Should I Get a Ph.D.?
Nine Interviews.

Tim Hopper
John D. Cook
Melissa Santos
Paul Rubin
Eric Jonas
Carl Vogel
Paul Harper
Michael Nute
Laura McLay
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Chapter 1

Introduction

As a naive college senior with little life experience outside of the classroom, I applied to Ph.D. programs in math, the history of math, and operations research. It wasn't until I started as a math Ph.D. student at the University of Virginia that it occurred to what my decision entailed: spending most of my twenties in poverty while college classmates were buying houses, spending at least two more years in classes, and setting myself on a career trajectory I'd given little thought to. I stayed at UVa one year.

I ended up earning a masters degree in operations research at North Carolina State University. While a student there, I wrestled with whether or not I should continue to get a Ph.D. As I considered this question, it became increasingly clear to me how poorly I had thought through this huge life decision as an undergrad. In hindsight, I wish I'd had a lot more advice on whether or not it was the right decision for me.

After getting out of grad school, I asked a handful of friends with varied backgrounds and careers to answer the question "Should I do a Ph.D.?" In particular, I wanted them to answer this question for me as a 22-year old, technically-minded, academically-capable college senior. My hope is that these interviews will help some answer question themselves and help others provide counsel to those asking themselves this question.

These interviews are primarily targeted towards those with technical backgrounds going into graduate programs in the United States. This has several implications. First, I'm assuming that the student asking this question will have his tuition waved and be

provided with a humble stipend. Second, I'm assuming a typical degree programs starts with two years of classes and is followed by 2-4 years of research.

There are two other great resources for those seeking answers to this question. Vivek Haldar, Ph.D. and developer at Google, has an excellent post on the very topic. Read it carefully, go for a long walk while thinking over it, and then read it again.

Second is Matt Might's blog. His "The Illustrated Guide to a Ph.D." is a brilliant, simple representation of what Ph.D. research really means in the big picture. He has a number of other essays on graduate school that will help you learn what grad school is like once you get there.

If you enjoy these interviews, please consider sharing them with your friends on social media.

— Tim Hopper, tdhopper.com

Chapter 2

Interviews

Dr. John D. Cook, freelance consultant and blogger

John D. Cook holds a Ph.D. in mathematics from University of Texas at Austin. He is an independent consultant. He blogs at The Endeavor and is active on Twitter.

> *A 22-year old college student has been accepted to a Ph.D. program in a technical field. He's academically*

talented, and he's always enjoyed school and his subject matter. His acceptance is accompanied with five years of guaranteed funding. He doesn't have any job offers, but he suspects he could get a decent job as a software developer. He's not sure what to do. What advice would you give him?

John: There are basically two reasons to get a Ph.D.: personal satisfaction, and credentials for a job requiring a Ph.D. It's hard to say what the financial return is on a Ph.D. Some say it lowers your earning potential, but that's confounded by the fact that people with Ph.D.'s tend to seek high security rather than high compensation employment. Some say a Ph.D. increases your earning potential, but they often don't account for the work experience you could have gained by working during the time it takes to complete a degree.

Would you recommend he take some time off prior to grad school, or should he jump right in?

John: Whether to go straight into grad school would depend on personal circumstances. It could be good to take some time to evaluate whether you really want to go to grad school or whether you are just doing that just because it's a natural continuation of what you've been doing for the past 17 years. If you're sure you want to do grad school, it's probably best to keep going and not lose momentum.

Do you have any thoughts on going from undergrad into a Ph.D. program verses first completing a masters?

John: There's more difference between a Ph.D. and a masters degree than many people realize. A masters program is a fairly direct continuation of an undergraduate degree. It's more specialized and more advanced, but it's still mostly based on class work.

The goal of a Ph.D. program is to produce original research and prepare for a career as a researcher. You won't necessarily even become very knowledgeable of the area you get your degree in. But you will

develop the discipline of working on a long-term project with little external guidance.

In the humanities, you're often required to complete a master's degree on the way to a Ph.D. That's not as common in the sciences. By going straight for a Ph.D., you might graduate a semester sooner. It's nice to grab a master's degree along the way so that you have something to show for yourself if you don't finish the Ph.D.. But I think most schools will give you a masters on your way out if you go straight for a Ph.D. but don't finish.

If you could do it over again, would you make any changes to the way you went about getting a Ph.D.?

John: If I were to do my Ph.D. over again, and if I wanted to be an academic, I'd learn more about how the academic game is played. When I was in grad school, I learned a lot of math, but I didn't learn much about how to succeed in an academic career. I knew nothing about grants, for example, or strategies for publishing papers. I also would be more selective

of my research topic, picking something I was more deeply interested in.

> *You've spent much of your career doing work different from your field of expertise. What would you say to a current Ph.D. student who is concerned that his field or research is too specialized?*

John: You've got to set your own agenda for your time in grad school. In addition to what is required to graduate, you may have additional things you want to learn while you have the opportunity: access to libraries, access to people to ask questions of, and most of all, free time. (When I was in college, a pastor once told a group of students that we had more free time now than we'd ever have again. Of course we all thought he was crazy, but he was right.) You ought to have a survey knowledge of your field, even if that's not required for graduation. You also need to have some idea how your field relates to the rest of the world, and your professors might not be the best people to learn this from. If a professor has

never worked outside of academia, I'd be skeptical of anything he or she says about "the real world."

Dr. Paul Rubin, professor emeritus

Paul Rubin holds a Ph.D. in mathematics from Michigan State University. He is Professor Emeritus at Michigan State where he started in 1980. He blogs at OR in an OB World and is active on Twitter.

> *A 22-year old college student has been accepted to a Ph.D. program in a technical field. He's academically talented, and he's always enjoyed school and his subject matter. His acceptance is accompanied with 5-years of guaranteed funding. He doesn't have any job offers but suspects he could get a decent job as a software developer. He's not sure what to do. What advice would you give him, or what questions might you suggest he ask himself as he goes about making the decision?*

Paul:

1. Do you want to be a college professor who teaches and does research, do you want to teach college but not do research, or do you want to get a job in industry (including government, non-profits etc. in that category)? The first path requires a Ph.D.. The second path may require a Ph.D. if you want to work at some private colleges, but it may also be possible to get a good teaching job with just a masters degree (which will put you into the salary pool faster). With the third category, it varies. There are quite a few industry jobs that require only a bachelor's or masters degree, while some require a Ph.D..

