

# Interviews with Top Finishers on the 2004 Putnam Exam

## *Interviews at Duke*

Oaz Nir  
Lingren Zhang  
Nikifor Bliznashki

## *Interviews at MIT*

Adam Donovan  
Daniel Kane  
David Vincent  
Timothy Abbott

## *Interviews at Princeton*

Ana Caraiani  
Suehyun Kwon  
Andrei Negut

## *Interviews at Harvard*

Steve Byrnes  
Inna Zakharevich  
Mark Lipson  
Gabriel Carroll

## *Interviews at Stanford*

Shaowei Lin  
Andrew Lutomirski  
Robert Hough

## *Interviews at Berkeley*

Vedran Sohinger  
Carol Hua  
Boris Buhk  
Jeremy Tauzer

## Interviews at Duke

**Oaz Nir** was born in Baton Rouge, Louisiana, a few years after his parents immigrated to the United States from Israel. He attended public school from first to fifth grade and private school from sixth to ninth grade in Jackson, Mississippi. As a seventh grader and again as an eighth grader, he represented Mississippi at the national MATHCOUNTS competition in Washington, D.C. The summer before his sophomore year in high school, his family moved to Cupertino, California, where he attended Monta Vista High School. He attended the Math Olympiad Summer Program (MOP) following his freshman through senior years, and he represented the United States at the 2000 International Mathematical Olympiad (IMO) in Seoul and the 2001 Olympiad in the United States. He entered Duke in the fall of 2001 and is graduating with a double major in mathematics and English.

*Were your experiences with mathematics in middle school and high school positive or negative?*

My experiences in high school were pretty positive. We had a math club in my school in California, that was tenth through twelfth grade, and there were quite a few other kids who were interested in math, especially competition math, so we practiced together. I think that contrasts with middle school, where it's a little bit more nerdy to do math, and some people might make fun of you. But in high school, you can find other people who have the same interests as you -- at least I did.

I was at St. Andrews [in Jackson, Mississippi] from sixth through ninth grade. I haven't thought about it for a while, but I was basically typecast as a nerd there, which is fine, but that probably would have continued through high school if I'd stayed at that school. At the school I went to in California, a very high value is placed on education. Did you see the article in *The New Yorker* a couple of weeks ago about the teacher in an elementary school who picked out a passage from the Declaration of Independence that talked about God as a divine being ["Jesus in the Classroom," March 21, 2005]? The first few pages of that article described the culture in Cupertino in terms of the high value placed on education. A large portion of the parents are first generation from China or from India, and their values are passed down to their children. So in Cupertino people were impressed by the fact that I was good in math, as opposed to making fun of me. It was a very good environment for excelling.

*Is anyone else from your high school still active in competitive mathematics?*

I had a couple of good friends who went to MOP from Cupertino. One girl goes to MIT now and has also taken the Putnam. For people who did the USAMO [the USA Mathematical Olympiad] and MOP in high school, it's a natural thing to do the Putnam. But at least for me it's not as important as the high school math competitions were. Part

of that is a gain in perspective as I've gotten older -- what does one competition really mean? Still, it's a good opportunity to have fun, and maybe make a little money. And it's also a good opportunity to teach other kids.

*I understand that you help teach a problem-solving class here?*

Each year two students help teach the class along with professor Kraines. We meet once a week, usually in the evening, for about two hours. There's a break halfway through where we order pizza. Each week we present a different topic, like geometry one week, combinatorics the next week, number theory the week after that. We prepare a handout of problems taken from Putnam exams or other math competitions. We have about 25 kids who come. It's a half-credit course in the math department, so about 15 kids are enrolled in it and get credit for it, and about 10 more come on and off whenever it fits their schedule.

*Is the class focused specifically on the Putnam?*

We cover some other topics that aren't really relevant to the Putnam. But that's functionally what it is -- preparation for the Putnam.

*How many people here at Duke take the Putnam, and how do they do?*

Not too many more than take that class -- maybe 35 each year. The last couple of years we've had three or four people who do really well. If you look at MIT or Harvard they have 20 people who do really well, but because of the way the Putnam is scored, we can compete with them.

*Were you recruited to come to Duke?*

I'm here on scholarship -- the Angier B. Duke Memorial Scholarship. Melanie [Wood] had that same scholarship. Among the students who apply to Duke, about 40 are invited to come in for an interview, and 15 are picked to receive the scholarship. It isn't a math and science scholarship, it's for other things as well. But if someone has done the IMO, assuming that they have some other skills besides math, they have a good chance of getting the scholarship. It's a way for Duke to compete with the Ivy League schools that have the big names.

*Has Duke been able to attract other top problem solvers?*

Nikifor [Bliznashki], who got 17th on the Putnam this year, has the same scholarship. He's a sophomore. Lingren Zhang, who's a freshman, is not on a

scholarship. But he's extremely good at math, even though he didn't make China's IMO team.

*Was the transition from high school to college difficult for you?*

For the most part it was really good. Right from the get-go they let you take graduate courses here, so I've taken really interesting stuff. My first two years here I was oscillating between whether I wanted to do math after college or something else. But even as I was trying to make that decision I was able to take pretty interesting courses. And then in the last two years, when I decided that I did want to go to graduate school in math, I was able to keep taking good courses.

*Has your background in competitive mathematics helped or hurt you here?*

I haven't encountered any prejudice here about having a background in competitive mathematics. My professors congratulate me when the Putnam results come out. As an undergraduate, people have been generally impressed by it.

*Have you continued to work on your problem solving here?*

I've taught that course, which is always a little bit of practice, because I have to get ready to lecture on various topics. And I have to grade the homework, so I have to know how to do problems that I've put on the problem sets. But I haven't worked as hard as I did in high school. It's a matter of priorities. Spending hours preparing for the Putnam is probably not the best use of your time in college.

*Have you had any negative experiences here at Duke, either in math or elsewhere?*

Nothing that has affected me directly. For a while there were some issues in the physics department, with what was perceived by the students as discrimination against the female students. But the math department has always been very supportive.

I still have lots of other interests. I've taken a lot of English classes, and I still write short stories occasionally. I joined the swim team here in my junior year. It's not an exceptionally good team -- it's about middle of the road for an NCAA division I team. We lose our conference meets and win our nonconference meets. It's been fun, but it's pretty intense -- it's three hours per day of practice. But I find that it really helps me regulate my time. I'm spending three hours a day at swimming, but I use all the rest of my time effectively. And I like it. It's fun to walk around campus wearing your Duke swimming shirt.

*What events do you swim?*

I swim the 200- and 500-yard free. I do a little bit of butterfly, but freestyle's my better stroke.

*What's your time in the 500?*

4:58. That's not really that fast compared to what people can do. Really good swimmers are down around 4:20.

*What are you planning to do after you graduate this spring?*

I've been trying to decide what I should do to use whatever talents I have to make a difference. That's led me to think about applied math. I've gotten interested in computational biology recently, like problems associated with how proteins fold. That's what I'm thinking about now. Not just protein folding, but other interesting problems in computational biology, like working out systems of gene regulatory networks, where one gene turns on another which turns on another, analyzing how that works.

I applied to MIT and Princeton [for graduate school] because they have the two best computational biology programs in the country. I'll be visiting them in the next two weeks to find out about those programs.

*Were there any opportunities you wish had been available to you either in high school or college?*

I probably should be more critical, but I've been really happy with what Duke offers. In some cases it took me a while to figure out what the opportunities are here, but I finally did. Like the university has a really good career center, but I sort of ignored it the first two years I was here.

*Do you have any regrets about coming here as opposed to going to some of the places where your Olympiad teammates went?*

I think it was a really good decision to come here as an undergraduate and then go to MIT or Princeton for graduate school. For one thing, the money was a factor -- I didn't have to pay for Duke. Also, I've gotten the impression that Duke focuses more on undergraduate education than do some other universities, especially here in the math department. For example, if you want to do a research project with a professor, and you show some ability to carry out reasoned mathematical thought, they'll set you up and let you work on a project. I've been working on a project on algebraic topology with John Harer. I started it last summer and have been working on it all this year as part of my senior thesis. That's been a good experience.

**Lingren Zhang** was born and grew up in Shanghai, China. He attended Jian-Xiang Elementary School, Yan-An Middle School, and Shanghai High School, where he was a member of an accelerated mathematics and science class and participated in the Chinese Olympiad, receiving silver medals two years in a row. In his senior year he applied to Duke University, was accepted, and decided to enroll there, though he had never been to the United States before.

*How was your experience in high school different from that of the other freshmen here at Duke?*

The system is quite different in China. In Shanghai High School, in grades ten through twelve, each grade is divided into ten classes, so groups of about 30 people. There is always one special class, among the ten classes in each grade, of people who are good at math or science.

*Does every high school in Shanghai have a class like that?*

No. There are only four schools like that in the whole of Shanghai. You apply and take a few exams to get in. A lot of people try to get in.

*What kind of special attention did you get in that class?*

Sometimes more advanced math, like calculus, and also more intense math, like the problems we did in the Putnam. There is a problem-solving part of the class.

*Is problem solving emphasized in China because of the college application process?*

Not really. If you do really well in those competitions, you can have the exams waived.

*Do more students in China participate in math competitions?*

Yes, more people there do them.

*Would people in the classes in your high school that do not emphasize math and science participate in the competitions?*

Usually not.

*Why did you decide to come to the United States for college?*

My cousin came to Duke many years ago. She told me all kinds of good things about the college -- that they have a good basketball team. So I was interested, and I applied.

*Did Duke recruit you?*

I applied on my own. I also applied to MIT, but I didn't get in there. It might be tough there.

*Is it unusual for students in China to go to a U.S. university right after high school as opposed to going to the United States for graduate school?*

Fewer people do that. As far as I know, there were four people from the city of Shanghai that came to the United States for college after high school. But one of my middle school classmates is here, at Duke.

*How many freshmen from China are at Duke this year?*

Several people from China are here this year. Some of them came to the United States when they were little, and some came from Singapore or Canada.

*What are your classmates from high school doing now?*

They're in good universities -- Peking, Fudan.

*Do you have any other family members in the United States?*

My cousin and uncle.

*Why did you decide to come this far to go to college?*

That's a hard question to answer. I had heard that the education was pretty different here. Many people in China would like to study in other countries. They would be very willing to go.

*Was it difficult to come here for college?*

It was different. First, from high school to college was different. Second, from China to the United States was different.

*What were the most important differences?*

In high school in China, each class would have a classroom, and all the kids would stay there and the teachers would walk in from other classrooms. Also, in China you don't have many electives. All the courses are pretty much set. You might have one or two electives each week.

