your future job demands will be fairly straightforward. Even for the die-hard pure mathematicians out there, the ability to code can open so many research doors, particularly for automated testing and development of conjectures. Basic programming should be a required skill for every mathematician, but I digress. If possible, look into documentation that you have acquired these skills, such as online course certificates, that make a bigger impact on your CV than just saying you can, e.g., code.

The next thing to do is get out of the math building. Do you have a particular application area you are interested in? Start attending talks in that department. Maybe even try to attend an interdisciplinary conference. No, you likely won’t understand everything in the talks, but you can start to get a sense of what people in the field are interested in; the problems they focus on; the vocabulary they use to convey their meaning. I have found that interdisciplinary research is often a matter of learning something close to a new language in order to translate across fields. We mathematicians are trained to have a precision in our language based on definitions we all have agreed upon. But, this concept is just as true in other fields. My favorite issue on this front has been trying to discuss “homology” with biologists. Sure, you’re reading the Notices so if you know what

2For US labs, and depending on the lab and project, there might be restrictions requiring US citizenship or permanent resident status.
3The answer is Python, don’t @ me.
“homology” means, you have a very specific definition in your head. But if I stand up and use the word in front of a bio conference, they think that I’m discussing the idea that bat wings and human arms are inherited from a common ancestor. To this end also, if you can find a grad student colleague in your applied field of interest, take them out for coffee. See if you can explain your research in a way that they can understand. See if they can explain theirs to you while you try to understand the big picture. In the future, developing collaborations might be tied to being able to have discussions like this with people who don’t all start with the same vocabulary list and/or definition, so practice! If you can manage it, having a project (even a small one) across disciplinary boundaries can go a long way towards showing your potential for working with people in these sorts of fields and will definitely strengthen your CV. But, even if these discussions lead you to a place where you can give a sense to someone outside of the math department what it is you study and how it might be utilized, it will be time well spent.

Preparing Documents and Interviews

Again, due to my experience within the US academic system, I will focus on advice for the documents and interview experience for a non-traditional academic job. The documents required for many of these jobs will be the same as for a standard math department job: research, teaching, and DEI statements. The biggest unwritten difference comes in the research statement, where you need to ensure that you are writing for the correct audience. For instance, in my department, the faculty have PhDs in many different fields, so explaining the mathematical advancements I have made, and especially placing them in a context that they can understand, often requires a change in vocabulary and a view towards big picture explanations. I want to emphasize that this is possible without a loss of rigor, and practicing this skill has made my research stronger by giving me a broader perspective of where I want to go. As a bonus, interdisciplinary or not, you will surely use these skills on any grant application you submit. For the teaching statement, you should be sure to do some homework to get a sense for what classes are taught in the department to which you are applying, especially for these new programs that are coming into their adolescence with the development of new interdisciplinary courses and majors.

My advice when it comes to the interview is similarly related to communication. You will be talking to people with very different backgrounds. In advance of your interview, make sure you have prepared a few versions of your research “elevator pitch”: a version for experts, a version for non-expert mathematicians, and a version for non-mathematicians. Having a solid place to start in these discussions can lead to very productive conversations. My advice for your job talk is similar, where I recommend giving your talk in a way that all but (at most) the middle third of the talk is accessible to non-experts. That way, you have people engaged at the beginning so that they can see the big picture, as well as the long game in your conclusions.

Questions You Should Be Asking

So you’ve gotten the interview! Congratulations! The biggest thing to do now is make sure you ask A LOT of questions about expectations for the position. Once you leave the standard departmental structure, there are many potential surprises as the program might not be run the same way your PhD-granting department was run. I’ll speak to a few of the learning curves I experienced when transitioning from having a tenure-track job in a math department to my tenure-track job at CMSE.

The first major difference was graduate student training and recruitment. In mathematics, we generally accept a student to the department without an official advisor. We train them for two years or so by giving them a heavy course load to gain a broad mathematical foundation. Sometime in the second year, the student starts doing some reading with a potential advisor, and then assuming all parties agree, the official advisor relationship starts after that. In my department, however, students matriculate directly into an advisor’s group. The upside of this arrangement is that my graduate students can start with focused research and training from the beginning. The downside is that if a student comes into graduate school the way I did (that is, with a very different view of the kind of research I wanted to do than what I actually ended up doing), there is a bit more friction in terms of changing their direction. This is mitigated by having a collegial department where students switching among groups is viewed as a natural part of the graduate program rather than a failure on the part of the student or advisor.

To this end, the other major difference I found when moving to CMSE was a difference in how funding worked. Because mathematics departments often get a great deal of funding through service courses such as Calculus, student funding largely comes in the form of TAships. Because the funding is not tied directly to a funded grant, a student shows up in your office, and you start reading some things together that seem interesting and develop a research project from that. On the other hand, at CMSE we have a more limited allotment of TAships for students (although this is changing with the rise of the very popular data science courses), so I am expected to bring in more grant money in order to ensure funding for my group. This also means that student projects are more tightly aligned with the proposals that have been funded. I by no means view this as a bad thing, since it has enabled me to develop a clearer view of the big picture. Because I have the grant as a template, I can hand a new student a decently detailed research

4I didn’t even know that my research field existed until several years into grad school.
project outline with key references and goals already in place, allowing them to get off the ground much faster.

Finally, a critical issue to explore in an interview is tenure expectations. In my experience, when working in an interdisciplinary space, unwritten rules and implicit assumptions about what it means to be a “successful” faculty member vary wildly across disciplines. To any extent possible, your goal should be to have a written understanding of expectations, particularly with respect to joint appointments, course load, funding, publication rate, and graduate students. This can be incredibly helpful towards guiding your focus over the tenure-track period, and ensure no one ends up surprised or angry at the end.

A Conclusion and a Call for Change
Moving to a non-traditional position was absolutely the best decision for my career. These sorts of positions are not for everyone, but building something new while pushing out the boundaries of what academia can be has been an incredibly gratifying experience. We need more mathematicians working across disciplines to bring the joy of mathematics and the training in logical thinking outside of the math department to ensure better numerical literacy, to create more informed citizens, and catalyze new knowledge in science. I know standing at the precipice of your PhD is a scary place to be when it’s not clear where this path will take you next. Whether you end up inside or outside of academia (with a particular emphasis on the fact that taking jobs outside of academia is no less of a success than taking an academic job), know that your training gives you the potential to do great things! I wish you the best of luck on your exciting journey!

Elizabeth Munch

Credits
Photo of Elizabeth Munch is courtesy of Harley J. Seeley/MSU College of Natural Science.