2. Do you enjoy (or do you think you will enjoy) research? Getting a Ph.D. is a major commitment of time, a substantial portion of which is quite likely to be devoted to original research. Some institutions, in some fields, allow "expository" dissertations – such as an annotated history of military purchasing patterns, from

Goliath to the 21st century Pentagon – but in technical fields and/or at reasonably prestigious schools, dissertations are very likely to require original research. Some people enjoy doing research, some hate it, some fall in between. If you do not enjoy doing research, pursuing a Ph.D. will be difficult, unfulfilling and possibly pointless (since you will not want a job with research expectations).

3. How important is compensation to you versus how interesting the work is, personal prestige, etc.? A Ph.D. is often the ticket to jobs that are more intellectually stimulating than those requiring just a bachelor's degree, with the caveat that "often" does not equal "always". For some people, being able to identify themselves as "John Doe, Ph.D." also carries some value. The compensation side is less clear. Compensation tends to go up with job experience (at least in industry; not as reliably in academe), and a lengthy postgraduate education delays your

entry into the workforce. Even if you have an assistantship, you will likely make less money as a student than you would as an employee with a bachelor's degree. Add in educational expenses you will incur and the fact that you will enter the workforce with less accrued history and experience, and possibly in a lower position or at a lower salary (depending on the job) than where you would have been at graduation date if you had gone straight into industry, and you may be better off from a purely economic perspective going straight to work. (On the other hand, you may miss out on a fair bit of fun as a graduate student. Work is, after all, a four letter word.) When I was completing my Ph.D., my intention was to go into industry. In one of my job interviews, I discovered that the employer counted a Ph.D. as the equivalent of something between two and four years of work experience for salary purposes, although it was taking me six years (post-bachelor's) and change.

4. Are you geeked by the idea of going as far as you can in a particular field? As a high school student, I made up my mind that I would get a Ph.D., not because I had any real sense of comparative job prospects, but simply because I wanted to take my education as far as I could in my chosen discipline (mathematics).

Would you recommend he take some time off prior to grad school, or should he jump right in?

Paul: This varies according to the individual. A Ph.D. program can be a long slog, especially starting from a bachelor's degree, so if you are a bit burned out on school after getting that bachelor's, definitely take some time off and work. Working helps recharge the bank account, and is also a useful motivator. Once you have experienced the 9 - to - 5 grind, you may see that Ph.D. in a whole new light. (I experienced the wonders of office drone life working summers while I was in college, so I did not need a gap between undergraduate and Ph.D. studies to convince me that

anything that delayed having to work for a living was a good idea.)

In some disciplines, having relevant industry experience will help put course work in perspective, will help enforce the relevance of some theoretical results, and will help to assess the low likelihood of satisfying the assumptions behind other theories. A special case is the desire to teach and do research in a technical field (such as Management Science) in a business school. Some business schools are skeptical of purely technical types. When it comes time to find a faculty position, having "real world business experience" in addition to that technical Ph.D. may well make you more attractive. (Having an MBA would make you still more attractive.) In part this has to do with somewhat fuzzy accreditation standards; in part it stems from a not-unreasonable belief that knowing something about how businesses actually operate will help you in the classroom, even when teaching technical subjects; and in part it reflects the desire for greater staffing flexibility (being able to plug you into a less technical, more business-oriented course

if push comes to shove). That last consideration may well exist in other application areas besides business.

If you are not burnt out, your bank account is not drained, and you do not need to acquire "real world credibility", going straight into the Ph.D. program has two majors advantages. First, it gets you out the other end and into your career trajectory that much sooner. (See previous comments about the economics of the decision.) Second, you will have developed certain studying skills and habits along the way, and if your record is good enough to get you into a Ph.D. program, those skills and habits are apparently fairly effective. For many people, there is a nontrivial atrophy of their study skills while they are employed, particularly in jobs not strongly related to their primary discipline. Some students have attributed lower than anticipated scores on graduate entrance examinations to a dulling of their test-taking abilities. A seamless transition from undergraduate to graduate studies is in some ways analogous to a distance runner not having to break stride.

Do you have any thoughts on going from undergrad into a Ph.D. program verses first completing a masters?

Paul: In business, an MBA is not strictly an interior point on the line segment connecting bachelor's degree to Ph.D. It covers substantial material outside your discipline, it brings perspectives distinct from those you will have in the Ph.D. program (and very often distinct from those in the undergraduate program), and (as noted above) can be a valuable credential.

In most technical disciplines, on the other hand, a Ph.D. thoroughly subsumes a masters degree. Having both a masters and doctorate in mathematics is no better than having just a doctorate. The primary, if not exclusive, virtue of the intermediate masters degree is to allow you to dip your toes into the graduate education pool. Often, though, a doctoral program has an early exit strategy that allows students who lose interest in the Ph.D. or fail to get past some hur-

dle (usually comprehensive examinations) to earn a masters with little or no extra course work.

The remaining case is when the masters is in a different, complementary discipline. In my case, I earned bachelors and doctoral degrees in mathematics but a masters degree in probability and statistics. For someone in operations research, even if they work primarily on deterministic models (as in my case), and understanding of statistics is useful when estimating model parameters from actual data, and understanding of hypothesis testing is useful when trying to prove that your algorithm is better than the previous benchmark, and an understanding of probability theory is useful in a variety of contexts. I also considered a masters in computer science – knowing data structures, database management principles and the essence of how compiled code works have all proven useful – but ended up filling those gaps just by course work.

Admission and funding aside, what should a potential Ph.D. student look for in a graduate program?

Paul: If you are aiming at an academic career, look at the job placements for recent graduates. Take a look at publication records for faculty (these days, you can usually find that on a web site at the school), and see if they are active in research. If you know you are interested in a particular subdiscipline (integer programming, compiler design, bionic limbs), look specifically for faculty active in that area. Not only will you want courses or seminars of relevance, but you will need a dissertation chair who has some clue about your topic. Finally, if you can get in touch with a few of their students, try to sniff out what the culture of the relevant department is like, and whether the faculty you most likely would prefer as mentors are accessible, pleasant to work with, and willing to take on students. (A somewhat common misconception among applicants is that you can pick your dissertation advisor. It generally requires mutual consent.) Senior students (the kind you want to quiz) often attend professional meetings (for job hunting as well as for the other attractions of the meeting); that might be a good place to try to make

new friends.

If you could do it over again, would you make any changes to the way you went about getting a Ph.D.?

