Surviving Graduate School

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Abstract

At least once in every graduate student's life there comes a time when you don't think that you will finish. Although this feeling is normal, many students, especially those who are the first in their family to go to graduate school, never overcome this hurdle. The goal of this paper is to describe what graduate school is about and offer various methods that might prove useful in overcoming this hurdle and surviving graduate.

1. Introduction

Many graduate students find at some point in their studies that they do not think they will ever finish. This feeling is quite normal. What is not obvious is that with few exceptions every person to ever get an advanced degree has suffered through a similar phase.

Unlike your undergraduate days, graduate school can be very unstructured. An undergraduate degree is a contract between you and the university. The university states a list of course requirements that when successfully completed results in a degree. Graduate school, however, does not assign you a certain amount of work, which upon successful completion, results in a doctorate. The idea behind graduate school is to teach you state of the art material while encouraging you to do original research.

Unfortunately, nobody can tell you how to do research. Doing original research is a creative process and if someone could tell you how to do research they could tell you how to be creative. However, people can do research and the faculty at your school has been doing it along with a handful of other people in the

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world. To be enlisted in this select group of people you must not only learn vast amounts of information but somewhere along the way you have to learn how to do research.

All of this can be overwhelming and certainly frustrating at the very least. You are under tremendous amounts of pressure to learn new material. But that is not the hard part of graduate school. The hard part is that you must learn to do something that no one can tell you how to do. If you are fortunate, someone who has been through this process will sit down with you and explain some of these facts. You may also discover some of these facts by talking to fellow students, family members, or other friends. Unfortunately, very few people like to admit that they lack the self-confidence to finish their degree. This leaves many students with the feeling that they are the only ones at school that are having problems.

This paper is an attempt to communicate the feelings that I felt while I was in graduate school. I have also tried to supplement my feelings with thoughts gathered from professors and students that I have had conversations with. However, the majority of the ideas presented came from conversations with Professor Ingram Olkin who seems to have a natural gift for conveying the essential ingredients of life in a research environment.

2. Methods

This section describes 12 ideas that might prove useful for someone starting in graduate school. Not all of these ideas will benefit everyone nor are they applicable to all schools, but to a certain extent I think that all good researchers practice some of these methods.

Before I begin I want to re-iterate that no one can teach you how to do research. Doing research is a highly individual, creative process that you have to learn to do on your own. Some people are cut out for it and others are not. As my advisor once told me,

> *to do research you have to believe that what you are doing is more fun than anything else in the world.*

This means that you are willing to put up with a lot of seemingly irrelevant and time consuming distractions. You also have to be willing to take chances and follow whatever path your work seems to be taking you in. Eventually you may find out that your pet idea or theory is completely false. The important thing is to learn from the process something that will help you understand the problem you are trying to solve, which is after all the underlying motivation behind research.

Barring this disclaimer, I still believe that you need not be the most intelligent person in school to be able to do original research. As a matter of fact I don't believe that the most successful people in any field are always the most intelligent people. Discipline, hard work, and perseverance are important factors in whether you will eventually succeed. This paper is then, more a set of tricks that helped me through the difficult initial stage that I believe every graduate student goes through. That initial stage usually starts off with one question:

Where do I begin ?

To answer that question I propose a list of 12 items. These are:

1. Do literature searches
2. Write a one page summary of papers
3. Build a tree of results
4. Talk to your advisor
5. Talk it out
6. Ask the right questions
7. Solve problems you can solve
8. Get insight from special cases
9. Have a plan for each day
10. Have two projects to work on
11. Use your time wisely
12. Do a scholarly job

The rest of this paper is an elaboration of these items.

2.1. Literature Searches

When I first started talking to the faculty at my graduate school I was most impressed by their knowledge of a particular subject area. It seemed to me that they knew everyone in the world who was working in their area. I didn't think that I could ever remember even a fraction of what they knew. It finally dawned on

me that what they knew so easily came from sitting down in the library and spending countless hours going over abstracts and reviews. To really know a field you have to know not only the subject material but also who is working on that subject.

One good way to accomplish this aspect is to do a literature search in your particular topic. For example, in mathematics look up relevant papers in *Math Reviews*. This will give you an idea of what has been done in the field. Unfortunately, this only gives you a view into the past. What you need to know is, who is working on the topic now. Therefore, you should cross check the references in *Math Reviews* by looking in *Science Citations*. This will tell you who referenced those papers and will give you an idea as to who else is working in that subject area. A side benefit of this approach is that you can pick up interesting applications for your problem area.

2.2. Summary of papers

In conjunction with doing a literature search you should write up a one page summary for each paper. Each summary should contain assumptions, results and possible relations to your work. You might want to xerox the *Math Review* abstract and paste it on your page. Don't go into details, just write down general results as you see them.

You will be surprised how much of your thesis is introductory or background material. You will be expected to have done a thorough literature search to show that your work is original. The summaries of the papers will be extremely handy when it comes time to write a review of past work done in your field.

2.3. Tree of results

Another trick for organizing the seemingly vast amount of information you need to know about your field it to build a tree of results. By this I mean, build a tree showing all the previous work done in your subject area. This will give you an overview of the field as it stands, some of the history leading up to today, and any relationships between results that might be important. More importantly don't forget to mark down gaps in the field. This will help you decide what has not yet been done in your field which is of greater interest to you. You should also ask yourself why some branches died out while others got bigger.

2.4. Talk to your advisor

Your advisor is probably the single most important person related to your dissertation work. Make sure and talk to him or her every chance you get. Drop by and chat with him. Pester him with your problems. Bug him. Eventually your advisor will either help you with your problem or graduate you to get rid of you.