*Have the courses you've taken here been difficult?*

I took a few introductory courses here, because I had to get used to English. So I took intermediate calculus, and linear algebra last semester, and the problem-solving seminar. Oaz and Nikifor were the TAs for the class.

I'm doing two math classes this semester, differential equations and probability.

*Can you stay in the United States as long as you want?*

As long as I'm in some school I can stay. And I plan to go to graduate school.

*Are you planning to be a math major?*

Yes. Next year I'm thinking of taking analysis, and maybe mathematical modeling.

*What other courses do you need to take at Duke?*

For math majors, I have to take eight courses over linear algebra. One is abstract algebra. Another must be calculus or basic analysis. And you need a physics course.

There are lots of other courses I need to take. This year I am taking two math classes and one computer science and Chinese 184, which is about literature and history. That's one of the courses I'm taking in order to fulfill the distribution requirements. You need to take courses in modes of inquiry.

*Do you mind taking the distribution requirements?*

Personally I do mind. Some of the courses have multiple codes, so I take those. I was thinking of getting a double major in math and economics, like many people do here.

But I didn't do well in econ the first semester, so I gave up that idea. Maybe I'll take some programming, maybe some applied mathematics. Econ was interesting, but it was pretty hard.

*Have you had language difficulties here?*

My English was not good. I had to take a writing course my first semester.

*Will you stay in the United States after graduation?*

I think I'll stay here for graduate school. After that, I don't know if I'll go back. Maybe I can spend time in both countries.

*What do you plan to study in graduate school?*

It'll be math, but I haven't decided what area.

**Nikifor Bliznashki** was born and grew up in Bulgaria, where he attended the Soviet High School of Mathematics. He was among the top 26 finishers on this year's Putnam exam.

*Tell me about the high school you attended.*

It's probably the best high school to do math in Bulgaria -- it usually produces three or four members of the Bulgarian IMO team. You apply to the school after the fourth grade -- that's when I got in. Then, after seventh grade, you reapply.

We have really talented teachers there who are devoted to working with students. In addition to your regular math classes, you have extracurricular meetings, up to four or five hours per week. You basically do problems, and the teacher presents different techniques and topics.

My highest achievement in high school was getting third in the national Olympiad. I never made it to the IMO team, but I qualified for the Balkan Olympiad, where I got a silver medal. One of my classmates made it to the IMO. We worked together, four or five of us who were on the same level.

Then I applied here, I got a scholarship, and I came here.

*Were there difficult things about the high school you attended?*

The program there to prepare for the IMO is really intense. It's a lot of stress, an incredible amount of stress. So even though it developed my mathematical abilities, it also pushed me away from it a little bit.

The teachers were great. Every grade had at least one teacher who was really into contests. So that means at least 10 teachers who are really good. They had to be passionate about the problems themselves to make us passionate about them. In some grades there were even two or three teachers doing contest math with students. But only a couple of schools in the whole country do that much.

*So every grade you had a new teacher who was enthusiastic about math?*

Not exactly. The math teacher you have in fifth grade stays with you in sixth grade, seventh grade, and so on. I had one teacher from fourth grade up to seventh grade, and she would have stayed with us up to twelfth grade, but she went to Canada. So we were assigned a new teacher who stayed with us from eighth to twelfth grade.

Teachers stay with a group because they don't teach a specific class, like algebra 1 -- they teach everything. They knew way more mathematics than they were supposed to teach.

*Did you come here planning to study mathematics?*

As a freshman I was intending to study engineering instead of math. I was also thinking of doing a double major with engineering and physics, or something like that. I guess everyone interested in math comes to a point where he starts to wonder, why the hell is he doing all these things. What is the meaning, the application? I was at that point at the end of my senior year in high school. So I went into engineering. But after one year of taking courses designed for engineering majors, which involves engineering classes, physics, things like that -- and stupid math -- I felt as if I missed math a lot. So I switched, and now I'm doing math.

*Was the mathematics for engineering majors different than that for math majors?*

There are engineering versions of the math classes, but I took the ones for math majors. I took linear algebra and differential equations. I thought that was incredibly easy. They were undergraduate-level courses, which made them easy. After that I haven't taken another undergraduate math course.

All the courses are given here in the math department, but some are especially designed for engineers. Actually, I did initially enroll in an engineering math course. I went to the first lecture, and I immediately dropped it and switched to the math major equivalent. Then I had another problem with that. It was multivariable calculus, and I thought it was very easy. So I skimmed through the book, and I said, I'm not going to take this course. I switched to another one, linear algebra, which also turned out to be really easy, but I wasn't all that familiar with it.

I took differential equations with Professor Kraines. He's probably not very happy with me, because I wasn't a very good student. I didn't attend most of the lectures and didn't turn in all the assignments. But I still had a good understanding of the material.

*Were you still able to do well on the exams despite doing so little coursework?*

Yes. I actually slept through one of the exams. The course is from 9 to 10, and I woke up at 9:45. Professor Kraines would be able to tell you about it from the other side.

*What other engineering courses did you take?*

I took electrical engineering 61, which is the introductory course, so really basic concepts. Even though it was relatively easy it had some complicated math in it. I might be able to be good at engineering, but I feel that I would be better at something else. I view math as my fate.

*What other factors made you decide to return to mathematics?*

It was mostly the feeling of missing math -- that was what was dragging me back. Also the contests -- that's a huge part of it. I enjoy them. I enjoy doing math.

I've also found the contests in mathematical modeling to be very interesting. It's a contest offered in the spring. You have 96 hours with an open-ended problem from real life -- for instance, optimizing toll booths on a highway. You can consult anything written on the subject, but you cannot get help from your professors. The papers are between 20 and 40 pages long. Normally we get sleeping bags and sleep in the offices here -- it's intense.

*Does the department here encourage or discourage you from doing competition math?*

We have faculty members who are interested in competitions and in organizing events. They congratulate you if you do well on contests, and they give you extensions on assignments because you are doing a contest. They understand, and they believe it's important, so they support it.

Contests make math more popular. Also, you have a reason to try to work even harder, in your classes, to learn things that you might be able to apply later to contests. Another thing is that you meet other people who are good and are interested in math, who are passionate about it. You get to work with them even outside contests. Math is learned way better working in teams than learning it individually. For instance, I went to Oxford this summer and I worked on contest problems with one of my classmates from here, even though we were taking a course in political science.

*Did many of your classmates come to the United States?*

Oh yeah. One is at Caltech, one is at MIT, one is at Cornell, one is at Yale. I believe that everyone who gets to the IMO level goes abroad, mostly in the states, sometimes in England. More than half of my [high school] class went somewhere else -- to the United States, Germany, Greece, Cyprus, France. High school education in Bulgaria is very good. But when it comes to college, it's not exactly like that. There are great professors, but they're not motivated at all. You can pass exams incredibly easily. Most students don't have any idea what the hell is going on. Especially if you're going to be a math major, you're going to be with people who don't know what's going on.

*So if you're good at math in Bulgaria, it's assumed that you'll go to another country?*

Not necessarily. You might stay there and become really good, and then you are either going to become a professor or go into the Bulgarian Academy of Sciences. If you want to learn, you can do it over there. There are people who might not be motivated but who are really smart. And if you are motivated, professors would love to work with you.

*Do people go back to Bulgaria after college?*

That's something we will figure out in five years. Going abroad for college is a recent phenomenon. It only started four or five years ago, or maybe ten, so I can't tell you right now.

I can't give you an example of someone who went back to graduate school in Bulgaria. It would be sort of pointless to do that. If you take advantage of the opportunities elsewhere, there would be very few reasons to go back home.

*How about once you have a graduate degree?*

You can always become a professor over there or teach. You can't actually go into the private sector, because there are no jobs for mathematicians over there. So you end up teaching. But you're going to be working with unmotivated kids, so you're not going to get professional satisfaction. You're going to get an incredibly low salary compared with almost everything else you could be doing, so you're not going to get satisfaction from this point of view. What's the point of going back?

There is a hope that things are going to change soon. Bulgaria is joining the European Union in 2007, so things might reverse. Also, big companies are investing there, and they might need mathematicians. If I could have a decent life there, I would prefer to go back, even though I'll get less money there than I would get here.

*How does the math program here compare with your high school experiences?*

I went to some lectures at Sofia University, after my first year here, because the schedule is different there. The math program here is definitely tougher and better taught, I would say. A friend of mine took commutative algebra at Sofia University, I'm taking it here now, and we are comparing experiences. I'm doing things that he would have no idea how to do.

Also, most of the graduate classes here at Duke are small. There are maybe five or six people in most of them, so you interact more with professors here. I'm taking algebraic topology, commutative algebra, and complex analysis. Last semester I took Galois theory and basic analysis. And the professors know that you are an undergraduate, so if they see you struggling with the material and they know you are really interested in it, this makes them happy. They really want to help you get through.

*What will you do in graduate school if you just take so many graduate classes here?*

You're never going to run out of math classes. And even if you do, there's plenty of research you can do by yourself. In graduate school, I can skip a lot of the classes I've taken here. All I need to do is pass the qualifying exams, and then I'm free to do anything I want.

*Do you plan to go to graduate school?*

I think I'm going to spend a year working and then go to graduate school. I'm not sure what I'll do exactly. Maybe something related to financial mathematics or mathematical modeling. Then I'll go to graduate school. But my interests have changed a lot over time. I might end up getting interested in physics from a mathematical perspective. You never know.

*Have you had any bad experiences with mathematics?*

In college I haven't had any problems. In high school I guess there were some, mostly with peers. The contests were very competitive, and at some point people can get envious. They could really enjoy when you didn't do well, and they would show it. That is one of the things I didn't like about math.

Outside of math I've never had any problems. I've never been referred to as a nerd. I've never been made fun of for being good at math, and it hasn't happened here at Duke either. I'm not embarrassed about doing math. I don't consider that as being any less normal than doing econ for instance. People actually appreciate it. They are fascinated that you might be so good at something and be so passionate about it. They don't consider you awkward or uncool, though of course that also depends on your social circle. There might be people at Duke who would say, "Oh, you're a math major, you're not interesting at all."

*Do competitions have their down sides?*

It depends. Let's say you do a contest, and at the end of the contest you go out and discuss a problem with your friends, and they help you, because you have to defend your solution. That's clearly a good experience. But if they make fun of you for not solving the problem, then that's a bad experience.

Another thing. If you go to a contest and do poorly, your team leader might say, "Don't worry about it, you'll do better next time." Or she might say, "You should have solved this." There's a big difference in how that would affect you.

*Do you think girls are driven away from math because of the competitions?*

At home some of the team members were girls, and it was completely okay. They were not considered uncool. Intelligence was a plus for them, as opposed to a minus. One of the really good people here is a girl, Shipira, she was top 100 in the Putnam this year. She's really bright. I don't think she's ashamed about that.