Paul: There are small glitches that I would repair if I could – for instance, my advisor took a sabbatical just as I was finishing my opus, and it sat unread for a full term – but overall, I have no significant regrets, and there is nothing substantial I would change.

Dr. Eric Jonas, postdoc and serial entrepreneur

Eric Jonas is a postdoc at the Berkeley Center for Computational Imaging. He was formerly a Predictive Scientist at salesforce.com and a Ph.D. student in Computational Neurobiology at MIT. He can be found at ericjonas.com and [@stochastician](https://twitter.com/stochastician "Eric Jonas (stochastician) on Twitter").

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talented, and he's always enjoyed school and his subject matter. His acceptance is accompanied with 5-years of guaranteed funding. He doesn't have any job offers but suspects he could get a decent job as a software developer. He's not sure what to do. What advice would you give him, or what questions might you suggest he ask himself as he goes about making the decision?

Eric: The first thing to recognize is just how different a PhD program is from being an undergrad:

Time allocation and duration: In undergrad, your life moves in term-sized chunks – you almost never have projects stretch over multiple terms. Something is expected of you every week. In a PhD, you are often much more at the mercy of your own motivation.

Learning: In undergrad, the focus is on learning as much new information as quickly as possible, and all of the information is well-organized. As hard as it may be to believe sometimes, there has been a real focus on pedagogy by your instructors, textbook authors, and institution. Problem set problems give you an instant sense of "getting it right", and often have well-defined answers. Graduate school classes

are often quite different – they are much smaller and often built on top of reading cutting-edge research, with ambiguity, contradition, and even politics.

School status: Most of us went to the best undergraduate institution we could get into. Undergraduate "school name" carries weight, and people (however unfortunately) pay attention to rankings such as those in US News & World Report. This is much much less the case in graduate school. What really matters is the advisor you work with, then the department, and only then the school. The smartest MIT undergraduates I knew at MIT scattered into the wind, some going to schools I had only barely heard of, to work with the best set theoreticians, or the best logicians, or the best experimental biologists, in the world.

My best advice to an undergraduate curious about the "experience" of graduate school is: work in a lab while you're an undergrad. Or even, take a year off and work at a low wage as a tech in a lab. Watch how the students work with their advisor. Observe what their lives are like. Figure out what makes someone

a happy and successful graduate student.

But above all, to speak directly to your hypothetical, never ever go to graduate school as a "backup" to getting an industry job. I have never seen this work out well. In graduate school for CS, your stipend will be $30k a year and you will work 80 hours a week. Your friends working 80h/week in finance will be making literally 10x that. You say "I don't care about money" but how will you feel when you can't afford to fly home because your parents are sick?

You left your Ph.D. program and then returned. Why did you decide to go back?

Eric: I never intended to "leave" my PhD program, and was actually (unfortunately) a student the entire time I did both startups. I always intended to finish. My work at the first startup, Navia, was much closer to my core PhD research than my role as CEO at the second startup, Prior Knowledge. My thesis was roughly finished around 2010, but various aspects of running a company prohibited me from finishing the

"last bits", writing up the results for publication, and assembling the committee. I would not recommend this to many people – it caused a lot of additional cognitive burden and stress! Things worked out well for me, but I want to stress this was the result of both luck and working with the most brilliant people I have ever met – not through my own doing!

We also had incredibly supportive investors (Peter Thiel's group, The Founders Fund), who were committed to advancing the long-term state of the art. Prior Knowledge's acquiring company, Salesforce, has also been very supportive in letting me take a little time here and there to finish my degree.

You also started a company while working on your degree. What advice would you give to a current Ph.D. student considering the same thing?

Eric: It depends – if you're just leaving your PhD to go start a company, that can be fine. I've heard (probably apocryphal) stories of Stanford CS PhD

students viewing graduate school as a holding pattern until they do a startup.

If your entrepreneurial ambitions are related to your research, FINISH FIRST. You will have more credibility with investors, and you will most likely have to deal with your school's Technology Licensing Office to resolve IP issues anyway. Patents and scientific publications can interact in many ways, some of which are good and some of which are bad. Talk to other successful graduate student entrepreneurs from your school to figure out the hoops to jump through. Feel free to e-mail me if you're in this boat, I'm happy to talk.

Finally, if you're going to ignore the above advice, check to see if your school has some sort of "all but degree" (ABD) status, which can save your advisor and department a great deal of money by reducing your tuition costs.

What benefit(s) does having a Ph.D. bring to your work industry? Is a Ph.D. necessary for that kind of work?

Eric: Beyond the credentialing problem in science (people take you much more seriously if you have a PhD), learning how to execute and direct research is the most important part of a PhD. I plan on living at the interface between science and engineering for the rest of my life, and formal training in that process has been crucial to my success.

A lot of people think of a PhD as being like an undergraduate degree in that you've "learned a lot of material". This is false. You've learned a set of skills to *produce* knowledge – to iterate on the scientific process and engage with the scientific community. That's one of the reasons why people basically never have "two" PhDs: once you've learned how to "do" the science, it's supposed to transfer across disciplines.

Mr. Carl Vogel, Data Scientist

Carl Vogel is an economic consultant at Navigant Economics. He has a masters in in economics from the University of Toronto and and masters in statistics from

Columbia University. You can find more of him on his website and on Twitter.

> *A 22-year old college student has been accepted to a Ph.D. program in a technical field. She's academically talented, and she's always enjoyed school and her subject matter. Her acceptance is accompanied with 5-years of guaranteed funding. She doesn't have any job offers but suspects she could get a decent job as a software developer. She's not sure what to do. What advice would you give her, or what questions might you suggest she ask himself as she goes about making the decision?*

Carl: The world is full of miserable grad students. Stressed-out, depressed, uncertain about when or if they'll graduate and what will happen to them when they do. Far more people go into Ph.D. programs than should. There are a two main reasons for this, I think. One is that for kids who've only really ever gone to school, and have been successful at it, grad school seems like a natural next step, and a career

in academia seems pretty great. The other is that bright, academically talented twenty-two year olds just don't know themselves very well; they tend to be overly-optimistic about their abilities and their prospects. They've never really known failure or crippling self-doubt, and just can't imagine it as a real possibility.

So I'd suggest the healthiest way to think of grad school is not as a default next step—as "undergrad 2.0"—but to realize that it's a tremendous commitment in terms of time and psychological endurance and lost income. She's going to be giving up a huge chunk of her prime years. And during this time, the positive feedback she's gotten from professors and peers is going to disappear. The cycle of challenges and accomplishments she's been used to is going to be replaced by an intangible but ever expanding nebula of expectations and her every victory will be fleeting, unacknowledged, and Pyrrhic.

