The $[m^3]$ Editorial Team

Basant V Sagar ‘11
Christopher Policastro’11
Nicole Fong’13
David B Rush’13
Editorial

Welcome to the Fall/IAP 2010-11 issue of [m³] - the Math Majors Magazine, brought to you by the MIT Undergraduate Mathematics Association. Our objective is to serve as an informative, fun and informal publication for the undergraduate mathematics community at MIT. Through interviews of professors and researchers, and articles about summer research experiences, we aim to make your life easier when it comes to making key choices.

In this issue, you’ll read how a grad student first fell in love with algebraic topology and how to make the most out of summer doing math. We also have a feature report on SWIM (Society for Women in Mathematics) – another math-related group on campus, which organizes weekly lectures and other social events.

If you are interested in getting involved with [m³] or sharing your math-related thoughts, email us at mmm-exec@mit.edu. We are already working on the next issue.

You can access past issues of [m³] on the UMA website: web.mit.edu/uma/www.

Have a wonderful term! We look forward to seeing you all at the weekly talks and other UMA socials.

Basant Sagar’11

Executive Editor
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An Interview with Inna Zakharevich

Inna Zakharevich is a graduate student of mathematics at MIT. Her research focus is algebraic topology. Inna received her bachelors degree in Mathematics from Harvard in 2006. She has a record of outstanding performances at math competitions and in her academic studies.

What do you think of Algebraic Topology?

I like part of it and don’t like part of it. I like category theory because the more details you get from it, the more real it becomes. Other people may feel that the more ubiquitous it is, the more concrete it will be, like analysis and partial differential equations. I think whenever the more abstract it is, the truer it is to me.

Why did you choose to do Algebraic Topology?

For me, it wasn’t exactly a decision. I really like number theory, and 3 quarters away from my junior year, I was thinking that I would do number theory. I took Algebraic Topology at the same time, which was a 2 semester class, and I hated the first semester of that class. It was a torture, but I still took the second semester because I wouldn’t let that defeat me. Then the professor came in and talked about a different topic in Algebraic Topology, which was category theory, and a few weeks later I was madly in love it! Then I went to the professor who I had been working with and explained to him, “I am really, really sorry. We have been planning the topics of the thesis, but I can’t do it. I want to do model category.” And I went to the professor of my class, and told him that I wanted to work on my senior thesis in model category theory. Actually this professor at Harvard is now my advisor. I still don’t like the other stuff in Topology, but I loved category theory so much. My husband always tells his friends, “When we first met in the Algebraic Topology class, she fell in love with me, but at the same time she fell in love with that topic.”
Back track to your undergraduate life. Why did you choose math as your major?

Well. Math is useful. I like technical things. I didn’t want to be a math major until my junior year in high school. My family is a mathematical family. My grandfather, my father, my aunt and uncle - all are mathematicians. When I was little, the picture of the world I had in my mind was that after you get a PhD in Math, you can decide whatever you would like to do later on in your life. Then the summer before my junior year (in high school), I met some people who were really good at math. We had conversations like this:

Inna: I like math competitions, but I am not very good at it.

Friend: I got a 3 in AIME last year, and a 4 this year.

Inna: How did you get better?


This book was part of my falling-in-love-with-math process. In December, I went on a skiing trip, but I ended up skipping skiing every day - staying in and doing math problems. Problems are hard to solve, but that is the key point. There was a problem which was really messy, with puzzles and logical stuff. At first I couldn’t solve, but about a week later, I solved it! This gave me a bug and I just did math problems all year. My mother told me that I couldn’t do math because I didn’t like to sit and think for a long time. I liked to mix around things and build things, i.e. not sit and do things instead. But after that year, I began to like sitting down and thinking (about problems).

This book really guided you to math!

Yes, I recommend this book to everyone. This book is different from ordinary math books, which just start with talking about problems. But this book isn’t like that. It has an entire chapter talking about ways of approaching problems. There are standard puzzles for kids such as: “There are 3 doors and 3 houses not in order. How can you build roads to connect each other, which do not intersect
with each other?" This book has a beautiful solution for it! What is the hard part of this problem? They are not in order, so you can’t just use straight lines. Now if you move two of the doors, the roads still work based on the book’s solution!