All my math teachers in high school were women, and they all encouraged us to do competitions. Men were actually a minority.

Once I was talking with Brendan Levine -- he's a sophomore here -- and he told me about an experience he had at high school. He was tutoring a girl, and she clearly

knew how to do a problem, but she wasn't confident enough. She preferred not to be able to do the problem, even though she could do it.

*What are your interests outside mathematics?*

I'm getting more and more interested in education and the psychology associated with that. So next semester I'm going to take a course in education and also in psychology.

I like playing soccer and biking. I really like biking. We bike around here, especially during the night.

I really like playing basketball. I played with my high school basketball team, which is nothing compared with the basketball teams here but was still fun. Soccer is still my favorite sport, although you don't get to play that much here. It's considered a girls' sport here.

I try to exercise physically for at least a couple of hours each day. If you do these real intense problem sets for three hours, your brain just can't take any more. You have to go outside and do something. Buying a bike was the best investment I've made here.

## Interviews at MIT

**Adam Donovan** grew up in Lincoln, Massachusetts, outside Boston. As an eighth grader at Lincoln Middle School, he was on the Massachusetts MATHCOUNTS team that finished first in the national competition. Now a sophomore at MIT, he is working simultaneously on undergraduate degrees in mathematics, physics, computer science, and economics. He received an honorable mention on the 2004 Putnam.

*Was your experience with Mathcounts important in establishing your interest in mathematics?*

Yeah. I was on the Massachusetts team in the eighth grade. In terms of exposing me to the community of people who do math competitions, that stuck me into that community, and I haven't left since.

Lincoln Middle School is a good public school and it's small, our graduating class was only about 50 or 60. And the math teacher there, Ms. Totten, was really devoted to Mathcounts, she made it a lot of fun.

I was the only one from our school who had been on the state team. I got kind of lucky, I had a good day at the state tournament, and I made the team. The coach of the state team was Mr. Mosca, and he came from Lexington, which was the town next to mine. Lexington Middle School wins the state competition every year, at least they did when I was there. They have about seven to eight people who get into MIT each year, which given the size of the school is amazing. Once I met Mr. Mosca I discovered that this was a much larger community than I'd previously realized. I got hooked, going to practices and talking math with friends.

*I've heard that it's harder to do math seriously in middle school than in high school, because there are more social pressures in middle school. Was that your experience?*

No, I'd say if anything it was the other way around. My middle school was very small, just Lincoln, while the high school was Lincoln and Sudbury, which is a very large town next to us. In Lincoln I had a group of six or seven friends, which was a big percentage of the graduating class, who were really into math and loved Mathcounts and were okay being nerdy with each other. When we went to high school we still had that small group of friends, but the percentage of people who were interested in math and doing various tournaments was smaller.

It didn't seem to pose a problem. My high school was very good about not getting in the way. People wouldn't harass you just because you were a "mathlete." But in terms of percentage, it was a little easier in middle school.

In addition to the math team we had a very large science team. There were 30 or 40 people who would spend a Thursday or Friday afternoon doing quiz bowl type things. That turned a lot of people toward math and science, because it was a place where people

who might not fit in as well in other places could go and spend time with other people who enjoyed these things.

*You mentioned before I turned on the tape recorder that you had bad luck with the USAMO and so never went to MOP. What happened?*

Part of it is I'm not as good as a lot of the other people at this. I'm not one of those people who are guaranteed to get into MOP. I would be kind of borderline, and maybe even that's wishful thinking -- it's hard to tell.

I qualified for the USAMO sophomore year and did okay, given that I was a sophomore and hadn't really been exposed to USAMO-type exams. My junior year was the year when everyone who went to USAMO went to MOP, but unfortunately I got sick on the day of the AIME and didn't do well and so didn't qualify for the USAMO. That was disappointing, given that I would have made it to MOP that year. But I was already taking the AIME on the B day [when the test is administered for the second and last time], and I did badly.

Senior year it would have been very hard to qualify for MOP anyway, but I had a science tournament in California that ended the day before the USAMO began, and there was no way I could fly back from California to here. So I ended up taking the USAMO in California, and staying two extra days, which wasn't great. And I had been very stressed out about the science competition the week before, because there was a lot of drama about that. Our team had been the first-place team going into that, but there were some unfair calls made, and we were very upset about that. It was hard to be at my best on the USAMO.

*It can seem to be a very unforgiving process.*

Well, if anything that bodes well for competitive mathematics in this country, because the process pares people down to the best.

*But here you are, one of the best problem solvers in the United States, and the process makes you feel as if you've failed.*

It's humbling, but that can be a good thing. People who aren't the best of the best are still very good. And they get plenty of chances to know how good they are. If anything, it's good that they know that they're not the best of the best. From my experience, if I hadn't gotten to know some of the other people doing math competitions, I'd feel that I was the big fish in the pond. I'm glad to know that that's not even close to being true.

*So your contention is that it's good for people to realize that there are always going to be people who are better than them at a particular task?*

That's been my experience at MIT. Most of the people here are the best at something, if not the best of the best. The people who are really really smart are not arrogant about it all. The people who are not as smart and didn't get exposed to these things sometimes get into conflicts with others about it, or they feel insecure when their bubble is burst. They come here and all of a sudden work is hard and they're not the best.

At least that's my experience of being someone who's not the best of the best but is trying to be somewhat close.

*Looking back at middle school and high school, were there opportunities that you wish had been available to you?*

I always kind of wish that I'd gotten started a bit earlier. When I talked to people who were really good at this, they might say, "The teacher at my school is a really good tutor and taught me this, that, and the other thing, and gave me a couple of books specifically for middle school and high school competitions." I'd say, "Oh wow, I wish I had known about those." I went out and bought a couple of those books and they really helped a lot, both in high school competitions and in math and computer science classes here. So it would have been helpful to have someone who could spoon-feed me a little bit of that earlier.

The person who won the Mathcounts competition the year I was there was Po-Ruh Loh. A couple of years ago I was looking at the records of people who had done well on the USAMO, and he was listed as either qualifying for the USAMO or being an honorable mention in the eighth grade. I thought, "Wow, while I was working on Mathcounts material, he was studying for the USAMO -- and doing well on it!"

I didn't know about AMC, or AIME, or any of that until high school. When I was a freshman, one of my sophomore friends who had been on the Mathcounts team said, "We have a whole series of competitions in high school." I remember being amazed that there are so many math competitions after Mathcounts. I didn't realize there's so much to it.

Teachers would be the best way of spreading that information. They are the first points of contact for math competitions in general.

*Did you say that your work on competitions was an advantage once you got to college?*

Oh definitely. I can't think of how many times I work on say a physics problem and use either the problem solving skills I learned in high school or specific theorems that I remember looking up for high school competitions. I feel more fluent in talking about math than some other people I know who didn't get as involved in competitions.

*I've heard that some professors are prejudiced against competitions because they believe that there are better ways to learn math.*

Problem solving mathematics is definitely very different from research mathematics. Problem solving is very directed, whereas research involves finding a problem to solve and attacking it in completely new ways. But where the competitions help is that I don't have to think as much about the menial or trivial stuff. I don't have to spend as much time working on the algebra of a problem. I can try to abstract that away and see something at a higher level.

*What classes are you taking?*

I placed out of some of the freshman and sophomore classes people normally take. That's pretty standard here. I started with analysis in the first term of my freshman year, and in the spring I took topology. Also freshman year I took a probability course.

The math department here is pretty lax about prerequisites. They know that a lot of people coming here know a lot of the material, even if they haven't taken a class in it. They're pretty good about letting people go to the level that they think is appropriate.

A lot of people take graduate classes. In particular, there's no algebraic geometry class taught at an undergraduate level at MIT, so people take the graduate version of that. Pretty much all math majors end up taking a graduate course at some point.

*Are you a math major?*

I've declared math to be my major. But I'm also a kind of physics and computer science major. At the moment I'm debating whether to go to graduate school in physics. I guess I'm kind of leaning toward that at the moment. But I'm going to take full advantage of the next two years to think about it, because now I'm not close to sure.

*Are you being pushed away from math or pulled toward those other subjects?*

I was always interested in high school in computer science and physics. A month or two before the AIME and the USAMO I might read a few books or learn some new things about math. But over the summer I usually would be programming for fun.

I've always tried to keep my options open. My senior year in high school I had an independent study with my physics professor and we did some kind of quantum mechanics, which I found completely fascinating. That was a lot of fun, and it made me realize that I could see myself doing that in the future.

With math, I'm not that sure about what kind of career I would have. At the moment I'm leaning toward physics -- it seems more flexible, and there are some really interesting things I can do with it. But I'll definitely use my math background a lot. It really helps to be a math major first and then a physics major. Something about having a rigorous mathematical background helps a lot for physics.

*And computer science is still a possibility?*

I'm torn. I have a lot of fun with computer science, but I don't see it in terms of a career as much as physics or math. I think it'll always be a very large hobby of mine, programming and working in something related to computer science.

*How do you have time to take all these classes?*

The standard MIT unit load is 48 credits, which is four classes. This term I'm taking 96. Three math classes, three physics classes -- statistical physics, a graduate quantum theory course, and a graduate course in quantum field theory -- an algorithms course in computer science, and one philosophy class.

*Are there many people who try to do that much?*

There are a handful of people who do the same thing. It definitely takes a lot of time. But this is one of the cases where high school math competitions come in handy. I can do a lot of grunt work on problem sets very quickly. I don't get bogged down in details but can see things from an overall view. A lot of my friends who aren't math majors spend a lot of time working through the menial details of the algebra. But doing that kind of algebra on a problem set isn't necessarily teaching you all that much. I'd like to think that I can spend more time learning the material.

*Don't you also have distribution requirements that need to be fulfilled?*

The humanities requirement is eight classes -- it's kind of expected that you'll take one per term. This is actually the first term that I've taken fewer than two humanities classes, because I'm trying not to become so monomaniacal about math and science. I'm taking a lot of philosophy classes in addition to writing classes, which is kind of hard to do at MIT. Most people take only one humanities class, and for a lot of people that's economics, which is essentially applied math.

*What humanities classes have you taken?*

I took a poetry class first term freshman year. The next semester I took a philosophy class called "Reason, Relativism, and Reality." I took a philosophy class in high school that was interesting but nowhere near a college level. But "Reason, Relativism, and Reality" really whet my appetite for philosophy. It's a humanities class, but there's also a very rigorous point of view in terms of being careful about your definitions. I found it very interesting to take something that's qualitative and try to put it in a quantitative framework.

I've taken a course in rhetoric, and a couple more philosophy classes. I'm also trying to get an econ minor, so I've been taking economic classes also. I think I'll be double majoring in math and physics.