The needle on the Ph.D. gauge should start at "No." If she isn't really aware of what jobs she could do in her field, and what those look like in terms of

career progression, she should definitely do that research. Software development is fine, especially if it's in a context related to her intellectual interests, and there's a possibility of learning, growing, and doing a variety of interesting work. She shouldn't take a job that doesn't excite her intellectually, unless she's really strapped for the cash or has a pile of school debt. At this age, she's got the chance to take a little financial risk for the chance to learn and get new experiences. There are a ton of interesting problems to work on in industry. She should make a real effort to see if any of those excite her. School isn't the only place to learn and do research.

To move the needle on the Ph.D. gauge to "Yes," I'd propose a 3-part process. Let's call the parts the Reality Check, the Personality Test, and the Skills Checklist.

The Reality Check:

I think a lot of students go into the graduate school decision with some overly rosy misconceptions. Mostly because their experience and advice to date has all been from within their department

and university and is rife with selection bias. So it's important to burst a few bubbles for our hypothetical student.

1. She's not going to be a professor. In almost every field, the odds are just strikingly against getting a full-time, tenure-track position.
2. Attrition rates are higher than she probably realizes. There's a non-trivial probability that she'll drop out or flunk out before she finishes.
3. Even if she does finish, it's not going to be in 4 or 5 years. Think seven.
4. Grad school is not an intellectual salon, where she's going to be discussing the big questions and probing into deep insights about nature and the universe and all. There's some of that, to be sure. But it's large part tribal initiation (with all the gratuitous nonsense that implies), and no small part straight-up hazing.

It's important to be pessimistic when making this decision. If she imagines some tough, but not-

improbable realities, and finds herself flinching, then grad school is probably not the right decision for her right now. For many, the realization that a successful academic career is unlikely is enough to deter them; if they're going to end up in industry anyway, why not start there?

If this bums her out a little, but she's so devoted to her field that she can accept these, she can go ahead and tick the needle towards "Yes" a bit.

The Personality Test:

Successful grad students aren't like normal humans. The following questions should test whether she's got the necessary personality traits.

Can she give one or, preferably, more examples of times working on a research project when she was:

1. **Inquisitive**: new research questions (not necessarily original ones) came to her while studying; when learning about a tool or technique she thought of new contexts it might be applied to.

2. **Disciplined**: she had set daily/weekly routines for making progress on a project; she persisted in these routines even when she was bored or burnt-out on the project.
3. **Obsessive**: she couldn't stop thinking or talking about her work; she couldn't tear herself away from a project without checking every detail, or testing every possible permutation of her model or experiment.
4. **Delusional**: she was sure she was going to uncover something new and important with her research.

The Skills Checklist:

Not all of these skills are necessary for someone going into a Ph.D. program—indeed, part of the point of grad school is to obtain these skills. But the more she goes in with, the less pain she's going to feel. If she's answering no to most of these, she'll want to hold off on a Ph.D.

1. Is she comfortable with at least some analyt-

ical software used in her field? R, SAS, Stata, Matlab?

2. Is she comfortable with at least one programming language like Python, Perl, C/C++, Java, etc.? (R or Matlab count if she's done more than just import data and run built-in functions.)
3. Does she have an organized and efficient workflow system? See, e.g., Keiran Healy's *Choosing Your Workflow Applications*.
4. Is she comfortable with mathematical proofs at the level of a first- or second-semester real analysis course?
5. Is she comfortable reading through an upper-level undergraduate or lower-level graduate textbook in her field? Does she have experience doing self-study at this level—not for a class or required project, but for her own interest?
6. Can she read and follow some recent empirical literature in her field?
7. Is she a competent, conscientious writer? Does she understand how to write in a clear, con-

cise style, using plain English? Does she understand how to structure an argument, and compose clear paragraphs and sentences? Has she consciously tried to improve her writing, either in a class or by reading writing/style guides?

If she's gone through these three tests and the needle has moved most of the way towards "Yes," then I have a whole other slew of advice for choosing a program (more importantly, avoiding bad programs). The most effective of which is to buy beers for some grad students in the department. After two rounds you'll probably know whether or not you want to be in that program.

She's decided to do her Ph.D. Would you recommend she take some time off prior to grad school, or should she jump right in?

Carl: There's a balance to strike here. On the one hand, I find people with a little more experience and

maturity, as well as stability in their personal lives cope better with the stresses of a Ph.D. program (and tend to finish faster). On the other hand, the older you get and the more responsibilities you accumulate, the harder it is to bear the costs in time and income required by a Ph.D.

But if she's 22 or 23, and all she's known is high school and undergrad, then yes, I'd definitely suggest doing something else a year or two before her Ph.D. See the Skills Checklist above. Try and find a job that will let her check off some of those boxes. There are lots of them out there. A normal job also confers a lot of meta-skills useful for grad school: working on teams, putting up with assholes, communicating effectively, dealing with hard deadlines, structuring her time and work-flow.

While she's doing that, take some night classes, work on side projects, keep a notebook of research questions she'd like to look into. Also save up some money and try to get into a stable, monogomous relationship with someone whom she can go to for emotional support during her Ph.D. Do some travel-

ing if she can.

> *Do you have any thoughts on going from undergrad into a Ph.D. program verses first completing a masters?*

Carl: In most cases (at least in the U.S.) an M.A. isn't really a meaningful prelude to a PhD. It's a different track. Indeed, I've spoken to professors at programs who've told me they avoid M.A. students—especially their own—in their Ph.D. admissions.

I wouldn't unequivocally say you shouldn't get an M.A.—I have two of them—but I'm a little down on them. I think many departments treat their M.A. programs as cash cows, and the programs don't provide a good return-on-investment.

So, given that, don't pay for an M.A. I didn't, and wouldn't have, paid for either of mine. Get a full-time job, look for a program with a part-time curriculum, and and try to get your company to pay for most, or all, of your tuition. Alternatively, some of the

better programs will provide financial support or merit scholarships.

Also, pick your courses with an eye toward Ph.D. admissions. Talk to program advisors for advice on this. This typically means spending your electives taking Ph.D.-level courses. Whenever a course has an M.A. and a Ph.D. version, take the latter.

What benefit(s) does having a Ph.D. bring for someone working in industry?