**Now you are a PhD student. What do you think is the major difference between graduate school, undergraduate school and high school?**

Math is like a house. In high school, you are just introduced to things like where the bedrooms and stairs are. In undergraduate studies, you are being guided around the house and rooms looking at the tables and appreciating the wall paintings. For graduate research, you finally get through the door and are told to build a house. Everything is horribly disoriented and you feel that you have no tools. All the tools are inside the house and the house is comfortable. But now you are in the middle of nowhere. You know that there are interesting things outside, but you don’t know how to find it.

**Since there are so many interesting topics in each area, how do you choose and pick topics for your research?**

You look at the whole picture and see the riddles. You read about the topic and dig deeper. Then if you like it, you would want to generalize it a tiny bit. A lot of small generalizations of the paper may be obvious for me, but why is it so? Why isn’t it generalized in the paper?

What happened to me was that there was a very simple question that I wanted to answer. I had read 2 books about this topic, but what was really shocking to me was that a problem I wanted to slightly generalize seemed intuitively obvious, but I couldn’t prove it. I tried to use the method from the book, but the method from the book could not handle this generalization, which meant that the method was not (exactly) correct because a good, robust method, which tells you what the heart of the problem is, should be able to be generalized. So I tried to find a different approach. It opened up many more questions. Right now I have written a paper and I am writing a second paper. I am not anywhere close
to the approach, even I don’t have much left. And I can’t even answer the main question that I wanted to answer. I was very frustrated. I have been working on it for a year and a half. I might have gone to the end of the chalkboard, but may be probably not. (Imagine you are in a classroom.)

It turns out that if you spend a lot of time thinking about something, you get a lot out of it, even if you don’t think so. And when you write it down, it becomes better and cleaner. It is difficult to choose a topic. The way to you write a paper is to write down things that you are thinking about. Don’t decide to write a paper and then write a paper. Often a tiny thing can turn out to be a paper. Really mathematicians don’t know that much. Every time we try to understand something, it turns into something.

There are a lot of famous unsolved problems in the math world. Do you want to solve them, or do you just want to dedicate your time in your area?

If you asked me a couple of years ago, I would have answered that I wanted to solve those problems. But right now, I like the stuff that I am doing. I don’t want to switch because there are so many problems that I can’t solve and I want to answer. I think I would do it if I am looking for problems.

Can you tell us about the timeline of the graduate life?

Most of the people take a year or a year and a half to pass the courses and then we start to find and learn anything. MIT has the requirement of handing in a thesis proposal one year after you pass your courses. This proposal does not need to be the topic that you are going to write, but it has to be something about something. Then you spend hours and hours working on it. By the end of your second last year or the beginning of your last year, or earlier if you are responsible (but most people aren’t), you start writing stuff down. Generally, if you think about one thing consistently for so long, you will have something to write down. Then you just need to turn it into a story. When you apply for postdoc (cross your fingers), get it and spend for 2 or 3 more years. You might
be invited to MSRI or IAS for a year. Then you apply to be a professor and hopefully get a 10 year contract. Then you will be happy; if not, your life will be tougher.

**Do you picture yourself as a professor (maybe at MIT)?**

I would like to, but the thing that strikes me in graduate school is you don’t know where you are. At the undergraduate level, it is easy to know which students stand out in academics. But in graduate school, you have no clue. I have no way of evaluating anybody else. I think I may be somewhere in the middle, maybe, maybe not. I have no idea. You can tell who the really good people are, but for most of the people, you have no idea because you work in completely different areas. So applying for a job is really scary because whether you get a job or not depends on how good your competitors are, what people think of your field, what particular area the place that you are applying to is looking for that year. You know, if you prove a big name theorem, you will get a job. But for most people, the most crucial thing is choosing your advisor.

Choosing a good advisor will completely change your graduate life. If you really like your field, you will somehow find something that you can work with. But the most difficult thing in graduate school for most of the people is not math. It is how lost, stupid and alone you feel at all time. Your advisor is the person who will support you. Stupid - everyone feels that way. When you don’t know where to go, he will point you in the right direction. Some advisors will give you problems. Some advisors may tell you things that you should look at. A good advisor will tailor things for your aid. If you are good at coming up with questions but do not follow through, a good advisor will ask you to follow through. A good advisor makes an enormous difference. I can tell you with 100% certainty that if I had an advisor who is not as awesome as my present one, I would have left graduate school. One particular year sucked all the way. If I had not been to my advisor, I would have dropped out.
My uncle had a trouble deciding whether to accept a position in Chicago. He had an offer from Stanford, but he wanted to stay in Chicago. He went to Stanford because he couldn’t say no to his advisor. At that moment I was wondering why he didn’t say “no”. But now if my advisor asked me to do so, I wouldn’t say no.