*How many people take the Putnam here?*

Probably 100 -- it sure felt like 100 people in the room.

*Do you do any formal preparation for the Putnam?*

There's a problem-solving class offered in the fall semester for freshmen. It's run by professors Rogers and Stanley, who administer the Putnam here. They usually try to keep it to seven or eight people. They're definitely trying to scope out freshmen who might be on the Putnam team in future years. Also, Rogers and Stanley are the freshmen advisors for those people.

I didn't take that seminar, but the people who did say that it's nice to have an advisor who knows the ins and outs of the mathematics department, because both of them have been here for a long time and are very well known.

*I'm surprised that the seminar focuses on the top students, since in other places the prep sessions are usually for a broader range of students.*

Personally, I think that the people who are going to be Putnam fellows are going to be Putnam fellows no matter what college they go to or what kind of preparation their professors give them. Professors Rogers and Stanley definitely know what they're doing, but personally I wish they would broaden the spectrum of the seminar somewhat.

The Putnam fellows I know don't seem to do much preparation in college for the Putnam. You're probably going to talk with Daniel Kane. He and Reid [Barton], from what I hear, don't really prepare for the Putnam. They just show up and rely on the knowledge they have from high school.

*What is the math department here like?*

There's a lot of variation among the math professors. They're all brilliant. Some are really really good teachers, and some are not. You definitely need to talk to upperclassmen to know which professors you should take a class with.

There's not as much of a math community at MIT as there is, say, a physics community or an econ community. The undergrads in physics and econ get together a lot to work or talk. Math is more of solo endeavor, in some respects. A lot of people work on math problem sets alone because they feel that when they're alone they can concentrate on it and churn it out, whereas with physics and econ a lot more people work in groups.

*Do you feel that the math students here at MIT are well-integrated into the rest of the university?*

There are many more engineering students at MIT than pure math or pure science students. Something like a third of the undergrads are in the electrical engineering/computer science department, and another third are in other engineering departments. So MIT is kind of dominated by computer science and engineering.

But I don't feel any pressure from engineering students. A lot of them are my friends. I help them on problem sets and things like that. Compared to high school and middle school, MIT is a big enough place that there are people here who do what you do no matter what you do.

**Daniel Kane** grew up in Madison, Wisconsin. The son of a mathematician father, he took calculus in the seventh grade and attended MOP the following summer. He represented the United States at the International Mathematical Olympiads in Glasgow in 2002 and in Tokyo in 2003. He was a Putnam fellow in 2003 and 2004 during his first two years at MIT.

*When you and I first met at MOP in 2001, I'd heard that you were home-schooled in math.*

I went to a private school K through 7. I was essentially home-schooled in math. Throughout that period my dad would essentially give me assignments in algebra or geometry or something, and I would sit and do them while the rest of the class was doing whatever work they were supposed to be doing.

*Did you do Mathcounts?*

Yes, I did Mathcounts in the seventh grade. In my school we had to piece together a team so I could go. I basically got three of my friends together and convinced them to be on the team. It was actually a bit of a problem with my school. My school is a 1960s anachronism, and they have noncompetitiveness policies. They eventually let it go because they also sent kids to the city spelling bee, so they said it's okay for now but they might have to look into it later. Their policy was fine, but doing it to that degree. . . .

There were some other problems with Mathcounts. For one thing, I couldn't compete with the local public middle school. Actually, Mathcounts wouldn't allow me to compete in the fifth grade, which is when my mom first told me about it. I was a little annoyed by this, so I joined the local high school's math team, and that was nice. Because of that experience I learned to be more careful. Early on I would get lots of problems wrong because of stupid mistakes. By the end of my senior year in high school I had a streak of something like a year and a half where I didn't get a problem wrong.

*So you were way ahead of your classmates in mathematics from an early age?*

I suppose that's true. My parents essentially had me skip over a lot of middle school math. It was essentially, here's another way to do arithmetic, and I didn't need that.

*Did you work with books of problems?*

Actually I hadn't done all that much problem solving. I completed precalculus in sixth grade. And in seventh grade my dad didn't want to send me to take classes somewhere else for calculus. My dad was teaching a course in discrete math at the University of

Wisconsin-Whitewater, and he said, “Okay, for this year you can sort of follow along with this course.” I learned lots of useful things from that course, like mathematical induction, which turned out to be very useful in the USAMO.

*Were you on Wisconsin Mathcounts team in seventh grade?*

Yes, I was on that team and came to nationals in Washington. But I skipped eighth grade and wasn’t able to do Mathcounts again. I skipped eighth grade because, in seventh grade I’d been taking Latin 1 at the local high school because my middle school didn’t have tests, and my parents thought it would be a good idea for me to learn how to take tests. Also, my spelling and grammar are really atrocious, and my spelling still is. The idea was that Latin would help. Some of my friends were going to the local high school to take algebra or geometry, so I went over with them.

By eighth grade I was really ready for calculus, and I had already been taking Latin at the local high school. If I had stayed in middle school, I would have been taking Latin 2 and calculus in a different school from my middle school, which would have ruined my day.

*Was the high school you began going to private?*

No, it was the local public high school, Madison West. The Lohs went to Madison Memorial. There are four high schools I can think of in Madison. I’m not entirely sure if there might be other ones, or if they’re in the Madison area instead.

*Did you go to MOP after seventh grade?*

Yes. That was my first year. I’d taken the USAMO in the seventh grade.

*So you were one of the youngest MOP participants ever?*

Yes.

*Did you go back to MOP every year after that?*

Yes, I went back every year after that. I was on the team the last two years, after eleventh grade and twelfth grade.

*Did your dad continue to help you with math during high school?*

My high school wouldn't have been able to. They did offer two years of calculus, but I probably wouldn't have wanted to take it there. There were some problems with that math class. For example, if you didn't bring a calculator to the test, you had to take the test without it. And Chris Moore, who went to MOP, got a B in this class; I'm not entirely sure why. Also, I was working at a higher level than that class.

Wisconsin has a program called the Youth Options Program, which says that if you're in high school but ready to take some college classes that your high school can't offer, the school district has to pay to have you take those classes at the local university. So I spent high school taking a lot of math classes at the University of Wisconsin-Madison. I also started taking physics classes there, because once I knew calculus I figured that I should be taking calculus-based physics, not AP physics. I took almost enough units there for a major during my time in high school. I took all math and physics classes and one computer science and one economics class.

I didn't take that much science at my high school. They didn't have many AP classes, and some of the classes were rumored to have problems. The biology class was rumored to have a system that would pair up bright students with the failing students, and to do well on presentations, the bright students would do all the work and say to their partners, on the day of the presentation, "Don't show up, we'll get a better grade."

I took chemistry by going to a summer program. I took biology by correspondence. The only math or science class I took at my high school was one semester of computer programming. The teacher was offering the class first and second periods. But I was taking a university class that met Monday, Wednesday, Friday at the same time, so I convinced the teacher to let me show up to class on Tuesday and Thursday for both periods. He had to arrange it so the lectures fell on Tuesday and Thursday so I wouldn't miss the lectures.

*Did you do the math team in your high school?*

I did. We ended up having something of a rivalry with Madison-Memorial, where the Lohs are from. My school tended to win reasonably consistently, mostly because we had depth. A team is eight people, and having two Moppers was useful.

*Who at your high school ran the team?*

A math teacher at the school. I didn't take a class with her, because I was taking classes at the university, so I didn't know her well.

There might have been six meets per year. Everyone gets in a bus and goes to some other high school. You sit down and there are three rounds of individual testing and a team round and then you get scores. Our math team also did things like the Wisconsin Mathlete Competition and the Mandelbrot competition, and also some other competitions.

*Did you get any grief from other kids because you were so proficient at math?*

If this was a problem for other people I never noticed. I had a very small group of friends, about a half dozen people I knew since kindergarten, and they were my social group. I would socialize with these people, and if anyone else were saying things about us, I wouldn't notice.

*Were you thinking about other colleges than MIT?*

I was. I decided not to go to Caltech largely because it seemed to be a small school so I didn't know how many classes the math department could offer, though that may not be a reasonable point. But I figured that I was going to start by taking graduate classes and I wanted to have a broad exposure to everything.

I didn't go to Harvard because some of the humanities classes seemed really uninteresting. The two I sat in on were horrible. In the first one the teacher just stood there and talked at you.

I actually spent some time deciding between Chicago and MIT. But my mom thought that Chicago might not be quite as safe. One of the advantages of Chicago was that I was getting a full ride there, but my mom was still in favor of MIT, and since I decided that my parents were paying my tuition, if they wanted me to come here, I should go.

*Since you'd already taken most of the undergraduate curriculum, what courses did you begin with here?*

I started out by finishing up the undergraduate math requirements. I took a second-semester algebra course, because even though I'd never taken a course in algebra I'd seen the stuff in the first semester. And I took the analysis on manifolds course.

Starting this year I'm taking mostly algebra and algebraic geometry courses. My plan is that next year I'll take differential geometry and algebraic topology and I think some other analysis-y course, to get exposure to that. Then hopefully I'll have exposure to all of this stuff.

*Have you been tempted by other disciplines, like physics?*

Actually, I'm thinking about double majoring in physics, mostly because physics has good mathematical models in it. It's fun to work on because of that. It's nice to stay a little bit diversified. I'm actually really enjoying the theoretical sides of other sciences. Algorithms, for example, are not very well understood, and there are all these wonderful tricks associated with them.

*Have you done much computer science?*

Yeah, but that's different. They don't go into any algorithms much more complicated than sorting. The rest of it is talking about software design and how you define objects. I find programming fun at times, but I don't want to spend a lot of time doing it. I like algorithms that don't involve programming but involve show code. How do you do this, and do you have a good run time?

*Did you ever do other Olympiads?*

I did the physics Olympiad -- I went to their camp one year. The next year they wouldn't let me go because I wanted to go to MOP instead.

The other Olympiads are certainly less publicized. The AMC-10 and 12 are given all over the place compared to other exams. For physics we basically had to get our school to give the exam.

*Do you also have a small social group here at MIT that you spend most of your time with?*

MIT has so many more interesting people than high school. Basically my social group went from maybe a dozen people to my entire dorm. Here I can talk math at some reasonable level and expect most people to understand what I'm saying. I can have fun, nerdy, technical conversations with almost anyone. It's the same sort of thing as MOP, but with more people.

*Are you intending to graduate early?*

No.

*What do you think you'll do after that?*

I intend to go to grad school. My objective as an undergraduate is to get a broad exposure to all of the major areas of mathematics, at the beginning graduate level. By the time I have to make a decision I'll hopefully know what field of research I want to go into, so I can pick an appropriate grad school.

*And you'll take the Putnam for the next two years?*

Yes.