Carl: It really depends on the industry. For some it opens doors, often a lot of them; for others it's absolutely necessary to progress past a certain point. In some cases, it can actually be a negative—you get pegged as an egghead and put in the back office. Avoid those places, even if you don't have a Ph.D.

For the most part it's an easy signal to recruiters, hiring managers, bosses, colleagues, and clients that you've got a certain set of skills (even if you don't really have those skills). Obviously, you may end up using a lot of what you learned in your Ph.D. to

do your job, but in my limited experience, someone without a Ph.D., but with enough experience on the job and who is a motivated learner can do pretty much the same work as someone with a Ph.D. Again, depends on the industry.

If you're working in a technical or research-oriented place where there are a lot of Ph.D.s, not having one may nix a lot of options for you, and you may have to fight to prove you can do the same work.

Dr. Melissa Santos, data scientist

Melissa Santos has a Ph.D. in applied math and statistics from the University of Colorado at Denver. A data scientist at Big Cartel, you can find her at [@ansate](https://twitter.com/ansate).

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cent job as a software developer. She's not sure what to do. What advice would you give her, or what questions might you suggest she ask herself as she goes about making the decision?

Melissa: Make sure to get an industry internship every summer to get a view of the real world. Have a plan to get a masters degree midway, and reassess the Ph.D. decision at that point.

Part of not being sure is not having firmed up other options - apply to some of those programming jobs! What do you learn in those interviews? How does that stipend look with a salary offer in hand?

The only reason you HAVE to do a Ph.D. is to become a professor. That is also the aim of the people training you in a Ph.D. program, which can make it hard to be realistic about your goals outside of academia - the entire structure around you will be telling you that everything else is lesser.

Do you have any thoughts on going from undergrad into a Ph.D. program verses first completing a

masters?

Melissa: I did a masters first, and I don't regret it - it's part of what has let me have such a wide variety of academic experience. My thought at the time was that it was helping me decide if I like grad school enough to go on, but it didn't help me appreciate how much different a Ph.D. program is for a masters. The jump from coursework to research was a sharp break, and you will want to talk to your potential adviser's other students to learn how much help you'll get in that transition.

What benefit(s) does having a Ph.D. bring to your work industry? Is a Ph.D. necessary for that kind of work?

Melissa: I work in tech. The Ph.D. might make my resume stand out a bit, but it's not necessary. To some extent, the process of getting the Ph.D. helped me have the mindset of putting together methods and being creative in my approach to problems that

I'm not sure I would have with just the masters degrees. Masters degrees gave me toolboxes but the Ph.D. enforced that the tools come from people like me, and I can be part of building them.

Dr. Paul Harper, professor of operations research

Paul Harper holds a Ph.D. in mathematics from the University of Southampton. He is Professor of Operations Research and Mathematics at Cardiff University in Wales. He is active on Google+; his personal website is profpaulharper.com.

> *A 22-year old college student has been accepted to a Ph.D. program in a technical field. He's academically talented, and he's always enjoyed school and his subject matter. His acceptance is accompanied with 5-years of guaranteed funding. He doesn't have any job offers but suspects he could get a decent job as a software developer. He's not sure what to do. What advice would you give him, or what questions might*

you suggest he ask himself as he goes about making the decision?

Paul: Put simply, students should first and foremost ask themselves if they actually **need** a Ph.D. If they aspire to an academic career, then almost certainly a Ph.D. will be required. An initial word of warning though; for many straight out of their first degree, knowing what an academic career actually involves or indeed how to climb onto the academic ladder is often not fully understood. This isn't surprising, after all most undergraduate students only see their lecturers in the lecture room or in tutorials, and typically don't appreciate the wide range of responsibilities and pressures they have across teaching, research and administration. My advice would be to those curious or aspiring to an academic post and thus getting the Ph.D., just as one would seek career guidance for any other job in industry, is seek advice from a variety of sources such as chatting to range of academic staff, research the prospects of employment in your field (see below), grab any opportunity

to work on research with potential supervisors to ensure it is something that you're both passionate about and intellectually able to fulfill (there might well be paid summer internships as an undergraduate, or just offer to work for free if you're that serious!). There is a reality check though, that permanent academic posts are increasingly hard to come by. Typically (in the UK at least), after a Ph.D. you would still be required/expected to have completed a 2-3 year post-doctoral position before even being considered for a lectureship. In reality you might even end up on multiple post-docs before an opportunity arises. It's tough and most certainly will require you to be willing to move locations in your quest for that first step on the ladder. That said, if deep down you know that this is your true desire, then coupled with the right attitude and willingness to put in the effort for potential reward, then go for it!

Based on my own experiences of chatting to Ph.D. applicants, the majority don't actually know what they want to do by way of career and wish to keep open the possibility of an academic career as

well as a stepping-stone in to industry. In this instance the *need* for the Ph.D. isn't so clear. There are some industrial jobs that do require or at least highly desire applicants to have a Ph.D., in which case the Ph.D. will again be necessary. Clearly the student should research what qualifications are required for the different careers they are considering. I am also aware of industrial jobs where those entering with a Ph.D. are fast-tracked to more senior posts with overall better prospects, hence the benefits of the Ph.D. might begin to outweigh the negatives such as 5 years of lost salary and industrial experience.

Returning to the case at hand, this student suspects he could get a decent job as a software developer, and so it seems the Ph.D. isn't required for the job. Here the student should ask himself if he **wants** to get a Ph.D. (as distinct from an actual *need* to get it). This is more complex with multiple factors to consider. Going straight into industry should provide 5 years of good income, experience and potential to rise up the career ladder. Staying for the Ph.D. will provide 5 years of much lower income and typically a com-

pletely different life and way of working to those in industry (I worked myself in industry for 2 years as a Management Consultant before retuning to University for a Ph.D., so I have some first hand experience of the differences). Ph.D.'s require much more time working independently and in isolation, thus for sure you need to be able to motivate and organise yourself and be able to bounce back from the inevitable lows. It will be tough work, long hours etc, although that can be true of course in industry (as a management consultant I'd spend silly hours at work too). On the plus side, the highs of achievement (a breakthrough in your research) are hard to eclipse, and provide enormous amounts of personal **satisfaction**. For me at least, you can't put a price on those moments, and I never personally got anything like this level of satisfaction working for those 2 years in industry. Perhaps the best way to summarise the life of a Ph.D. student is to look at the awesome Ph.D. comics (phdcomics.com) by Jorge Cham, which are spot on!

