Eleven things I'm glad I knew (or wish I'd known) as a grad student

Benson Farb, 1999

1. Work on a reasonably regular basis. Doing this really adds up after a few years. It makes it easier to make progress on problems, and makes doing math a lot more fun. Conversely, it's easy to go for months and even years doing minimal work. Bottom line: you get out what you put in.

2. Constantly work examples and do computations. This is crucial. Even working simple or trivial examples is a useful confidence builder and a tool for concrete understanding. Working the right example can often point to a new phenomenon or the proof of a theorem. Also, learn a wide variety of examples, and keep your "bag of examples" accessible at all times; it will prove invaluable.

3. Keep reading papers. If you find a term you don't know then look it up. If a result is referred to and you don't know it, look up that paper. You should be xeroxing hundreds of pages each year. A broad mathematical knowledge is useful.

4. Constantly ask questions. When reading a paper, ask after every result: "How can I generalize this result?" This is helpful in the learning procss, and is a good way to take first steps into research. Keep a list of questions and ideas.

5. Take notes during lectures and talks. This will help you pay attention. Also, even when you don't understand a talk at the time, you may well find the notes useful later. Case in point: in graduate school, I took notes on a talk on exotic hyperbolic spaces. At the time I didn't understand a thing. It turned out later that some of the material was essential for my thesis, and wasn't in any other source. I'm glad I had those notes!

6. Put effort into understanding courses. Go over your notes outside of class. If you are unclear on a point, ask for help. Look things up in books and papers. Agan, you get out what you put in.

7. Keep organized notes. Keep a list of questions and ideas. A notebook can be useful. I remember taking 3 days to do a complicated computation, which I later thought I didn't need. Later still I realized I *did* need it, but as I'd lost the scraps with the computation I had to redo the whole computation!

8. Buy books. Considering that your decision to go to math grad school has changed your life dramatically (at least in the short run), don't be cheap about spending a few hundred dollars on books that will make your experience a more fruitful one.

9. Talk to other graduate students. Work through a paper with another student. Bounce ideas off someone. Ask people questions when you're stuck on something. Typically, most of what you learn will be from other graduate students.

10. Try to learn principles. There are certain key principles in each field that form the foundational tools for any researcher; you'll know when you run across one. Put effort into understanding it "deeply". Always keep the key principles in the forefront of your mind. Example (in geometry): a compact group action can usually be "averaged", to obtain things like an invariant metric, an invariant form, or a global fixed-point.

11. Practice drawing pictures. Do this on paper and on blackboards. Continued practice will eventually result in great pictures. This is a very useful skill to have. I don't have it, and I really wish I did.