**David Vincent** grew up in Manchester, New Hampshire, and attended public schools from kindergarten through sixth grade. He attended Derryfield School in Manchester in seventh and eighth grade and Philips Exeter Academy during high school. He attended MOP in 2002 and, as a sophomore at MIT, received an honorable mention on the 2004 Putnam.

*When did you begin doing math that was beyond the normal school curriculum?*

I took algebra 1 in the sixth grade. It's a funny story. In the fourth grade I was in a normal math curriculum. I don't remember this, but my parents said that I went up to the teacher and told my teacher that I knew everything in the book. So apparently I had looked through the book and thought I knew everything. The teacher called my parents and said, "Your son tells me he knows everything in the book. What do you want me to do?" My parents said, "Well, give him the final." So she gave me the final and I got a 90-something on it.

*Had you really read through the book?*

I think I just knew it. I don't think I read it. I don't remember studying it. It's all so logical -- how fractions work, and this and that. I certainly didn't know everything. I went up to my dad after the test and said, "There's one thing I didn't know, can you explain this to me?" He explained it to me.

My parents talked to the principal, who reluctantly let me go to the fifth grade classroom. So I sat with the fifth grade kids and did fine there. Then in fifth grade I did independent work since the sixth grade was in another school.

The summer after my fifth grade I went to the Center for Talented Youth program at Stanford and, over a three-week intensive program, learned pre-algebra. The organizers of the program say that most people can place out of a year of math in three weeks. My parents were very skeptical, and I was a little skeptical -- how good a foundation can you build in three weeks? But we went with it.

It was a great program. I loved it. When I went out there I was having so much fun that I forgot to call home and my parents had to call the director to make sure I was okay. It was the first time I was ever surrounded by smart people. Everyone around me was smarter than me. It got me interested in chess, in playing the piano, in playing games -- all the standard math things.

There were 100 or 200 kids, just coming out of fifth and sixth grade. We all lived in dorms together. It was my first long experience living away from home. I'd done Boy Scout camps, but I had never been that far away.

After that program I was even more ahead, and the principal was even less sure if I was able to handle the eighth grade class. But he let me. And a couple of other kids after me were also advanced, and the principal was more willing to let them take advanced classes after seeing my success.

*Why did you switch from a public to a private school in seventh grade?*

I was too advanced in math for the classes in the public schools, so my parents said, “Okay for seventh grade, you should go to a private school to be in a higher math class.”

Derryfield is a small school, about 45 kids in a grade. I took geometry and algebra 2 there but the school wasn’t big enough to have any higher math classes.

*Did it have a math team?*

I remember the math teacher asking if I wanted to do Mathcounts. I think I showed up for a day and didn’t like it, so I just never did any of that stuff. We had a team, but I wasn’t very interested in it.

I saw the kids in Mathcounts doing a lot of arithmetic. But I didn’t want to do that. I really have no interest in doing mental arithmetic. I didn’t have any teachers in middle school who made me want to work hard or work outside the classroom. I thought of math as something I could do in school so I wouldn’t have to do homework at night.

*Why did you switch to Exeter after eighth grade?*

By the time I was going into ninth grade I was still running out of math classes, so we started looking at boarding schools, and Andover and Exeter popped up as schools with good math departments. I’m lucky I didn’t get into Andover, because I would have gone there. Exeter has a much better math program -- I have nothing against Andover’s program -- but I ended up at Exeter with Zuming [Feng, the leader of the U.S. IMO team] and started taking classes with him right away. I was trained by Zuming over my four years at Exeter. That’s really why I have such an interest in math, because of Zuming.

*So you must not have stayed opposed to participating in competitions.*

I only started competing at the end of my freshman year, when Zuming put pressure on me to join the math club and the team. He put me right on the top eight math team, where I did terrible my first couple competitions. Then I started picking it up.

*How did Zuming convince you to start doing that kind of mathematics?*

Zuming is amazing. When I came to Exeter, I was placed into a lower class than I deserved because I did terribly on the placement exam. There are some foundation issues there. My background in algebra 1 was weak. I didn’t put the time into those classes that I should have. I didn’t have to do much work in those classes to ace them, so I didn’t.

I went to my teacher in the class and told him I wanted to be moved up, so I was moved up. A couple of weeks later I wanted to be moved up again, so I was moved up again.

I don't know if you know much about the Exeter system. All of the mathematics classes there are taught around a big wooden oval table. Classes tend to be about 12 people, plus the teacher. The system that Exeter uses is called the Harkness system. Students have about eight homework problems, all word problems. They're out of a book that the department wrote. The table is surrounded by blackboards. During class, each student, one at a time, goes to the blackboard and presents a solution to a problem. It's designed so that you learn from each other, basically. Of course, the teacher has to help students sometimes because there are problems that no one can solve, or there may be a cleaner solution. It's a great system.

When we were looking at Exeter we were unclear whether this was something good that would help me develop a stronger mathematical background. It worked out very well. I've learned that you don't really understand math until you can explain it to someone else -- or to everyone, really. When you're at the blackboard presenting a homework problem, you have your own method, and half the class might understand the method but the other half might not, so you have to explain it a different way to that half of that class.

For the people who really put time into developing these proofs and learning how to explain them to everyone in the class, this system works very very well. The people who don't put in the time just sit back and watch everyone else put up their problems, and they may do one of the eight homework problems and hope that they can write up that problem to show the teacher that they're doing the homework. Those people fall behind. You get out of it what you put into it.

About halfway through the fall term, I thought that Zuming was the scariest guy I've ever had in my life. At the first class, when I didn't know anyone, someone finished explaining a problem, and Zuming looked at me and said, "Vincent, go up and explain it again." He didn't think I was paying attention. He made me go up to the blackboard and explain all the steps again. He's that kind of person.

This was an advanced class, not a class that everyone has to take. So Zuming expected more out of his students because they're there because of a choice rather than a requirement. That was intense -- and probably the best math classes I've ever taken in my life. It started around algebra 2 and went all the way through precalculus in just a year, getting you ready to take BC calculus.

*A criticism of that approach to teaching is that you can't cover as much material.*

It's true, but what you do cover is so much more engrained for those students who work at it. I've sat through the lecture-based learning in algebra 1, and I don't like it nearly as much. I don't get as much out of it. I get so much more out of the seminar style. Partly because I'm so excited to get up and show my solutions to the class. It encourages me at night to work hard and perfect the solutions that I want to present to the class.

*How did Zuming get you started doing competitions?*

Here's what happened. Exeter has a math club, and my freshman year it was small, maybe 15 kids who regularly showed up. It was twice a week, for an hour. The top of the club were USAMO top 50 finishers, so it was a pretty good club, a very competitive club, with lots of smart people. It was very intimidating to show up for the first time as a freshman and see all this crazy competition math and not understand any of it.

I showed up to the club a couple of times my freshman year, and it kind of scared me away, to be honest with you. But Zuming said, "I want you to sit through this club every single time every week."

*Why did he pick you out that way?*

I'm not sure. I think he saw some creativity, which is the most important thing. So that's what I did. You know the Harvard-MIT math tournament? He put me on the team for that tournament. I goose-egged both tests. But I was in the room for the team competition where everyone had to solve their problems, and I watched the better kids. I was working on one problem, a standard problem where you have a circle with  $n$  points around it and you ask how many intersections the diagonals have. It's  $n$  choose 4. I was working on this problem for the longest time, I'd never seen it before. I said what is it for  $n$  equals 4,  $n$  equals 5, I started making a list. Twenty minutes later the captain of our team looked at the problem and wrote the answer on the board. I looked at that, and said, "Where'd that come from?" It's humbling. That's one thing that made me want to come back week after week and learn these tricks and learn how these people can do all these things. I just kept doing it.

*But you must have gotten good pretty quickly, since you went to MOP after your junior year?*

Not really. Sophomore year was the first time I took the AMC. I think I got a 112 on it -- that was a tough year. It was the second highest score in the school to Tiankai [Liu, a member of the 2001 IMO team], who got a 144. It's tough to beat Tiankai. But I had a terrible time on the AIME that year. I ended up getting a two, or maybe a three. I had focused on the first 12 problems on the AIME, and I solved 2, 3, and 12, so I got a three. What happened to 4 through 11? I thought I had most of those, but I was very sloppy. One thing I always have trouble with is sloppy arithmetic, sloppy algebra. Those are foundational issues again.

Zuming was pissed. He's not going to tell me good job. He's not going to let me settle with a three on the AIME. He wants me to make the team someday. He wants me to be great, like he wants all students to be great.

*Did that make you more determined to do well, or did you feel like giving up?*

I watched a lot of my friends give up, or just not put in the time. I don't see that as necessarily a bad thing. I want to be a mathematician when I grow up, I want to be a math teacher. Other kids want to do chemistry, or physics, or something else, so they don't want to focus on math.

*Did you say you want to be a math teacher?*

Yeah, probably a high school teacher. Ever since freshman year I've wanted that. I'm not worried about money, I just want to be happy. Especially if you go to a place like Exeter to teach, you get housing covered and meals and all that. It's a huge lifestyle change -- you live with your students. But I think I'd love it. You dedicate your life to teaching if you want to teach.

*Have any of your friends here ever expressed an interest in becoming a teacher?*

It's rare. People here always say, "It's great that you want to be a teacher. I don't." No one thinks it's a bad thing. It's something you have to really want. I think a good teacher really really wants to teach. I remember having teachers at Exeter and thinking, this wasn't what they wanted to be doing with their lives. It shows in their teaching.

*What happened in the competitions the next year?*

Junior year I had a 144 on the AMC-12. I was kicking myself for not getting a perfect score. And on the AIME I had a terrible showing again. I got an eight. I tried to solve the first twelve problems, but I missed one, two, four, and seven. So that was just very very sloppy work. On number 1, I wrote down the most obvious answer I could think of and just left it as right, but it wasn't right, and I never went back to check it.

Again Zuming was furious. I could tell he was mad. After the AIME I went up to him and handed him the exam, and he said, "You got an eight." But all he told me is, "You have to hope. You have two weeks, and then you'll find out where the cutoff is for USAMO." This is something that I desperately wanted. I know how good qualifying for the USAMO looks for colleges, especially for MIT.

A couple weeks later I got a phone call from Zuming. He said, "Hey David, you made it, study hard." I had made it by two points, mostly because of that 144 on the AMC 12. I remember Zuming had no expression in his voice, because he didn't want me to think that it ended at making MOP. He wanted me to get better the next year.

I worked hard at MOP, and I did very well at MOP, toward the upper end of the people who weren't honorable mention on the USAMO. That's really when I started working on Olympiad problems and Putnam types of problems, once I knew that I could do AIME problems pretty regularly.