What are your thoughts on getting a masters first

versus going straight to a Ph.D. in a British university? Would you differentiate that advice for an American-style Ph.D.?

Paul: I would suggest that whether to obtain a masters first versus going straight to the Ph.D. largely depends on the subject area. For instance I obtained my masters first (and moved University to do this) because Operational Research (OR), at least in the UK, is mostly taught at masters . (I only studied one OR module in the final year of my undergraduate degree which sparked my interest.) Masters can therefore offer intensive training (in the UK they are usually 1 year full-time courses) in a particular field that can then be a stepping-stone to the Ph.D., helping to decide on which aspect of the field to focus on for the Ph.D. As Director of MSc programmes at Cardiff University (OR and Applied Statistics), I get many students asking for my advice on the masters versus industry, or masters versus straight to the Ph.D. My advice would be that for those not certain on the Ph.D. (as discussed above) the masters would make

more sense as it will improve prospects for both jobs in industry and Ph.D. scholarships. For example the majority of big employers in OR in the UK tend to recruit first from MSc (there are exceptions and good students with exceptional first degrees are highly employable as well without the MSc).

For those students wishing to do a Ph.D. and have high grades, my advice usually differs and that the masters might not be the best investment of their time (and potentially money). An exceptional student could start the Ph.D. and for instance sit in on masters modules as required or attend national training events. Here the differences between the UK Ph.D. and elsewhere become more important. In the UK, a Ph.D. usually lasts for 3.5 years (and certainly not 5 as in the case at hand). Increasingly first year Ph.D. students are required to take taught courses (could be internal modules or as part of national taught course schemes we have in the UK). When I was undertaking my Ph.D. (1998-2001) there were no such programmes or expectations, hence the time to completion was less, typically around 3

years. Introducing the requirement to sit on taught courses is a good move in my view, as it allows the Ph.D. student to widen their knowledge (they may well be asked to study something not directly related to their Ph.D. for instance). So for the US system, with more formal training in the first 2 years of Ph.D., my advice to go straight to the Ph.D. rather than the masters would probably be strengthened. In the case where the student was absolutely sure they needed or wanted the Ph.D., the masters would seem somewhat unnecessary.

I haven't yet mentioned scholarships/bursaries, and of course these may play a large part in the decision-making processes too. Typically funds for Ph.D.'s are much harder to obtain, hence the masters first (where possibly more scholarships are available) might at some Universities improve one's chances of subsequent funding for the Ph.D. Some Universities nowadays in the UK are also offering funded places for a 1+3 scheme (Masters + Ph.D.) so the bundle of funding covers you for both. This is increasingly the preferred option of some of the major

UK funding councils, so in future going straight to the Ph.D. might in fact not be an option at all but there will the necessity to complete the Masters first.

Would you advise an American student to do a Ph.D. at an British university? Visa versa?

Paul: I suppose the most immediate difference between the US and UK Ph.D.'s is the duration (3 to 4 years compared to more like 5) largely resulting from the necessity of the taught programme components (as discussed above). In practice I imagine the decision would be largely driven by ensuring you have the right supervisor as an expert in their field (whether they happen to be based at a UK or US University), financial considerations (scholarships, cost of living etc) and how much weight one places on how 5 years of a Ph.D. (including the benefits of taught component) in the US compared to less of a time commitment in the UK.

Admission and funding aside, what should a potential Ph.D. student look for in a graduate program?

Paul: First and foremost, ensure you find a supervisor/advisor with similar research interests willing to take you on, after all they'll be a big part of your life for the next several years, and it is very important that your research interests mesh! Consider the reputation of the department, read publications to get a better feel of potential supervisor's interests and track-record etc. Ask what types of training programmes are available, what teaching/tutorial duties are possible, conference funding, other activities of the research group (seminar series etc) and destinations of recent graduate students. Consider the number of other graduate students under their supervision and indeed within the department as a whole since working within a larger team of fellow grad students can be more supportive and better chances that others are working on similar research work to yourself, although conversely if you are one of many grad students being supervised by the same person, you might expect to have to fight more for their time and attention!

A very common misconception is that applicants

can simply pick a supervisor of their choice, but this requires mutual consent. So approach potential supervisors with the courtesy it merits and to impress them both with your research ideas and interests, but also the right attitude to be willing to work hard and to learn. One of my favourite quotes (courtesy of a colleague, Dr. Vince Knight, from whom I first heard this from) is by Dr Seuss: "It is better to know how to learn than to know." Hold fast to this principle and it will keep you in good stead!

Dr. Laura McLay, professor of operations research

Laura McLay holds a Ph.D. in industrial engineering from University of Illinois at Urbana-Champaign. She is is Associate Professor of Industrial & Systems Engineering at University of Wisconsin-Madison. She blogs at Punk Rock Operations Research and is active on Twitter.

A 22-year old college student has been accepted to a

Ph.D. program in a technical field. He's academically talented, and he's always enjoyed school and his subject matter. His acceptance is accompanied with 5-years of guaranteed funding. He doesn't have any job offers but suspects he could get a decent job as a software developer. He's not sure what to do. What advice would you give him, or what questions might you suggest he ask himself as he goes about making the decision?

Laura: I would recommend visiting Tough love: An insensitive guide to thriving in your Ph.D. by Chris Chambers for guide for knowing if you are ready to pursue a Ph.D. I don't have too much to add. If this list doesn't frighten you much, then I highly recommend relocating to attend a top Ph.D. program in your field, such as the Department of Industrial and Systems Engineering at the University of Wisconsin-Madison.

It's important to think about how a Ph.D. fits in with other life decisions. I definitely felt like it would be hard to go back to graduate school if I started an-

other career. And if I did go back, I was afraid that a two-body problem would mean that it would be easiest to go to the local Ph.D. program rather than move to go to a top Ph.D. program. Relationships need a lot of compromise and mutual sacrifice to work, and a Ph.D. doesn't always fit in nicely. I decided to go straight into graduate school so that life didn't get in the way later on. That's not the right decision for everyone, but it might be harder to go back than you may think.

Many people go and get Ph.D.'s later in their career as part-time students if their employers pay for them. This is a nice perk, and it is rare. This experience will be very different from that of the 22-year old student jumping straight into a Ph.D. program. The part-time career student may just be interested in getting a Ph.D. to qualify for moving up the corporate ladder. The full-time student should be more interested in building a set of skills and expertise to challenge important problems in their field for life. I believe that the motivation to get a Ph.D. should be more than just getting the diploma.

