Know When to (at Least Temporarily) Abandon a Project

Perhaps, even after trying everything, you still feel like you can't get anywhere. Maybe you can't focus on your project and instead find yourself starting a time-consuming new hobby. This could be because you are just not that into the project, or you don't feel that it is worthwhile (in this case try to get a second opinion), or maybe it is just currently not feasible.

Some novelists speak of a "drawer" containing manuscripts that they could never finish to a satisfactory state, and it is possible that your project belongs there. If so, be sure to note down a summary of what you were thinking and where you got stuck; you can always revisit the problem another time. Meanwhile, maybe throw a goodbye party for your project.

Confused

Being confused is fundamentally different from being stuck. It means that you have identified a specific place where there is a gap in your understanding. Many things can cause confusion. Something you are reading in a paper may seem wrong (it's probably right). Something you think you can prove can seem too good to be true. You may think you have found a contradiction. You know that an isomorphism exists but you can't tell whether or not it is canonical.

Being confused is good! It means you are about to learn something. Avoid reading from more sources; this can just increase the confusion. Carefully work through the logic step by step, use simple examples to debug, ask for help if needed, and soon you may have made an important bit of progress.

Michael Hutchings

Credits

Photo of Michael Hutchings is courtesy of the author.

How to Help Your Graduate Students and Postdocs Find a Problem

Izzet Coskun

When I am asked how to advise graduate students and postdocs, I often think of my niece and nephew. My nephew has always been an adventurous eater. Eggplant, cauliflower, kale, mushrooms, beans, shishito peppers—he enjoys it all. His younger sister subsisted on mac and cheese, blueberries, and cheerios for a long while. My sister-in-law would often wonder how the two kids had such different palates, even though they were raising them the same way. I often puzzle over the analogous question for my graduate students.

In my experience, being an advisor shares many similarities with parenting. An advisor's role is to model good and productive practices, while supporting and encouraging younger mathematicians as they develop to their potential. We must respect students and postdocs as individuals. They will have different interests and talents, and reach milestones at their own pace.

Awake at Night

Settling on a thesis problem is one of the most consequential decisions in graduate school. Unsurprisingly, each of my students have found their thesis problems through different paths. Above all, I advise my students to work on a problem that inspires them.

Of course at any stage, there are many factors one could consider when choosing what to work on: Is this question significant? Is it fashionable (this can be good or bad)? If I solve the problem, will I get a job? Will this work lead to a research program, and will such a program lead to funding? These are important questions and play some role in how I steer the students. However, I always tell my students to find a problem that keeps them awake at night. It is crucial that students and postdocs (everyone really) be invested in and passionate about their work.

Exposure to Ideas

It takes effort and time to hone in on a good thesis problem. I ask beginning students to read papers on a variety of topics to see what sparks their interest. I meet them weekly and introduce them to problems that I am thinking about. I run reading courses and seminars on current research where I introduce the students to many open problems. Since I'm an algebraic geometer, I urge my students to attend the algebraic geometry seminar. Beginning students can resist

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attending seminars because they cannot follow the talks. I instruct them to try to follow at least the first 10 minutes of each talk, pay close attention to the problems the speakers are raising, and attempt to answer these questions for simple cases. I require my students to attend the student algebraic geometry seminar and the graduate student colloquium. In these venues, they can learn problems that spark their interest from older students.

While not every PhD granting math department has student seminars and student colloquia, there are many online seminars and schools, and recordings on almost every topic.

I encourage students to follow the daily arXiv posting and to think about the problems mentioned (often in the last section). I reinforce the importance of following the arXiv by periodically asking students whether they have seen postings relevant to their research.

Transitioning to Research

Usually, after fumbling around with two or three ideas, students organically settle on their thesis topic. I have found that when students find their own project, they seem more invested. If after a year a focus has not been achieved, I provide more direction by assigning explicit toy problems to solve. I tailor the problems according to the student's interests.

For most of the students I have advised, the hardest part of transitioning from an undergraduate to an independent researcher is finding their own questions and formulating their own conjectures. I feel the process of settling on a thesis problem is great practice for what comes next. Being exposed to many open problems serves the students well later in their career.

I encourage my students to write up their results as they discover them. Writing helps refine problems, solidifies their thoughts and often allows them to expand in new directions. Communicating clearly also forces students to be more precise and allows them to catch mistakes and gaps in their arguments. This can spark new research projects.

Options

There are different types of theses. One may take a paper and generalize it, either by extending a technique to a new situation or by removing a technical assumption. One may work on an aspect of a big program, such as the Langlands program or mirror symmetry in a particular example. One can reinterpret an existing theorem in a new framework, such as Tate's thesis. One may develop the framework of a new theory, such as Mumford's thesis on Geometric Invariant Theory. One may attack a conjecture. One may study different examples and find a unifying pattern. Generally, a thesis will combine several different aspects.