Senior year I finally got a 13 on the AIME. That was the right score, and I didn't have any errors. By my senior year I was being careful and checking things, so I was finally satisfied. But I was never satisfied with my USAMO performance.

One of my goals in college has been to make honorable mention on the Putnam, and I was really happy to do that this year. I didn't get everything that I should have gotten. But most of the time people don't.

*So you started out as someone who was skeptical about competitions, but now you've become an advocate of them.*

Problem solving for me is a passion. I do it for pleasure much more so than for the competition. In college, people don't care about competing as much. There's one competition, the Putnam, and there's nothing else. People care much more about whether you've done research, or whether you've done something significant in the math world. But I still love problem solving.

Every once in a while I'll think of a problem and just have to solve it, or I'll read a problem online and have to solve it. Even though I don't actually study for the Putnam, you're always doing things that will help you prepare for it.

*Let me ask you one more question about your experiences in school. When you were going through the process of deciding to go to private school, and then to Exeter, how much were your parents driving that process, and how much were teachers and administrators responding to what you needed?*

Unlike a lot of people who end up in private school, my parents did not push me or necessarily want me to be in private school. They love the public school system -- it's free, it's an education. My parents never told me anything, or put any ideas in my head. They didn't make me go up to my teacher and say I knew everything in the math book. They've always wanted me to do my own thing. It was my idea to go to CTY. Both of my brothers had gotten the same letter, and I was the only one who said, "I want to take the test to see if I qualify." They never pushed me. When I got the test back I was qualified for the program, along with ten other kids in my town, and I was the only one in my town ever to go.

My parents really didn't push me. They were great. My success is not because of them, but they have definitely let me achieve so much. Both of my brothers went to public high schools, and I really wanted to go to a private boarding school, and my parents let me have that opportunity. They've been extremely encouraging and extremely proud of how I've done. But they always have the attitude that they want me to feel that it's my achievement and not theirs.

My dad's actually an alum of MIT, and for a while MIT was the last place I wanted to go because my dad went there and I thought it was all nerdy and geeky, I wanted to be at Harvard or Princeton or Stanford. He always talked about the school as a good school that I ought to look at, but he never pushed it. He never brought me to campus before I went around touring colleges. He let me make my own decision.

I made the decision to come here after talking with Zuming and after going around and talking to people in each math department here and in Princeton and Chicago. My dad, who loves the fact that I'm here, still never pushed it on me, and I think that's a great thing.

This place is amazing, for anyone who likes being around math- and science-oriented people. It's not nerdy or geeky. I have fun doing all sorts of things other than math and science in my dorm and with my friends. I love the city. I think my stereotyping the school was a little immature, but I was young. When I actually started looking, this was the place for me.

**Timothy Abbott** grew up in Houston, Texas, and McLean, Virginia, where he attended Thomas Jefferson High School for Science and Technology. He attended MOP in the summer of 2002 and received a silver medal at the International Olympiad in Informatics in the summer of 2003. As a freshman at MIT in 2003-04 he received an honorable mention on the Putnam, and this year, as a sophomore, he was within the top 16 finishers.

*I understand that you help run the Harvard-MIT Math Meet. What's the format of the competition?*

It has an individual part. Each person picks two one-hour-long subject tests, which are on subjects like algebra. The team round is the standard proof-type round. Then we have a weird Guts round, which involves basically getting three problems at a time, you turn that in, and then you get the next three problems. It's very exciting to watch, since it's scored in real time with the results projected onto a screen that everyone can see. I hear that we stole the idea from the Greenhill High School Math Tournament in Texas.

*It's for high school teams in the surrounding area?*

A lot of teams are from this area, but we have teams from all over. There was a team from Florida this year, and also a team from Virginia. I was going to come here with the team from Thomas Jefferson my senior year, but I had something else to do that weekend.

*How did you get started doing these competitions?*

I started doing math competitions seriously my sophomore year in high school. I did do Mathcounts sort of, but I wasn't even an alternate on my school's team. It's probably because I was the only one on my school team who had a different teacher than the person who was running it. He taught honors math, and I wanted to take algebra and geometry.

I wasn't really doing very much math then. My math teacher told me to show up at the Mathcounts tryout, and I did pretty well, but the head of the math team was unhappy with my lack of attendance. If I'd been thinking carefully I could have avoided the issue by finding out when the practices were in advance, or asking him for what the schedule was, but I was a bit lazy. One problem is that it's after school, so you have to figure out how to get home.

*You must have been in an accelerated math class.*

I took algebra and geometry during middle school, so I was a bit accelerated but not massively. I did well in a math competition other than Mathcounts, the Virginia Math League. I tied for first place in the state, but it was a three-way tie with almost perfect scores; it wasn't a very hard competition.

*Then you started doing math more intensively in high school?*

Actually, I didn't do anything at all my freshman year. Thomas Jefferson has an eight-period schedule, where a lot of kids stay after school, so basically there are two 45-minute blocks two days a week to do extracurricular stuff. My freshman year I did stuff in the computer lab.

My sophomore year I didn't really have anything to do so I started going to the math team. Also, somewhere it said that you have to be in precalculus or above to be on the math team, and I hadn't taken precalculus by my freshman year, so that also deterred me.

*Right, freshmen often don't get started on the math team right away.*

Most people in years other than mine got involved as freshmen. For some reason, people in my class joined later.

Anyway, my sophomore year I started showing up, though I wasn't particularly good at math contests. Then, the summer after my sophomore year I went to the Ross summer program in Ohio. My grandfather is a mathematician, but neither of my parents are mathematicians, so my parents had my grandfather ask the head of some math organization he was involved in what math programs were good, and that was the program he recommended.

It was pretty cool. It's between 30 and 50 people. Basically it's an eight-week-long number theory course, with an hour of class every day and lots of activities. The Ross program doesn't have a lot of organized nonmathematical activities. The students are generally free to work on their math when they choose, and they work as hard as they choose, within reason. Every weekday the students receive a problem set, which has a mixture of numerical problems and explorations, where one figures out what is going on, and also proofs of the clean statements that were developed on earlier problem sets. The proofs start out as two-column arguments, to make sure that the students understand why their claims are true, but a week or so into the program one is expected to move to more traditional writeups. I think that starting with two-column arguments is really valuable when you start generalizing number theory. I see a lot of people who write proofs that contain lots of correct statements, but they never mention the key reason why their claim is true.

It's a very noncompetitive environment. The students team up to work on harder problems, and the counselors and peers are there to patiently help you when you get stuck. But in the end, the student works through deriving most of elementary number theory, from their own ideas.

But the Ross program isn't really about number theory. It's about learning how to think, how to reason. I became a lot smarter, in general, especially after my first summer at Ross. (I was a counselor there the last two summers; this summer I'm doing research at MIT).

Some students have a less positive experience because they don't really want to do math (or only want to do contest math). However, people who had a genuine interest in mathematical phenomena often deeply enjoy the experience.

MOP has some of that. But I was only at MOP in 2002, which was the screwed-up year, the year that like 150 kids were at the program.

*I remember that that was the year that everyone who took the USAMO was invited to MOP. Why wasn't it successful?*

It was really unfortunate, because you had a lot of people who weren't that turned on by the math we were working on. They would play computer games most of the time or stay in the computer lab. In general, it was not a great experience for a number of people, but people have a tendency to go if they get invited because it's prestigious. The biggest problem was for the people who were fairly serious about learning mathematics.

Also, I have this general feeling that when you're working on contest math, there's a bit too much emphasis on doing contest problems hour after hour. The motivation is to teach you a technique for doing contest problems rather than looking at general mathematical principles. The problem is that in these MOP courses, you learn primarily to solve problems with a certain complexity. It's not really clear that the skills you learn to solve these apply later in life.

*But you must have continued to do competitions, given how well you did on the Putnam exam?*

I don't prepare for the Putnam. I just show up and take the exams. Preparation is generally a waste of time for the Putnam, I think. You need a certain amount of experience to solve the problems. Then, if you practice, you can solve the problems faster, by having all of those techniques ready. But I don't think that's a good use of my time when I can learn about relativistic quantum field theory or all the real mathematics out there.

*Does MIT encourage people to do the Putnam?*

There is a Putnam seminar, sort of a freshman-advisory seminar. I was actually involved in that. It's an actual class, not outside work. The lectures are on techniques and how to do problems. I don't really feel that holding it for credit is all that important. The credit just helps people show up.

*How do you get into that class?*

You apply over the summer. I'm not sure how they do the application. I think they try to focus on getting people who are experienced in math but not necessarily in contest math. The people who have already done contest math probably aren't going to learn much from the lectures, because they are probably familiar with most of the techniques.

*I've occasionally heard that math professors are prejudiced against contest math because they feel that it's not the best way to learn mathematics.*

I somewhat agree with them. I'm not really convinced that the IMO produces any new mathematicians. The people who get involved with it are typically the people who would be involved with math anyway. However, I think that math competitions do produce useful advertising for mathematics, and they bring together mathematically minded people.

*And plenty of people interested in math don't seem to be interested in competitions, especially girls.*

That's perfectly reasonable.

*Yet you must see value in competitions, since you help organize the high school competition that's held here.*

I think competitions are fun. Also, my dorm [Random Hall] runs the MIT side of the high school competition. It's the consequence of a weird event where someone was running the math meet two or three years ago who was living in the dorm and she made all her friends do things. There are a lot of people who do math in that dorm.

I ended up being volunteered to run it, because I was willing to make the time commitment.

*It must be a good deal of work.*

It was. I was only superficially involved in writing the problems. My friend Ricky Liu was in charge of the problems. I just proof-read his stuff and bugged him to give me stuff to print.

I dealt with planning the schedule, reserving rooms, assigning staff to jobs, making sure they actually did their jobs, making decisions and keeping our staff informed. My big success was that only the last event didn't start on time, which is perhaps unprecedented. I was very happy that the contest date was before a long weekend, because I didn't want to do anything for about two days after it ended.

*How many kids come for the meet?*

Six hundred. We've been experiencing huge growth over the last few years. We're pretty sure we can't accommodate any more than that -- we just don't have the room. And Harvard has even less space -- we alternate each year.

*Are you a math major here?*

I'm not a triple major, because that's not allowed here. But I'm essentially taking classes in math and computer science and physics. I declared a math major more than a year ago, which I think I finished this term. There's a credit limit during first term, but the next term I took eight classes, and after that I took nine, and I took seven this semester. But the number of classes here is not a very good metric for how much work you have, because some classes involve a lot more work than others.

*How do you even schedule all of these classes?*

I don't go to some of them. It's just that I have an interest in a lot of things and want to know about a lot of stuff. Like I'm pretty interested in math, but I've also been taking a lot of algorithm classes, which is the more theoretical side of computer science. I'm taking my fourth and fifth theoretical algorithm courses this semester. I took two each term of my sophomore year. I've also been taking physics. I'm probably not going to have a physics major, because there are certain physics classes I'm not interested in taking.