I realize that some of this may not be applicable to all schools. I went to a small school with an even smaller graduate department where the faculty was particularly accessible. This may not be true in other schools. However, there is always someone you can talk to. If you are at a large school where the faculty is not readily accessible then it is usually the case that there are more graduate students that you can talk to.

2.5. Talk it out

This idea is similar to that of talking to your advisor. In addition to talking to your advisor, you should also talk about your work with your colleagues or fellow students. You can learn a lot by explaining your results to others. Not only can they point out mistakes, inconsistencies and other matters of confusion, but you will find that you will also understand the material better. At times you will also find that a rather 0 remark made by someone outside the field can give you a fresh viewpoint that will lead to a breakthrough.

2.6. Ask the right questions

One of the first strategies I learned in problem solving was to ask the question "What's the idea?". At first I thought this was so elementary that I wouldn't even mention it. But the more I attacked different problems the more respect I came to have for this idea. I also noticed that all successful researchers that I knew were always asking good questions. They would constantly be making conjectures or hypothesis and then trying to prove them. I realized that one of the goals of graduate school was to learn to ask the right questions. When solving problems you should also consider questions such as, is this the right question, is it an important question, and what can I expect to gain by answering this question? Until you get clear answers to these questions you will not have a goal and without a goal you don't know what direction to start looking for the answer.

2.7. Solve problems you can solve

Although this sounds ridiculous it can be easily overlooked. Part of the idea behind graduate study is to solve a problem that no one else has solved. This may be because the problem is too hard to solve. More likely, the problem has not been solved because nobody has looked at it in the right light. When I say, solve a problem you can solve, I mean transform the problem you have to some nearby problem that is easier to solve. If you can't solve your original problem alter some of the assumptions to make the problem easier. See if you can solve this nearby problem. Then go back and see where the solution method fails with the original assumptions and try to fix it. An excellent reference on how to solve problems is the book by Polya [2] which can be read for general ideas on how to attack problems. Another good reference for mathematicians is the book by Solow [4] which deals specifically on how to prove theorems.

2.8. Get insight from special cases

Always try to reduce the problem you are trying to solve to special or simple cases. Try to gain some insight from these special cases. If you are working with large dimensional problems try cases with a small number of dimensions. If the problem has no structure try cases where the problem has some special structure. In general, you will want to extend someone's work by relaxing certain restrictions or by adding certain constraints. When doing so always make sure that the original problem can still be solved.

2.9. Have a plan for each day

At the risk of being repetitious, I should point out that unlike undergraduate life graduate work can seem very unstructured. There will be no one pushing you to complete assignments, turn in projects or study for exams. It is up to you to decide what to work on and when to work on it. This is both the beauty of graduate work and the danger of it. If you are floundering and you don't know where you are heading it's very easy to panic and lose your goals. At this point you stop because you don't know which direction to head in. Inertia sets in and it can be the hardest thing to overcome in graduate school. That is why it is very important to always keep moving. Keep your momentum going. At the end of each day before you go to bed you should say,

> I wish I had had enough time to do X today.

This gives you a plan for the next day, which will keep you moving. Another useful idea is to keep a log book in which you write down interesting results, ideas, conjectures or anything else that you think might prove useful later on.

2.10. Have two projects to work on

One handy trick in starting off is to come up with not one idea but two. Call them Topic A and Topic B. Start working on Topic A until you can't seem to get any further. When you can't make any progress for an extended period of time, say 48 hours, switch to Topic B. Do the same thing with Topic B and return to Topic A when you can't make any progress on Topic B. At some point you will make some breakthrough in one of the topics. At that point, stick with that topic. The key idea here is that you always want to be doing something.

2.11. Use your time wisely

Everyone has a different schedule. Some people are day people, others are night people. Regardless of that, everyone has a period during the day when they are the most productive. Find out which time of the day is the most productive for you. Then schedule your creative work for the most productive time of the day. Save literature searches, writing or any other task that does not require you to think as hard for times of the day that are not as productive for you.

2.12. Do a scholarly job

Always do as good a job as you can. People will judge you by the end results: how well it is written, the thoroughness, the organization. A very good idea can be lost in the literature simply because no one can read the paper. The best way I can suggest to do a good job is to find papers or books that you find easy to read and understand. Then analyze what you like about that particular style and try to emulate that style. This does not mean that you should give up your style, merely that it is easier to learn what to include and what to leave out of a scientific paper by imitating some of the better writers. In addition the usage of proper grammar and style cannot be overemphasized. A good investment is the manual by Turabian [3] which gives excellent advice on organizing dissertations. On the general topic of writing mathematical papers the article by Halmos [1] is also very good at describing the usual pitfalls of writing for a mathematical audience.

3. Final words

All in all, there is nothing quite like graduate work. You have to be willing to sacrifice many things to pursue your goal of a doctorate. There were many times when I thought that I would never finish. I like to use the analogy of running a marathon. I used to wonder when I saw people competing in a marathon why so many people could not finish after they were 90% finished. It seemed to me like they had gone so far that all they had to do was walk or crawl the last mile or so. After going to graduate school, I suddenly understood why so many people quit so close to the end of the race. There comes a time when you are so tired of school that it just doesn't seem that there is any way that you can finish. At times like that I thought of the marathon runners and I tried to imagine how they felt being so close to the finish line and yet not being able to muster the last bit of strength to finish. Like a marathon runner, somewhere along the way you have to decide if the goal you are striving for is really worth it. When you make that decision the work becomes a little easier. The last mile is sometimes the hardest but it is also the most satisfying.

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References

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[4] Solow, D. *How to read and do proofs.* John Wiley and sons, New York, 1982.