The type of thesis often depends on the personality of the advisor and the student. I tend to prefer thesis problems that are example based and have many layers. The first example may be easy to explain to an undergraduate. The next example may be suitable for a problem set in a graduate class. The next example may be novel and suffcient for a basic thesis. Solving the problem in general might be a significant achievement. I find that problems with parameters are easier for students to navigate. They are less likely to get stuck because they can adjust the parameters. I shy away from assigning students a make-or-break problem. This primarily reflects my personality. There are many successful advisors who can get their students to solve diffcult conjectures.

There are problems whose solutions I can anticipate even if I have not worked out all the details. Such a problem may be suitable for a beginning student or for a student who has decided not to pursue a research career. However, in general, I prefer having students work on problems whose solutions I genuinely do not know and are likely to present some surprises. Students should have some space to explore the problem on their own. I only intervene with small suggestions when they are stuck. On the other hand, if I suggest a problem to a student, I like to have a general approach to try or at least some examples to study. If I had no idea of how to approach my student's thesis problem, our weekly meetings would be rather awkward, and so I try to be prepared.

Occasionally, a student may want to work on a problem far from my expertise or interests. The first time this happened I was worried that I would be a terrible advisor. Now I see it as an opportunity to learn new mathematics. If a better advisor is not available, I am agreeable to advising students working in areas I do not normally work on. At the outset, I warn the student clearly that I am not an expert on the subject and if they get stuck, I might not be able to help them. I also caution them that they will need to be very diligent in surveying the literature. I then do my best to introduce the student to researchers who are experts in the area.

It is important to keep an open dialogue with the student throughout their studies since their goals and focus may change. One can then adjust the scope and emphasis of their problem accordingly.

Postdocs

I approach helping postdocs find a problem slightly differently. Postdocs already have considerable expertise in several areas. When working with postdocs, I try to suggest problems that will utilize their expertise while expanding their horizons. I treat them as collaborators whose expertise in a particular area will help me solve interesting problems. I also tend to propose harder problems.

Community

An important aspect of developing a research program is becoming part of a research community. I encourage students and postdocs to attend summer schools and workshops

such as the AMS MRC program and the MSRI summer schools. These are great opportunities for budding mathematicians to get exposed to new problems and develop collaborations with peers. I invite senior researchers working on problems close to my students' and postdocs' interests to the algebraic geometry seminar. I make sure to introduce my students to these researchers. When students are further along in their work, I mention their work to colleagues at conferences. When I am giving talks, I describe my students' or post-docs' work. This helps publicize their work and helps them connect to other researchers, sometimes leading to seminar invitations and job opportunities. When young mathematicians are part of a research community, then they are exposed to many more problems and start generating their own problems through other collaborations.

In Summary

If there is a recipe for successfully advising graduate students, I have not yet discovered it. However, there are a few general principles to follow. Keep in mind that each student is an individual with their own interests and passions. They will reach different milestones at their own pace. Respect your students, be generous in sharing your ideas, and introduce them to a lot of different problems. Promote their work and connect them with other researchers in the community. Then each time, a slightly different magic will happen, and the undergraduate of yesteryear will transform into an independent researcher.

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Photo of Izzet Coskun is courtesy of Micah Block Weiss.

MSRI Addresses the Challenge

Hélène Barcelo and Michael F. Singer

The Mathematical Sciences Research Institute: Purpose and Goals

Founded in 1981, the Mathematical Sciences Research Institute (MSRI) aims to further mathematical research through broadly-based programs in the mathematical sciences and closely related activities. MSRI realizes this goal by hosting researchers in semester- and year-long programs in key and timely areas of research in the mathematical sciences, training the next generation of researchers, reaching out to ensure equitable representation of historically underrepresented populations in its mathematical activities, and communicating the power and beauty of mathematics within the profession and to the general public.

MSRI typically hosts two major programs at a time, each lasting a semester or a year. Those programs, designed to support and enhance communities of researchers and catalyze their collaborations, represent the core of our mission. Long-term visitors come for periods ranging from one month to ten months. During a semester-long program, MSRI becomes a world center of activity in the field of the program, with visits from top experts as well as from those who will become the next leaders. Welcoming about 1700 visitors a year, MSRI also sponsors or hosts workshops on diverse mathematical and educational issues; summer programs for undergraduate students, graduate students, and faculty; and diverse public events both at MSRI and elsewhere in the world.

An Awakening

In the mid 1990s, Bill Thurston and Lenore Blum, then Director and Deputy Director of MSRI, were concerned about the lack of diversity in the Institute's programs. They created the Human Resource Advisory Committee (HRAC) in response. The HRAC was mandated to advise MSRI on how to be inclusive, diverse, and equitable. Over the years the committee proposed several new activities meant to encourage researchers from a variety of backgrounds to learn

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