For some of the courses I'm taking, I learned about half of the material in high school, or in another related course. That's how I can get away with not going to those classes, because most of the time they're not going to talk about something I don't already understand. If they do, I'll just read about it in the textbook, so I can pick up the material from other sources.

*Do you think there's a way to get more high school students interested in mathematics?*

The general problem with high school is that the standard high school math curriculum is, in some sense, fairly pathetic. Most of the time your high school math class is repeating itself or repeating some previous class. It's very unlikely that someone is going to be interested in something if they never feel like they're doing anything new. The generic high school math class just doesn't do very much. People get bored.

Competitions can persuade people to learn new things, but I don't know to what extent that's going to persuade all that many people who aren't already involved in math.

*And that's your experience at Thomas Jefferson, which has some of the best math classes available in the entire Washington area.*

Well, it has the standard mathematics courses for Fairfax County, and then it has more advanced classes afterwards. It's very hard for schools to have different sets of math classes, because you get equivalency problems -- okay, I've taken this class, but what is that equivalent to? And if the classes were that much more advanced you'd have a lot more people taking calculus, but most schools don't have the people to teach calculus.

## Interviews in Princeton

**Ana Caraiani** was born and grew up in Bucharest, Romania. She began doing local mathematics competitions in fifth grade and national competitions in seventh grade. She represented Romania in the International Mathematical Olympiads in Washington, D.C., in 2001, in Glasgow in 2002, and in Tokyo in 2003, winning a silver medal and two gold medals. As a freshman at Princeton University in 2003-2004, she was a Putnam fellow -- becoming just the third female Putnam fellow in the 65-year history of the competition -- and she was a Putnam fellow again as a sophomore.

*Did you attend schools in Romania that specialize in mathematics and science?*

No, I went to regular schools in Bucharest. Some high schools emphasize training for math Olympiads, but I didn't go to one of those.

I was lucky, because I had a good math teacher in [middle] school, and she worked with me personally. She had been in competitions, too. Then I applied to a good high school and got in. There were some good kids in my class, so that created a little bit of competition. Also, the woman who first got me interested in math, she continued to train me privately. She had left the [middle] school by that point.

At least in the beginning she was training me for the competitions. But as I started learning more and more, and because we were talking, I got interested in things other than competitions.

*How were your regular mathematics courses in high school?*

They were okay, challenging at times. They weren't very sophisticated, but I guess compared to the American system we do calculus, analysis, linear algebra -- things that people here do only in college. Also, there were some interesting problems that required the same sort of skills as Olympiad problems required.

I had a good teacher in my high school classes. The reason I applied to that high school is because there were kids going to Olympiads who also applied to that high school, so I was hoping to be in class with them. That worked out for a while. But then they all started going to a different high school.

*Do you think Princeton was interested in you because of your experience on the Romanian IMO team?*

I think that attracted their interest, but I don't think that's the only thing that got me in. I think they look for consistency throughout your high school years.

I applied to several places, but in the end it was between Princeton and MIT, and I chose Princeton because I wanted a liberal arts education. I wanted a chance to take

literature and other things, not just mathematics and science. Also, I thought that by coming to Princeton I would be more able to do pure mathematics rather than applied.

*Had you ever been to the United States before?*

Just at the 2001 Olympiad. We did some training with the American team. We came to the US about a week early.

*Do most of the Romanian students who excel at mathematics competitions apply to colleges outside Romania?*

Most of the people who do well in Olympiads apply to universities in the United States. It's easier to get financial aid here, compared to colleges in Europe. Most students from Romania couldn't afford to pay for a college like Princeton. And colleges here seem to be more willing to accept people.

*What have the math classes at Princeton been like?*

They've been pretty different. I've had to learn a lot of theory and definitions. I've had to learn the building blocks. So I don't get to think about problems. It's not as direct. In Olympiads you just work on the problems. Now I know that there is so much more for me to learn before I even start thinking about questions.

*Have you enjoyed that approach to mathematics?*

Yes. The more advanced classes have been the more enjoyable ones. I took only one introductory course, and I didn't really like that.

*Are you taking any graduate classes in mathematics?*

I've been sitting-in on a graduate-level course this semester, but I haven't understood a lot of it. There is a big difference between undergraduate and graduate courses at Princeton. You can take graduate courses, but you have to work really hard to understand them.

*Have you been able to take many liberal arts classes so far?*

I've taken art, literature, philosophy, a writing seminar, Russian, and econ.

*Have you had negative experiences with mathematics that have made you question your commitment to it?*

The only time is when sometimes I try to solve a problem and I just can't, and I wonder if I'm good enough.

Also, after my first semester at Princeton, I was wondering if I wanted to do math anymore. I really didn't enjoy the 200-level course I took. At the same time I was taking this art course, and that was so exciting. Everything was so new, and you could take a thesis and try to prove it, whereas in the multivariable course it was all follow the proofs as your professor explained them at the board and then plug in answers. I didn't like it.

But once I took a 300-level course it was better. The course was more interesting, and you had more challenging assignments and exams. When the material becomes more advanced, you can see that the person is actually working in that field and interested in that field, and that makes it more appealing.

*Have you encountered difficulties in competitive mathematics because you're a female?*

Here it has been very good. In Romania it was sometimes an issue. I was the first girl to be on a Romanian IMO team after 20 years. Some of the other teams had girls, but not Romania.

It wasn't discrimination. It was an attitude that you're a girl so you can't do much. It was a lack of confidence. For instance, none of the teachers who were training people for the IMO ever tried to train me in particular. After tenth grade I was still very good friends with my math teacher from [middle] school, but she was teaching at a college and wasn't really training me anymore and I had no one else to go to.

There are more and more girls on teams each year. In 2002 I was the only one to get a gold medal. In 2003, three other girls received gold medals, so there were four girls total. And there are many girls in math departments who don't do competitions. They do well in mathematics, but they're not training for competitions.

*Why do you think girls don't do competitions as much?*

I guess it's because guys are more aggressive and more confident. That can be intimidating. Some girls don't try hard enough because they don't think they can do well.

I think once there is a precedent there will be more and more girls.

*I know that Princeton has informal training sessions for people planning to take the Putnam. Did you participate in any of those?*

I think the training is meant for people with less experience, people who didn't go to math Olympiads every year. It seemed very basic, because I had so much experience

in high school. Melanie [Wood, one of the instructors] told me not to come any more. But the problem sets were interesting.

I think about 20 or 30 kids come for the training session, and all those kids take the Putnam. They're getting more here each year.

*Did you train for the Putnam on your own?*

No. It's not so important anymore.

*I've heard that you may have gotten the top score on this year's Putnam. Do you know if you did?*

I think I solved 11 problems. But I'm not sure if I got points for all 11 problems, because the graders can be very harsh about giving points. I can't say what score I had.

I don't really want to know. I have two more years. Maybe next year I will be completely sure that I got all the problems.

*What are you thinking about after this?*

I'd like to go to graduate school, probably here in the United States or in Western Europe.

*You wouldn't go back to Romania?*

No. It still has a long ways to go until a Ph.D. program there could be compared to one here. I always had this plan that I was going to go to college, I was going to get a Ph.D., and I was going to become a professor. I haven't had any doubts about that.

**Suehyun Kwon** grew up in Pusan, Korea, where she attended Sadong Elementary School and Dongju Girls' Middle School. She participated in national mathematics competitions throughout middle school and high school and was on the Korean IMO team in 2001, earning a gold medal. She came to Princeton in September 2002 and was among the top 15 finishers on the 2003 Putnam. On the 2004 exam, she finished with an honorable mention.

*How did you get involved in math competitions in Korea?*

The Korean Mathematical Society organizes summer and winter programs each year, and I had a chance to participate in the summer program in eighth grade. I liked the people and the atmosphere of the program a lot, and I wanted to keep participating. To do that, I had to place within the top 40 or so on the national competitions, and I began participating in the math competitions.

*Was it difficult to participate in the national program, especially as a girl?*

In Korea you use your GPA to apply for colleges. And unless you make it to the IMO team, even if you do well in the national competitions, it doesn't guarantee that you will be accepted in the universities. So a lot of people, if they cannot do both the IMO and GPAs, have to choose between the two. If they are going to do Olympiads, they might not be able to do as well with their schoolwork.

Also, in Korea, a lot of girls tend to choose the safer way, so they do well on their schoolwork and get higher GPAs. But they don't really do well on the Olympiads.

Some people do both. In my case, I didn't have so much trouble maintaining my GPA, so I was able to spend more time on Olympiads and managed to be on the team my senior year. But I definitely feel that if I had devoted more time to Olympiads from an earlier age, I would have made it earlier, maybe my sophomore or junior year. But I had to spend some time doing schoolwork, so I couldn't spend as much time on mathematics as other people.

I was lucky to be on the team my senior year. It was my last chance, and I really hoped I could make it.

*Had there been girls on the Korean IMO team before you?*

I was the fourth girl on the Korean team. There was one on the team about ten years before me, then there weren't any girls for a while, and then there was a girl who was two years older than me. There was another girl who was on the team again the next year, and I was on the team the year after that, so there were girls on the team for three years in a row. But since I graduated, there haven't been any girls on the team.

*Did you go to a high school that emphasized training for math competitions?*

Most of us in Korea were in science high schools. They're public high schools, but also boarding schools, so you live in a dormitory. You take 14 to 16 classes a semester, so you have 34 hours of classes every week.

You apply to high school in the second semester of ninth grade, so it's for three years. They emphasize math and science courses, but not Olympiads. If you want to make it onto the national team, you have to study on your own.

The other thing is most people in Korea who were on the team were from Seoul. I'm from Pusan. There aren't many people who specialize in math Olympiads from Pusan, so I kind of had to teach myself. I mostly worked with books.

*Was it common in Korea for girls to be doing Olympiad-level math?*

For my high school I was the only one in my grade who was doing math at the Olympiad level. I was also the only girl. There was one guy who was one year ahead of me, and one year behind me. We got along well. I don't think there was any problem with them because I was a girl.

But people didn't expect me to do as well when I started doing math Olympiads. That was a little bit annoying. I started in the eighth grade, and at that point people said I might be able to place in the top 30 or 40 and make it to the summer school or winter school. But they didn't expect me to be in the top ten or be on the national team and make it to the IMO.

But later on, from the tenth grade on, people started expecting me to do well. So I don't think there was anything against me then.

Still, when I started doing better, people said, "Okay, but you're the exception." In other words, they didn't change their perception of girls as a whole. They just took me out of the category of girls.

