chair, departmental politics, grant proposals, teaching, setting up a webpage (1999! Still have the same one; looks like it's from 1993). More importantly, what to do mathwise? My good old friend $\bar{\partial}$ was no longer on my horizon. Hilbert schemes? Yes, but it was not the Hilbert schemes anymore, really. Somehow, the topology of complex algebraic varieties, with its difficulties, was occupying my thoughts. It had started dwelling in my mind without much fanfare as a result of thinking about Hilbert schemes. It was there, and it did not budge. What was going to happen? I was on tenure-track, needed to write papers, get grants, and this math was so new to me (and so weirdly exciting). What if it did not pan out? What about the grant renewal? Tenure (tick-tock)? In the end, there was really no choice. It was too interesting, difficult, and beautiful. The light was too blinding. I went towards it, and that was it. Luckily, as it turned out, it was not a truck.

Today

Undergrad years, compulsory military service, grad school, postdocs, tenure-track, promotions… It's all a vivid, awesome blur. There have been more changes in direction since then, but, at least mathwise, none more pronounced than the ones of my younger years. When I look back (when do I do that? There's no time!), it seems to me that the real changes of direction in my research were not recognized by me as such when they started happening: I was simply drawn to work on something that fascinated me, and to do that, I needed to learn and discover new math. And it was fun, pure and simple. At some point, suddenly, I found myself already moving in a new direction. It seems that there was no moment in time when I made a conscious decision to change. Quite simply, it just happened. And I am very, very happy it did.

Mentoring Undergraduate Research: Advanced Planning Tools and Tips

Courtney R. Gibbons

My first experience with mentoring undergraduate researchers was as the undergraduate mentee, and the critical importance of that summer features prominently in my mathematical coming-of-age story. That summer was a success because my mentor had a pretty clear idea of what we would do: the problem, the schedule, the follow-up. With this in mind, I'm sharing five homework exercises that I assign to myself (now that I'm the mentor!) to make sure that my students and I have a fun and productive experience.

But first, a reminder: Whom you mentor matters. Students form their mathematician identity through their experiences with us, the mathematicians in their lives. Our outside recognition of them as "the kind of people who do math" is a component of this development, especially for students who don't see themselves represented in mathematics often or at all. For an entry into the literature on this topic, see the recent paper [RCJ19] and its thorough bibliography. The upshot? Inviting students from underrepresented groups in mathematics to work on our research projects is one way of committing to diversity and inclusion in our profession.

Exercises

I recommend completing these exercises several months in advance of your anticipated research project with undergraduates. For example, if you are thinking of working with students over a summer, consider working on them between the fall and spring semesters.

Exercise 1. Answer two questions: What do you hope to get from the collaboration? What do you hope your students get from it?

Your answers here (and below) don't need to be deep, philosophical reflections; keep it workable. For example, when I was a pretenure REU mentor, my goal for me was to produce a paper with my team. My goal for my team was to give them each ownership over specific parts of the project.

It's a good time to state that every piece of advice comes with exceptions! While I usually ask students to work on a project I designed, I've had gung-ho students pursue their own problems, and they've come up with surprising (to me) approaches and results. In those cases, I revised my goals for myself and made sure I felt like I had enough background to jump in and help.

Exercise 2. Write up a project proposal, including the problem(s) and a potential pathway to a solution.

The first time I did this, I didn't have a choice. I had agreed to be a visiting REU mentor, and I had to write this as part of the grant proposal. I think it's the most useful exercise on the list. From this, you will figure out what kind of background your future research students will need and what supplemental material they'll need to learn. You will start to see how to divide up the project into parts.

You can guide students along a path and stay a few steps ahead of them. You can even assign students some preliminary homework if they seem interested in working on research with you!

Exercise 3. Decide on the length of the collaboration and structure your time.

1. Break the project into phases: ramp-up (literature review, "classes" to cover background material, and time for students to build up stamina), active research, and

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ramp-down (writing up results in various formats). Fill in some of the details for each phase. What topics will you cover? What software will your students learn to use? What will students be responsible for presenting?

2. Draft a sample weekly and daily schedule. Big blocks of unstructured time are great for research if you already know how to support your research process. Those doing research for the first time benefit from having finite chunks of time planned for specific purposes.

Your weekly schedule can include a lunch outing, times for group meetings, or whatever you like to break the time up. For first-time researchers, I schedule 2–3 hours twice a week to sit side by side and work on math so that I can help them develop research practices for what to do when they're stuck. If there are other faculty working with students along a similar timeline, I coordinate with them to have joint "show-and-tell" meetings.

Exercise 4. Write a paragraph dedicated to your future research student to share your expectations for them and yourself. How much time do you expect them to work on the project each day/week, and how will you keep them accountable?

I have found that remote mentoring is far less effective than mentoring in person. For me, this means when I decide to work with undergraduates, I'm committing to being in the same room (at the beginning) and in the same building (later on) for most of the collaboration.

Exercise 5. Describe how you will commit to your students' professional development after the time is officially up. Will you send them info about conferences where they can present? Will you write down some preliminary notes for letters of recommendation?

I like to keep a file with notes about what my students accomplished during our project and any other tidbits I think might be useful for future formal or informal recommendations. It can be as simple as a text file.

Parting Advice

Working with undergraduates was a highlight of my early career. Not every project turned into a bullet point in my research portfolio for tenure and promotion, but the energy that each young researcher brought to a collaboration gave me a booster shot of enthusiasm for all of my projects. Without other commutative algebraists around to talk to in my department, I found it was talking to my research students that did the most to keep me motivated and productive. I'll finish with the advice I received that I keep in mind when I start a new project with undergraduates: be ambitious for your students; they can learn a lot and do excellent work. They may just be your best local collaborators.

References

[RCJ19] Sarah Rodriguez, Kelly Cunningham, and Alex Jordan, *STEM identity development for Latinas: The role of self- and outside recognition*, Journal of Hispanic Higher Education **18** (July 2019), 254–72.

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Credits

Author photo is by Victor Lou.