How often do you meet your advisor?

Once a week. However he is really awesome. He is really busy and has a lot of students, but if you email him and say you really, really need to meet him, he will squeeze his time and talk to you. I had a complete freak out time a year ago. I didn’t know how to fix the problem, everything fell apart, and all the ideas didn’t work. One morning I proved that my idea didn’t work, and I sat on my desk and started to cry. My husband said, “Look. It’s the time to find your advisor.” Then I called my advisor and met with him. He saw my problem and said,

“Isn’t it the thing (approach) that you were selling me this Wednesday? You said that you were going to fix it, weren’t you?”

“Yes…”

“Did your ideas work?”

“No…”

“Yeah. That happens. You are thinking too hard. Let’s try a really, really brute force computation. If it doesn’t work, that’s great too because you have spent five days thinking about this problem really, really hard. You probably understand all the things that could go wrong and don’t work, which is way better than other people in this class. So even the thing that you worked last year is pointless, that is still (an acceptable) product.”

Luckily, it worked out. But, he was really helpful.

When are you graduating?
Next semester. I won’t think about the application for postdoc positions this year. There’s no point stressing myself out right now. It is a very difficult thing for graduate students because every year we see people who are really good and could not get a job. Last year, Matt Gelvin, who is really good, didn’t get any offer from US. He applied for 50 places and he got 0 job offers. He finally got a job in Copenhagen. He is really enjoying it right now, but he was very stressed before that. He had no funding. Even if you use your savings and prepare for applying again next year, you still don’t know whether you can get a job or not, no matter how good you are. So every graduate student has a lower threshold i.e. where you don’t want to end up. MIT has 18 graduate students in Math Department, but MIT has only 3 postdoc positions, Harvard has only 2. It shrinks like that.

The best universities that you can be at have both undergraduate and graduate programs, and there are fewer and fewer positions. That means that if you are amazingly good, you will get a position at the first tier schools; if you are really good, you will get a position in a second tier school. A lot of people leave and go to industry. Or they go to Europe. There are more postdoc positions there, although with fewer papers published. People who don’t love what they were doing leave. People who love their work stay, as long as they have jobs. I would be fine with accepting an offer from even a second tier school because I can work on things that I really like.

Thank you for the interview!
Some Advice on Summer Work

Christopher Policastro’11

Summer experience is very important. No matter what your postgraduate plans are, you should try to stay involved with math over the summer.

IAP/ early Spring is the time to submit applications for summer programs. Deadlines usually fall in late January or early February and often require at least one letter of recommendation. This letter should come from a professor or graduate student familiar with your work. The most substantial letters usually result from previous summer experiences.

You should begin by deciding what kind of work is interesting to you. This includes teaching, interning, studying, or research. This list is obviously not complete and no two options are necessarily exclusive. Keep in mind, though, that your pals will be doing something like this.

Your choice should reflect on your curiosities, goals, resources and preparations. Most work begins in late June, and ends in early August. While shorter programs or jobs exist, the longer the work, the more you’ll likely get out of it.

Speak with your advisor, and upperclassmen— especially former participants in the programs or jobs of interest to you. Most importantly, you should pursue many options, and apply to many places.

**Teaching:** You’ll find that an interest in a subject and the desire to share it are related. By teaching, you can raise awareness about math, while improving your communication skills, and learning more about the profession.

Almost all opportunities will involve teaching high school students—either in a summer camp, or through an organization like ESP Junction.
Summer programs for mathematically talented high school students are becoming commonplace. These programs include PROMYS, Ross Mathematics Program, HCSSiM, and AwesomeMath, among others.

PROMYS has the benefit of being across the river at BU, and being flexible enough to allow for work on other projects. On the other hand, it might mean rooting against RSI during an annual Frisbee match.

**Interning:** Gaining work experience is an important part of your career development.

Internships and summer jobs let you apply your coursework, and learn about possible future occupations. Not to mention that internships can be a great way to make money over the summer.

Focus on what you want to learn from your experience, and the sorts of companies or organizations that appeal to you.

The career office and career fairs are a good place to get information and to be seen. You should explore options like F/ASIP and UPOP, but keep in mind that internships can be found in other ways too—like through networking. Avoid craigslist!