And it's worth saying that five years of guaranteed funding is a sweet deal. Think about it.

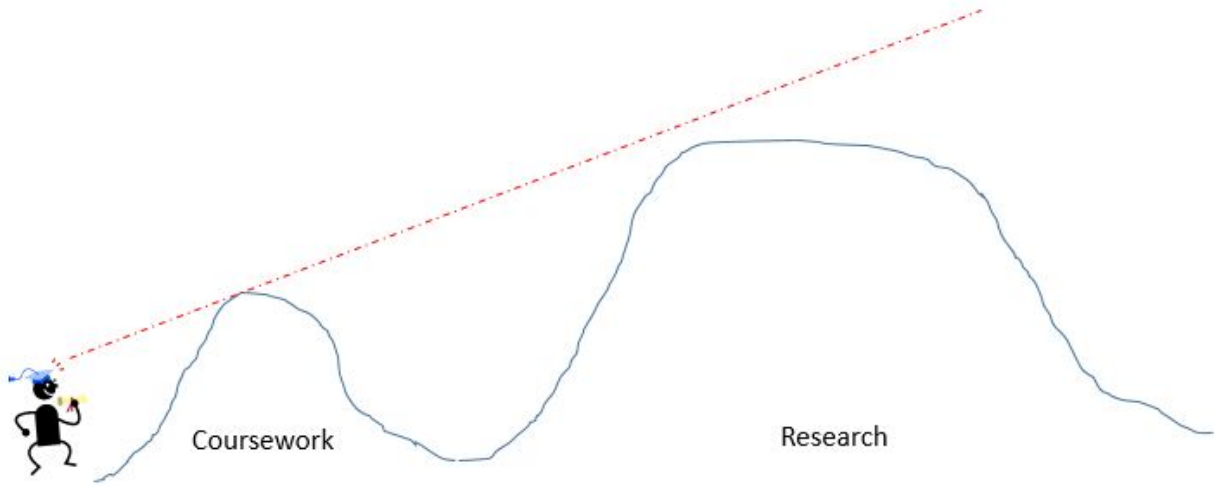
Our hypothetical student specifically aspires to be an academic and sees a Ph.D. as essential to getting there. Do you any words of encouragement or caution about that goal?

Laura: It's a great career, but it's not for everyone. Graduate students should have plenty of time to discover if academia is right for them. I am introverted and was painfully shy at age 22. I did not enter graduate school with the goal of becoming an academic. Luckily, I was converted along the way.

Do you have any thoughts on going from undergrad into a Ph.D. program verses first enrolling in a masters program?

Laura: There are many more funding opportunities for Ph.D. students than for Masters programs. If you're on the fence, apply to Ph.D. programs.

Let me be clear: a Ph.D. is not a Masters degree plus a little more coursework and a small project. This is a sketch of what my colleague Jason Merrick uses to explain the concept of a Ph.D. to prospective Ph.D. students. The Ph.D. student first sees the "hill" of coursework, which seems like a lot of work. From where the Ph.D. student stands when he/she starts a Ph.D. program, the second, bigger "hill" of research is not visible. But it is there. "All but dissertation" (ABD) is not very close to finishing. If the idea of tackling that hill of research is daunting, maybe consider a Masters instead of a Ph.D.



Admission and funding aside, what should a potential Ph.D. student look for in a graduate program?

All graduate students should look for top programs that have friendly faculty who have interesting blogs and/or engage in human pyramids. There should also be several nearby lakes for kayaking on days off, bike trails everywhere, the best union you've ever seen, beer aplenty (and better yet - the birthplace of kegball), and a mascot who is a lovable woodland creature.[1]

I have a slideshare presentation on applying to Ph.D. programs that has more tips and advice.

What should a Ph.D. student look for in an advisor?

Laura: Choosing an advisor is a two way street. One thing prospective students may not know is that no faculty member has to oversee their dissertation research. It's important to be polite, diligent, and responsible with faculty. Even in a big program, there may be only a couple of faculty members whose interests may match yours. You will not finish if one of

[1] *If Tim left in this shameless plug for my department, I will be extremely grateful!*

them isn't on your side. Chris Chambers put it well: "Above all, remember that you and your supervisor are in this together. Those three years can be an energizing, productive, and career-making partnership. But they can also be a frustrating waste of time and energy. If you want your supervisor to go above and beyond for you, then lead by example and work your butt off."

Mr. Mike Nute, recovering actuary and Ph.D. student

Mike Nute is a recovering actuary and a current Ph.D. student in statistics at University of Illinois at Urbana-Champaign.

Dear Young Student,

First, as far as whether you should do the Ph.D. program, you should think long and hard about it because there is a lot of upside and a lot of downside. Here are some things in particular to should think about:

1) Going to a Ph.D. program straight from undergrad and continuing essentially the same field of study is a lot like marrying your high school sweetheart. Certainly for some people that works out ok, but for many others in ends in a terrible divorce. In the case of the Ph.D. program, you should bear in mind that the academic world and the real world are two very different places, and that up until this point you have only seen the academic world, so you might very well enjoy the real world just as much. Bear in mind also that the professors and advisors you have dealt with up to this point tend to be people who have thrived in the academic world and their advice will come from that lens. So do your best to get at least some exposure to the variety of jobs out there where you could apply the discipline. You should especially do this if the reason that you think you'd like to get a Ph.D. is to enter academia afterward. Take a little Rumspringa from that life before you enter the order.

2) If you find yourself thinking about the Ph.D. program as a means to an end, like as a requirement for some job, then you should strongly consider whether there is an easier way. More specifically, if you don't think that getting the Ph.D. is going to be fun on its own, then there's a strong chance you'll be miserable and it will end badly. If you want to be a professor, then getting a Ph.D. is really the only way to go about it, but for virtually any other goal there is probably an alternative that doesn't require the same sacrifice.

3) The way you should be thinking about the program is like this: it's a chance to spend five years doing nothing but studying your favorite subject in great depth while keeping adequate health insurance and avoiding debt. You really won't have either the time or the money to do very much else, so you had better really love this subject. You remember that episode of the Simpsons where the devil's ironic punish-

ment for Homer is to force feed him an endless stream of donuts, but gets frustrated because Homer never stops loving the donuts? Well you have to love your subject like Homer loves donuts, because that's going to be you. If you do love it though, you won't even notice being broke or studying all the time.

