

MENTORING STUDENTS AND POSTDOCS

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One way to summarize the VIGRE program in one sentence is to say that its goal is to improve the training of mathematicians at all levels — graduate, undergraduate and postdoc. This entails improving retention, attracting under-represented minorities to mathematics and helping them succeed, and also creating interest and opportunities in mathematics (increasing the number and quality of math majors etc.). VIGRE seeks effective new ideas for achieving these goals. Mentoring is a basic tool in these endeavours.

The following thoughts on mentoring are based on experiences in the Mathematics Department at Duke University.

Issues in mentoring. Since we are trying to improve the training of mathematicians in general, I suggest that, in as much as is possible, *all* students and postdocs be mentored in the same way — regardless of citizenship or involvement in other aspects of the VIGRE program. Doing this should help ensure the durability of the benefits of VIGRE. Of course, VIGRE funds can only be used to support citizens and residents of the US. Mentoring is also a valuable tool for all departments, not just those with VIGRE support.

Mentoring Undergraduates. Undergraduate research provides an ideal vehicle for mentoring, as well as an effective way of getting students interested in continuing their mathematical studies. Participating in a research project is a great way for undergraduates to learn to think creatively, and to write up and talk about their results. In order to be successful, this requires mentoring.

Supervising undergraduate research projects is an excellent way for postdocs to gain experience supervising research students. It is natural (and a good idea) for the postdoc to be mentored in this endeavour by a faculty mentor.

Undergraduates will take away much more from mentored research projects than just the mathematical skills they have developed during the project. Undergraduates are often unaware of opportunities in mathematics (and other sciences). They are often unaware that graduate students in mathematics are paid to study and teach. And they are

frequently unaware of emerging areas, such as mathematical biology, in which there is likely to be considerable employment opportunities, both in and outside academia. Mentors can bring such opportunities to their attention.

At Duke, we try to recruit undergraduates into our REU program at the beginning of the junior year. The mentor can then direct students towards courses which will help provide background before the actual research is undertaken in the summer between the junior and senior years. During the senior year, students typically continue their projects through reading courses and finish with a paper or senior thesis. Undergraduates involved in research projects give talks to each other at various stages of their research. The quality of presentations typically improves considerably over the course of the project.

Mentoring Graduate Students. Here it is a good idea to keep our goals in mind — decreasing time to degree, improving retention rates, broadening the education (and the opportunities) for graduate students, improving teaching and communication skills, including writing.¹ Many of these roles have traditionally been, and continue to be, filled by the thesis advisor. However, many places, including Duke, are finding it very useful to assign mentors to incoming students, whose role is to mentor students until they have a thesis advisor. They can help guide the student through the standard oral or written exam, and help the student think about possible areas of study and with the process of finding an advisor. They can also aid with the improvement of communication skills, oral and written by having the student present solutions to sample exam questions.

In addition, there are opportunities for group mentoring. For example, some funding agencies (such as the NIH) now require that graduate students and postdocs in departments that receive their funding be given ethics training. I will elaborate on this in the section on group mentoring below.

Mentoring Postdocs. In a broad sense, the mentoring of postdocs is to prepare them to be more effective faculty members, if they are headed to academia, or to guide them towards the kind of interdisciplinary research experiences valuable for those who intend to work in industry or government labs. Postdocs should be encouraged to show

¹Halmos' articles *How to write mathematics*, L'Enseignement Math. 16 (1970), 123–152, and *How to Talk Mathematics*, Notices of the Amer. Math. Soc. , 21 (1974), are great aids.

initiative in their research, teaching and service. Specific thoughts on mentoring postdocs include:

- Postdocs are in transition between being graduate students and full-fledged faculty members (or researchers in an industry or national lab). Some postdocs may need help in balancing their research and teaching responsibilities, especially early in their tenure as a postdoc.
- Postdocs often need help orienting their research programs. Intellectual growth in the first job is often important in obtaining a tenure track job. Mentors can help postdocs find new research problems and directions (such as interdisciplinary ones). They can also help students who want to work in industry gain valuable group research experiences by connecting them to researchers in other departments.
- Creative innovations in teaching can also help a postdoc obtain a tenure track job, as well as improve and broaden the training of undergraduates. It is a good idea to give postdocs the opportunity to teach courses where they can experiment a little. For example, postdocs who teach undergraduate algebra can introduce cryptography into the course, and computationally minded postdocs can help develop courses with a significant computational component. Mentors can help by nudging their postdoc to do this, and by being a sounding board for ideas. On the more mundane level, mentors can help postdocs when they have trouble in the classroom.
- It is desirable that postdocs do some service. This should not be onerous. Some examples of how postdocs can contribute include running seminars, supervising undergraduate research, curriculum development, and outreach. Some of these can be done during the summer. Mentors can help postdocs find suitable ways to contribute by bringing various opportunities to their postdocs' attention and encouraging creativity.
- In Duke's VIGRE program, VIGRE postdocs are expected to contribute to the VIGRE program. There are many ways for them to do this, such as by supervising undergraduate research projects, helping high school teachers develop teaching materials, running seminars, running summer programs, but there is great flexibility in what the postdoc does.
- Obtaining a research grant also helps a postdoc establish a career. Mentors can help postdocs understand the grant writing process, especially what reviewers are looking for. This can be

handled through a grant writing workshop for postdocs. Duke's model is described briefly below.

Group Mentoring. Some mentoring can also be done in groups. Here are two examples:

Duke's Ethics Workshop for Third Year Graduate Students. Since the Duke Mathematics Department receives NIH funds, we are required by the university to run an ethics workshop for all third year graduate students. These workshops are Duke's response to the concerns (or mandates) of the NIH and other funding agencies that students funded by them, or programs supported by them, receive training in the ethics of research practice.

The half-day workshop *Responsible Conduct in Research and Teaching* is run jointly with the Physics Department. It is a follow-up to a one-day workshop for all new graduate students in the sciences, mathematics, engineering, and some other departments, which is organized by the university.

There were two guest speakers. The first discussed plagiarism, emphasizing that plagiarism has a broad scope, while the second made a presentation on academic dishonesty among undergraduate students and how one can respond to it. There was a break-out session to consider case studies.

Grant Writing Workshop. Early last fall the Duke Mathematics Department ran a grant writing workshop for postdocs and other interested parties. (Some final year graduate students and junior faculty also participated.) It focused on submissions to the NSF, although making submissions to other funding agencies was also discussed.

There were two sessions, separated by one week. The first session consisted of several presentations followed by a panel discussion. The presentations covered topics such as: what grants pay for (and what they don't); funding agencies; how to apply; the structure of a proposal; budgets; the process; deadlines; where to get information. The panel, which consisted of four experienced reviewers, discussed the reviewing process and attempted to give some idea of what reviewers are looking for. Between the two sessions, participants prepared a draft proposal in consultation with their mentors. During the second session, the participants were divided into "review panels," each containing at least

one experienced reviewer. The groups then collectively discussed all of the proposals in their area and gave constructive feedback.

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