**Studying:** The summer gives you time to explore a topic that you’ve touched on in class, or maybe you’ve just heard about.

While an independent study is not a replacement for coursework, your project can help you learn about a subject you’re unable to take, prepare you for a class, or even let you skip something.

Make an effort to structure your time, and to receive credit for your hard work by applying for 18.098 or 18.099. Under either distinction, the project will need
the support of a professor, or graduate student, who can help you organize your studies.

A great way to learn the material and to mark your progress is through expository writing. This will give you a chance to develop your communication skills and to gain experience with programs like LaTeX and other math-related software.

**Research:** Mathematicians have mixed feelings about the use of undergraduate research. Some feel that it would be time better spent studying; others feel that no matter the results, the work is meaningful to students.

The choice should be your own, and should reflect your fluency with mathematical reasoning, and your seriousness to develop your abilities. Mathematical research is very different from the mathematics in coursework and problem solving. You’ll have to think about questions in context, often in new or puzzling ways.

So receiving guidance and encouragement from seasoned researchers is very important. In my opinion, this is part of the benefit.

The experience of working with professors and graduate students, and alongside other undergrads, will help you grow mathematically, while giving you exposure to the math community.

Whether you’re working in groups or by yourself, you’ll get to meet people from diverse backgrounds, who can help you understand opportunities, and get you motivated about math. This might include attending seminars or conferences, mentoring students, or authoring articles.

If nothing else, you’ll enjoy the camaraderie of these programs, which can make the math community seem more inviting. This usually means going for hikes and
jogs, chatting over tea and coffee, and playing unhealthy amounts of Bridge, Scrabble, and Mafia;

Much of the difficulty of undergraduate research is choosing a suitable open problem. So try to find a program where the questions are tailored to your abilities and your interests. Look for well-established and well-funded programs, with a history of participants from the department.

A list of REU’s is available on the AMS website. These programs are held at different universities across the country, and certain research institutes like IAS and MSRI.

While MIT does not host an REU, it has a research program called SPUR. It is a six week program that has you work under the mentorship of a graduate student on various topics.
The goal of the Society for Women in Mathematics [SWIM] is to bring together women who enjoy mathematics. We work to provide a welcoming and supportive environment for the women in the mathematics department here at MIT.

The Founding of SWIM:

During her undergraduate career, Nur Shahir ’10 (SWIM President 2008-2010) realized she did not know many of the female students in the math department. Recognizing a need for networking among women in the math department, Nur along with Sandhya Ramakrishnan (‘10), Minh-Phuong Huynh-Le (‘10), Elise McCall (‘11) and Michelle Princi (‘11) founded the Society for Women in Mathematics in the fall of 2008.

What we do:

SWIM runs events geared towards undergraduates in mathematics, both on its own and in conjunction with other math and women or mathematics groups on campus. Past events have included a UROP dessert night, where students could learn about the UROP opportunities for undergraduates in mathematics over tasty desserts; a math mixer, with a panel discussion between the students and TAs about the freshman math classes and beyond; a math panel, where graduating seniors talked about their experiences at MIT and their future plans; you might have also seen us at the Activities Midway playing SET.
SWIM’s upcoming events for the 2010-2011 year are exploring how to use math in your academic path, your future career, and where math is being used to do amazing things in the world today. Keep a look out for our future events!

Recent Events:
- Math Mixer
- UROP Dessert Night
- Senior Math Panel

The SWIM Community:

Together, we strive toward the same goal: to make women in mathematics aware of the various opportunities and support available to them.

As Women in Mathematics, we share the unique appreciation for the field and study of mathematics. In SWIM we do more than just holding meetings and planning events: we learn, we bond, we form a family. The women in mathematics are a group of extraordinary women exploring the amazing opportunities here at MIT. We create a supportive network of women helping each other to succeed. SWIM also fosters connections with other student groups such as the Undergraduate Women in Physics (UWIP), the Society for Women Engineers (SWE), the Undergraduate Math Association (UMA), and Graduate Women at MIT (GW@MIT). SWIM also and has a seat on the MIT Undergraduate Women’s Council. As SWIM continues to grow we look to expand our role on campus. We send out a weekly newsletter letting our members know about the math events going on around campus that week. We hold meetings 6-7pm on Mondays and events as announced.

Our events are open to both women and men.
We welcome new members – come join us!

If you have any questions about SWIM or would like to join our mailing list please email swim-exec@mit.edu.

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