4) In fact, you should come to grips right now with the fact that you may finish your Ph.D. and find that you want to change careers and never revisit that subject again. That may sound unimaginable, but it's possible mainly because you're 22 and who the hell knows what you'll want when you're 28. If that happens though, will you look back on having gotten a Ph.D. as a terrible decision and a waste of time? If so, then don't do it. If you think you'll be proud of it and will have enjoyed yourself no matter what, then it's actually a low risk move because that's basically the worst case scenario.

5) You should also note that there is a major difference between a Masters and Ph.D. program. First of all, the Ph.D. will be much more intense, even in the first two years, than a Masters. Since most Masters programs are not funded but Ph.D.s are, you can think of it as the difference between being an employee and being a customer. But on the other hand, most industry jobs are as happy to have you with a Masters as with a Ph.D., so you can easily use the extra years of work to pay off the loans from the Masters program. This reinforces the last point above: the only real reason to do a Ph.D. program is for love of the subject.

In my case, I came back to grad school after seven years in industry. From my experience you can take two lessons: 1) try to avoid waiting seven years to go back if you can, and 2) if you do wait that long, just know that it's never too late. The longer you wait, the harder the sacrifice of time and money will be. But you gotta do what's going to make you happy,

and there are a lot of ways to be happy with a job. You can literally enjoy being at work every day, you can do something that benefits others, you can do something very challenging, or you can do something that enables you to enjoy other parts of your life, like gives you schedule flexibility or a sufficiently high salary. There are others too. In my case, I had a very tiny bit of all of those but not enough of any one to really count, which is why it took me so long to leave. Grad school though is challenging, and it makes me proud as hell to tell people about because I know how hard it is. So think about which of those is the most important to you, and plan accordingly.

So anyway, good luck young man or lady, and don't stress about it too hard; you can always change your mind later.

Regards,

Mike Nute

Dr. Oscar Boykin, software engineer

Oscar Boykin is a software engineer at Stripe. Prior to joining Stripe, Oscar was a data scientist at Twitter and a professor of computer engineering at the University of Florida.

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Oscar: The number one question: does he or she have a burning desire to do a PhD? If so, and funding is available without taking loans, then absolutely! Go for it! It is a wonderful experience to try to, at least in one small area, touch the absolute frontier of human

knowledge. If you greatly enjoy the area of study, and you find it is the kind of thing you love thinking about day in and day out, if you imagine yourself as some kind of ascetic scholar of old, toiling to make the most minor advance simply for the joy the work, then by all means.

The second reason to do a Ph.D., and this one hardly needs discussing, is that you want a career that requires it. If you want to teach at a university or do certain scientific occupations, a Ph.D may be required.

If the student has doubts about any of the above, I recommend a master's degree and an industry job. There are a few reasons:

1. If you lack the passion, the risk of not completing and the time investment do not equal the cost.
2. There is little, if any, direct financial benefit to having a Ph.D. and the cost in time is substantial.

3. Professions are changing very fast now and you should expect a lifetime of learning in any case, so without a strong desire for a PhD, why not do that learning in the environment where it is most relevant?

He decides he wants to do the Ph.D. but his timing is negotiable. Would you recommend he jump straight in or take some time off?

Oscar: Doing an internship or one year of work at a relevant company will often give students much better insight into choosing research topics. Choosing a great topic and a great advisor is the entire name of the game when it comes to the Ph.D. BUT, taking time off makes it very easy to get out of the habit of studying and learning, so if commitment is a concern, there is substantial risk that time off will turn into never coming back.

Are there skills developed while earning a Ph.D. that are particularly valuable to being a practicing soft-

ware engineer? Are there ways in which a non-Ph.D. can work to build similar skills?

Oscar: You can't take too much math. Learning linear algebra, probability theory, information theory, Markov chains, differential equations, and how to do proofs, have all been very valuable to me, and very few, if any, of my colleagues without PhDs have these skills. I have seen on the order of 3-10 people in the hundreds to ~thousand that I've interacted with, that picked these up on their own, so doing so is clearly possible. It is hard to say if getting a PhD helps learn those things: perhaps the same people who learned them with a PhD would have done so without. A safe bet seems to be structured education to pick up such classical mathematics.

In your experience, are there potential liabilities that come with getting a Ph.D.? Do doctoral students learn habits that have to be reversed for them to become successful in industry?

Oscar: One problem with the industry/academia divide is that each has a caricatured picture of the other. Academics fear entering industry means becoming a "code monkey" and often disparage strong coding as a skill. I think this is to the detriment of academia as coding is perhaps as powerful a tool as mathematics. Yet, many academics muddle through coding so much that the assumption by teams hiring academics is they will have to unlearn a lot of bad habits if they join somewhere like Twitter, Facebook, Google, etc… This assumption often means that hiring committees are a bit skeptical of an academic's ability to actually be productive. This skepticism must either be countered with strong coding in an interview or some existing coding project that gives evidence of skill.

You didn't really ask much about the career path of academia vs industry. I did want to address that a bit. First, those paths are much more similar than most people realize. As a professor, on average, your colleagues are brighter, and that is exciting. But academia today is very focused on fund raising, and

that fund raising is involves a lot of politics and salesperonship. In the software industry today, one has a lot of perks: great salary, lots (even unlimited) vacation time, the freedom to focus on the things you enjoy the most (compare to being a professor and doing 3-4 different jobs concurrently). As a professor, you are running a startup that can never be profitable: you are always raising money and hiring. The caliber of the very best in industry is also just as high or higher than academia (though the mean may be lower). I much prefer my job at Twitter to my time in academia.

Chapter 3

Additional Resources

- The illustrated guide to a Ph.D. — From Professor Matthew Might
- My "Twitter Moment" on the topic
- So Many Research Scientists, So Few Openings as Professors — 2017 NYT article on the lack of academic jobs
- The Professor Is In: The Essential Guide To Turning Your Ph.D. Into a Job — 2015 book by Karen Kelsky
- Why They Want to Reject You Article by Kel-

sky on how you're unlikely to land a good academic job

- Advice to (prospective) grad students — Article by Vivek Haldar
- There's an awful cost to getting a PhD that no one talks about — Article about Ph.D. students and mental health
- Should You Get a Ph.D.? — Reflections by a computer science professor
- Should You Go to Grad School? — Article by Duncan Watts (Principal Researcher @ Microsoft)
- Rethinking graduate education — Article from Science magazine
- The disposable academic — 2010 article from The Economist subtitled "Why doing a PhD is often a waste of time"