Krantz Reading 1

It is of the essence that you work in a subject area, and on a thesis problem, that you like and can develop some enthusiasm for. Just as an athlete will say, "No pain, no gain.", so a Ph.D. student in mathematics might say, "No passion, no thesis." Just so, you also want a thesis advisor who can light a fire under you and can find a problem that will absorb you. You want a mentor who will inspire you to strive for excellence and achievement. You also want a thesis advisor with whom you can work comfortably and have a congenial relationship. If you decide that logic is

Be courteous and friendly to the staff. They are the people who hold the department together and are there to help you with your work. If they do something especially nice for you, bring them cookies or flowers. At least

will be some that are completely off the wall—completely unpredictable.

I have covered the chapter and verse of how to teach, and in particular how to teach recitation sections, in the book [KRA1]. I shall not repeat those insights here. Let me just conclude by noting that you must take your teaching duties seriously. Learn your students' names. Show them that you care. Make yourself available outside of class. Be fair and even-handed. Your department depends on you to do a good job, the math department's reputation around campus hinges on you and the other math teachers, and

3.7. Am I Supposed to Work All of the Time?

Definitely not. Fred Almgren, my friend and faculty mentor in graduate school, liked to say that graduate students should work four hours per day. What they did beyond that was their own business.

Now one should bear in mind here that Fred had extraordinary powers of concentration. Four hours of work for Fred was like ten hours of work for

problems on the qual, then you had better get seven or eight of them almost entirely correct. If some of the questions ask you to state theorems or definitions, then you had better get them letter perfect—with proper English and all the quantifiers in the right places. What you are learning is a *discipline* and your work had better manifest that discipline.

As I've stated previously, a qualifying exam is not like a calculus test. You will not pass a qualifying exam on partial credit alone. The examiners are trying to determine whether you are *qualified to do thesis work.* Can you see to the heart of a problem? Can you write a proof well? Can you recognize correct mathematics and incorrect mathematics? Can you think critically?

As a result, what the examiners want to see on your qual is a substantial number of questions answered substantially correctly. If there are ten

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first time I took them. It was no big deal.

Well, you don't want to flunk too many quals and you don't want to flunk them too often. Every program will give you at least two tries, and different people mature (intellectually) at different rates. The quals are not like the thesis.[3] Qualifying exams are just a basic learning situation, one at which you have excelled all of your life. If you apply yourself and follow the advice given here (and *of course* follow the advice of your advisor), then you will certainly get through the quals.

- When I was a graduate student, we were expected (if possible) to get

the questions is terrific training. Learning to answer them is an even better regimen. And you can work out the answers together. Learning to talk about mathematics is an essential part of any graduate education.

- Your department can provide you with copies of old qualifying exams,

that each point $P \in \partial\Omega$ has an internally tangent ball of radius r.

So how do you study for an exam that contains such questions? Typically, you are not going to find questions like these in books. And, even if you do, you are not going to find the answers laid out for you. Let me put it this way: When you study for a qual, it is not enough to learn just the statements of the theorems and the proofs. Of course you *must* do at least that much. And at some schools this basic effort may be sufficient for a low pass. But the new thing that you must learn to do in graduate school is to ask yourself questions. Turn the ideas over in your mind and ask, "Why is the theorem stated this way? Why is this hypothesis really needed? What happens if we change the conclusion from this to that? What would be a counterexample? Why does the proof go like this? It seems that a much easier method would be ..."

- The best way to

I will conclude this section by enunciating a very important principle (which will be repeated often in this text) of getting an advanced education. You are no longer learning calculus or another trivial subject where it is sufficient to read the text and do the homework. You are now doing the toughest thing you will ever have done in your life. It is *essential* that you talk to people—all the time. In this way you can orient yourself, keep to your course, be sure you are doing the right thing, and have a constant reality check. It is also an important part of being a mathematician to be able to communicate—not just technical mathematics but also information *about* mathematics, about teaching, and about the profession. You are now not simply *learning* mathematics—you are learning to *create* it. So my advice is to talk to your fellow students and to the faculty (and to the staff) about *everything.* Eat lunch with a group, socialize, talk to your office mates. This is your new life.

One thing that you begin to realize while you are a graduate student is that learning does not have to be a formalized process. You do not need to take a course, with a teacher, homework, and a grade, in order to learn a new subject. By the time you reach an established level in the academic world, you probably will not have the patience to sit through courses; instead, you will learn things entirely on your own. An intermediary step to that lofty position is to develop the habit of *auditing* courses. One of the things we were taught right away in the Princeton graduate program is that we should think of the courses just as we think of the books in the library: these are resources that you can drop in on, and drop out of. You don't need to register. Just access them as your interests and your studies dictate.

Always remember that the qualifying exams *are not the point of graduate school.* They are just a step along the way. The main thing is to write a good thesis. So your short-term goal, at the beginning of your graduate career, is just to get through those quals. The quals are a zero-one game. Once you have passed them, then you need never look back.[1] It's time to write the thesis.

Make a point of getting to know some of your classmates (your peers) and also some of the graduate students who are ahead of you in the program. The latter bunch will be full of a lot of gossip and a lot of baloney, but they also have passed the quals and they are familiar with how the program works. They know which classes to take, and the various hoops that a graduate student must jump through. Pick their brains. They can tell you which quals are hard and which are easy. Who writes the quals and who grades them. How quickly you are expected to get through the qualifying exams. They will know who the good instructors are, who gives good courses, and who the good thesis advisors are. This is vital information that you must know and understand.

- Some of the advanced graduate students will already be writing their

where the graduate students hang out, what is expected of you. Where the coffee pot is. Do the same with the Department Chairperson.

- Make a point of getting to know some of your classmates (your peers) and

this is your first day in graduate school, I admonish you to take charge of the situation. Figure out where the math building is, go there, and introduce yourself to the Chairperson's secretary and the Graduate secretary. If the Graduate Chairperson[4] is around, shake hands and introduce yourself. Ask

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much as the limits of their program will allow.[2]

As your program develops, keep in touch with the Graduate Director and with your thesis advisor to make sure you are making good progress. The rest should take care of itself.[3]

- If you are in graduate school, then you are probably at least 22 years old.

there is some material for students coming from other countries.

It is my fervent belief, well-supported by experience, that the main reason that people often fail at tasks or programs that they set for themselves is that they never figure out what it was that they were supposed to be doing. The Ph.D. program in mathematics is a multistep, fairly complex process. There are many junctures at which one could lose track and not get the right mentoring or advice. The purpose of this book is to provide some objective reference material, presented in an accessible but authoritative tone, to aid in the graduate education process.

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