Mathematics: Graduate School

★ Mathematics: What do grad students in math do all day?

Do they just sit at their desk and think?

1 Comment

26 Answers

Yasha Berchenko-Kogan, PhD student at MIT.

2.7k Votes by **Jessica Su**, CS PhD student at Stanford, **Kevin Lin**, PhD in Mathematics from UC Berkeley, **Daniel McLaury**, Ph.D. Student in Mathematics, **Joachim Pense**, Got a degree in Mathematics., Anonymous, and 2736 more.

A lot of math grad school is reading books and papers and trying to understand what's going on. The difficulty is that reading math is not like reading a mystery thriller, and it's not even like reading a history book or a New York Times article.

The main issue is that, by the time you get to the frontiers of math, the words to describe the concepts don't really exist yet. Communicating these ideas is a bit like trying to explain a vacuum cleaner to someone who has never seen one, except you're only allowed to use words that are four letters long or shorter.

What can you say?

"It is a tool that does suck up dust to make what you walk on in a home tidy."

That's certainly better than nothing, but it doesn't tell you everything you might want to know about a vacuum cleaner. Can you use a vacuum cleaner to clean bookshelves? Can you use a vacuum cleaner to clean a cat? Can you use a vacuum cleaner to clean the outdoors?

The authors of the papers and books are trying to communicate what they've understood as best they can under these restrictions, and it's certainly better than nothing, but if you're going to have to work with vacuum cleaners, you need to know much more.

Fortunately, math has an incredibly powerful tool that helps bridge the gap. Namely, when we come up with concepts, we also come up with very explicit symbols and notation, along with logical rules for manipulating them. It's a bit like being handed the technical specifications and diagrams for building a vacuum cleaner out of parts.

The upside is that now you (in theory) can know 100% unambiguously what a vacuum cleaner can or cannot do. The downside is that you still have no clue what the pieces are for or why they are arranged the way they are, except for the cryptic sentence, "It is a tool that does suck up dust to make what you walk on in a home tidy."

OK, so now you're a grad student, and your advisor gives you an important paper in the field to read: "A Tool that does Suck Dust." The introduction tells you that "It is a tool that does suck up dust to make what you walk on in a home tidy," and a bunch of other reasonable but vague things. The bulk of the paper is technical diagrams and descriptions of a vacuum cleaner. Then there are some references:
"How to use air flow to suck up dust."
"How to use many a coil of wire to make a fan spin very fast."
"What you get from the hole in the wall that has wire in it."

So, what do you do? Technically, you sit at your desk and think. But it's not that simple. First, you're like, lol, that title almost sounds like it could be sexual innuendo. Then you read the introduction, which pleasantly tells you what things

are generally about, but is completely vague about the important details.

Then you get to the technical diagrams and are totally confused, but you work through them piece by piece. You redo many of the calculations on your own just to double check that you've really understood what's going on. Sometimes, the calculations that you redo come up with something stupid, and then you have to figure out what you've understood incorrectly, and then reread that part of the technical manual to figure things out. Except sometimes there was a typo in the paper, so that's what screwed things up for you.

After a while, things finally click, and you finally understand what a vacuum cleaner is. In fact, you actually know much more: You've now become one of the experts on vacuum cleaners, or at least on this particular kind of vacuum cleaner, and you know a good fraction of the details on how it works. You're feeling pretty proud of yourself, even though you're still a far shot from your advisor: They understand all sorts of other kinds of vacuum cleaners, even Roombas, and, in addition to their work on vacuum cleaners, they're also working on a related but completely different project about air conditioning systems.

You are filled with joy that you can finally talk on par with your advisor, at least on this topic, but there is a looming dark cloud on the horizon: You still need to write a thesis.

So, you think about new things that you can do with vacuum cleaners. So, first, you're like: I can use a vacuum cleaner to clean bookshelves! That'd be super-useful! But then you do a Google Scholar search and it turns out that someone else did that like ten years ago.

OK, your next idea: I can use a vacuum cleaner to clean cats! That'd also be super-useful. But, alas, a bit more searching in the literature reveals that someone tried that, too, but they didn't get good results. You're a confident young grad student, so you decide that, armed with some additional techniques that you happen to know, you might fix the problems that the other researcher had and get vacuuming cats to work. You spend several months on it, but, alas, it doesn't get you any further.

OK, so then, after more thinking and doing some research on extension cords, you think it would be feasible to use a vacuum cleaner to clean the outdoors. You look in the literature, and it turns out that nobody's ever thought of doing that! You proudly tell this idea to your advisor, but they do some back of the envelope calculations that you don't really understand and tell you that vacuuming the outdoors is unlikely to be very useful. Something about how a vacuum cleaner is too small to handle the outdoors and that we already know about other tools that are much better equipped for cleaning streets and such.

This goes on for several years, and finally you write a thesis about how if you turn a vacuum cleaner upside-down and submerge the top end in water, you can make bubbles!

Your thesis committee is unsure of how this could ever be useful, but it seems pretty cool and bubbles are pretty, so they think that maybe something useful could come out of it eventually. Maybe.

And, indeed, you are lucky! After a hundred years or so, your idea (along with a bunch of other ideas) leads to the development of aquarium air pumps, an essential tool in the rapidly growing field of research on artificial goldfish habitats. Yay!

Via Jessica Su.

80+ Comments · 26 Nov, 2012

Catherine Asaro, Theoretical chemical physicist, Harvard Ph.D.

484 Votes by **Jessica Su**, CS PhD student at Stanford, Anonymous, **George Hagstrom**, I am a postdoc at the Courant Institute in the ..., **Joachim Pense**, Got a degree in Mathematics., **Eric Peterson**, PhD student in Mathematics at UC Berkeley, focu..., and 478 more.

Typical day

12 noon: Get out of bed.
12:01 pm: Do whatever is nece...

9+ Comments · Updated 16 Feb, 2013

Daniel McLaury, Ph.D. Student in Mathematics

33 Votes by **Jessica Su**, CS PhD student at Stanford, **Anurag Bishnoi**, Ph.D. student in Mathematics at Ghent University., Edwin Khoo, Craig Montuori, and 28 more.

Usually we teach one to three classes or discussion sections of pre...

Comment · 11 Nov, 2012

Ashok Rajaraman, who moved to the Light.

49 Votes by **Jessica Su**, CS PhD student at Stanford, **Yasha Berchenko-Kogan**, PhD student at MIT., **Anurag Bishnoi**, Ph.D. student in Mathematics at Ghent University., Brendan Ross, and 44 more.

So, I have been asked to answer this question, but I have encounter...