*Were there other problems you encountered doing high-level problem solving in high school?*

I had trouble finding materials to work on, because there weren't that many books written in Korean that I could read. And to order English books I had to know the titles and needed some kind of idea about what I should read. But I didn't have any information about that until I went to the training programs. Then I found out about some of those books, and I could work on previous years' exams.

Also, in ninth grade and tenth grade, I was getting frustrated, because I had some questions, and I thought that if there was someone who specialized in math Olympiads that person could give me a one-hour session and answer all of my questions. But there was no one I could ask. I had to work on my own, and it took me a while to figure things out. But eventually that helped me. When I was on the Korean team there are usually two or three professors who worked as guides or just went with us when we went to take tests, and they said that the way I do problems is quite different from the way other

people approach problems. With some people, how well they do on an exam depends on whether they have seen that kind of problem or not. But for me, I haven't seen most of the problems, so it doesn't make any difference. I see the problem, I think about it, and I do it. That could be another reason why it took me a while to be on the team.

But after the eleventh grade I felt that I knew most of the techniques that everyone else did, either from studying solutions or from learning them on my own. From that point on I was more or less in the top six or top ten.

*Were there many girls who attended the national training program?*

No. I remember out of 40 to 80 people, which was the size of the summer program, there once were 11 or 12 girls, but usually there were 3 or 4. I don't think they focus on the number of girls in the program, actually. Also, it depends on what kinds of Olympiads you're talking about. In physics and computer science or math, there were only a few girls, but in chemistry or biology, there were a lot more girls.

*Had you been to the United States before the 2001 Olympiad?*

That was my first time.

*Do many high school students from Korea apply to U.S. colleges?*

Most stay in Korea. I think after my year more people started to apply to American colleges. Nowadays, I would say tens of kids, or maybe hundreds of kids [from Korea], get into pretty good schools.

*Did you apply to other places besides Princeton?*

I applied to a couple, and I got into MIT and here.

*Why did you choose Princeton?*

I thought I wanted to go to a college that emphasized humanities. Also, because I went to a science high school, I wanted to meet other people who were interested in the humanities. I'm not that interested in the sciences. I'm more interested in the humanities than the sciences.

*Were you always planning to be a math major?*

I figured that as an undergraduate I wanted to do as much math as possible. But I thought I would try other courses, too.

Some of the undergraduate math courses I took weren't very challenging. Especially the ones I took freshman year. But the courses I took sophomore year were very good. One of the courses I took in my freshman year was single-variable analysis, an honors class, but still pretty easy.

I sat in on a graduate class this semester, and it just went over my head.

*What other courses have you taken while you were here?*

I've taken a lot of random courses. Freshman year I took physics, computer science, and philosophy. Also in freshman year I had to get used to speaking English. I could understand English, but I'd never been in an environment where I had to speak it all the time. Then, in my sophomore year, I took psychology, art history, econ, linguistics. And last fall I took classics and French.

*You haven't taken a lot of sciences?*

I took two semesters of physics and one of computer science. And the psychology class I took was a science class. But other than that, no science.

*Have you encountered some of the same attitudes toward women doing mathematics here at Princeton that you did in Korea?*

Not really. There are lots of other girls studying mathematics here, especially in my year. There are maybe 4 or 5 of us out of 17. But I'm used to being the only girl, so I don't care whether I'm the only girl or not. I don't pay much attention to the fact that I'm the only girl or one of just a few girls.

*Have there been other difficult things about going to school here?*

Sometimes I wish I could go home more often, maybe once every three months rather than twice a year. And in the beginning, during freshman year, English was a little trouble. I feel I still have to work on my vocabulary. I have a lot more vocabulary in Korean than in English, and when I want to talk about something more abstract or more profound I often know what the word is in Korean but I have to explain it in English.

*Did you do the training sessions for the Putnam here?*

The training sessions are mainly for people who might want to solve 3 problems out of 12. So if you are actually on the team you probably work on the own. Mostly I

use what I learned in high school. I kind of lost interest in competitions for a while after the IMO, so I stopped training. After that I've been competing just once a year.

If you did the IMO, you can do most of the Putnam problems with what you learned in high school. It doesn't really require knowledge that you've learned here -- maybe linear algebra or a little bit of analysis.

*Does the math department here encourage undergraduates to do the Putnam?*

They advertise it and they organize sessions. But they don't put much emphasis on it. They see it as one way of challenging us. They definitely are happy when we do well, but they wouldn't make us work hard just to get high scores.

I, personally, was disappointed by how I did this year, but I wasn't feeling well the day of the exam.

*Are you planning to go to graduate school?*

At this point, I'm not 100 percent sure what field I want to study in graduate school. I've been considering a lot of possibilities. I'm also interested in econ, though not in the mathematical side. I think the mathematical side of econ is quite boring, because a lot of what you're doing is just finding optimal points. But I like to find how policies can explain or affect people's decisions and influence events. So I'm more interested in macroeconomic issues.

But I have to see if I'm interested in econ because it's something new for me or whether I'm really interested in it as a research subject. I have to apply [to graduate schools] this coming fall.

I have way too many interests other than math. That's one reason I'm having so much trouble figuring out what I want to do after I graduate. I have to look at my interests and see what I really want to do, so I've been trying other things that I didn't have time to do in high school.

*Do you have to return to Korea on your visa before you can go to graduate school?*

As a foreign student, I can take one year off from my education and then pursue some kind of graduate training. My visa doesn't expire until 2010.

*Do you plan to stay in this country after graduate school?*

I'm hoping to. I don't know where I'd want to be in my mid-50s, but until my mid-40s I'd want to stay here. I want to do research, whatever the areas will be.

**Andrei Negut**, like Ana Caraiani, was born and grew up in Bucharest, Romania, where he attended General School No. 12 from first through eighth grade. In his first year at Tudor Vianu High School of Computer Science, he was invited to the Junior Balkan Mathematical Olympiad, and he represented Romania at the International Mathematical Olympiads in 2002, 2003, and 2004. He entered Princeton in the fall of 2004 and finished in the top 26 on the 2004 Putnam.

*When did you begin doing mathematical competitions?*

I discovered them gradually through elementary school and middle school. By the time I was in the seventh grade I started going to competitions. I didn't do so well at first -- I was pretty mediocre back then. I think my first pretty good year was in ninth grade, when I went to the Junior Balkan Mathematical Olympiad. It's a contest in the Balkan area for students below 15. That was my first international competition. After that I participated at the IMO every year.

*What was your high school like?*

It was very science oriented. A lot of Olympiad participants gathered at that school. They had so many good students at that school that it was very competitive and stimulating -- it was a good environment to grow up in.

*How did you prepare for competitions in school?*

I had a mathematics professor who showed me lots of stuff beyond the regular schoolwork, and that helped spark my interest. And the thing that had the most to do with my preparation in math was the sessions that the Romanian IMO teams organized. Even when you weren't on the team you were invited to participate in those sessions. The sessions were led by really good professors who were passionate about training students for math competitions.

The sessions were held mostly before the Olympiad, so in April and May. But the professors who led the sessions did volunteer work with us through the whole year, and that kept us sharp. Some of them are high school teachers and some of them are university professors.

*Did you have any negative experiences with mathematics in high school?*

I didn't have any negative experiences in math particularly. The only unpleasant experiences I might have had as an Olympiad participant involved my own frustrations about contests in which I didn't do so well. But that's something for me personally.

*But how frustrating is it to go into a competition and not do well?*

To miss something obvious is by far the most frustrating thing, but it happens. Whenever something like that happens, you just have to move on to the next competition, because there are always going to be new challenges. You haven't lost anything; you just haven't won this time.

*Do you know people who give up on competitions because of frustration?*

I don't know of people who got so frustrated that they just said I'm not going to participate in competitions anymore. But I know a lot of people who slowly lost their interest or their drive, and it's really sad, because a lot of those people are really good. There were many people who were the same age as me who were really good as middle school students and didn't get past the threshold into high school competitions.

In many cases it's not an issue of intelligence or mathematical capability but of character and personality. That's what professors should really focus on, helping students cope with morale and attitude and so on.

*Can it be frustrating simply not to finish first, since after all only one person can be at the top?*

At least at the IMO they don't necessarily emphasize being first. That's why they give gold medals to all the top finishers, to make it seem like a more friendly competition. And this whole competition environment, even though it can become stressful, is still necessary to be a good student. It's good to realize that the real world of mathematics is not all fun and games but is also hard work and dedication and discipline.

*Do you think that more high school students in Romania participate in competitions than in the United States?*

Definitely a higher percentage of students in Romania do competitions, because of the culture -- the culture in Romanian schools is somehow more oriented toward competitions than it is here. And the only competitions that were available to Romanians for a very long time were Olympiads. Students in the U.S. have many more opportunities than just math competitions. That's why we have a higher proportion of students who do competitions.

*Are there more girls who participate in competitions in Romania?*

The same thing happens in Romania that happens here. Ana was the only girl for many years on our IMO team. It somehow seems like a male thing to do socially. I think it's just a cultural thing that girls don't participate more.

*Have a lot of the Romanian team members come to the United States for college?*

Lately they have been coming to the U.S. because people from Romania have become aware that it's not impossible to get here. Before, everyone had the opinion that you had to be a genius to get in here, but that's really not so. In the last few years, virtually all the members of the IMO team have applied to colleges in the United States, and almost all of them have gotten in. Some of them are going to places like France and Germany, and some of them are staying in Romania, but not many compared to the ones who are here.

*Once Romanian students come to the United States, are they likely to stay?*

Most people probably will stay. I, for one, have not yet decided. My opinion is that a mathematician does not necessarily need to stay in a single place or be bound by a job or by a university. He can afford to travel and do research wherever.

*If people did stay in Romania for college, where would they go?*

At least for the math people, they have a couple of universities they can go to, especially the University of Bucharest, which is one of the best math colleges in Romania. Most of the really good professors I know teach there. Or you can go to the Polytechnique University or to the Superior Normal School. But you don't have all that many options. Over here it's much more wide open.

*Do people see going abroad as an opportunity, or are they being pushed out of Romania?*

I decided to come here because it's an opportunity that I'm not sure I'll have again, to study in a foreign place. Still, many people decide to leave because they are fed up with the situation in Romania, either the economical situation or the political problems. So it's a mixture of what you said. Some people are drawn to the good things that they see here, other people just want to get out of Romania.

*Did you apply to more than one college?*

Yes, I applied to more than one. Princeton was my first choice. Luckily for me I was accepted.

*Why were you attracted to Princeton?*

I had heard, or had the impression, that Princeton had the best math department, and I still think that it's so.

*What have your initial math classes here been like?*

My first math course here was multivariable analysis, which was a 200-level course. I liked it because it was analysis and not calculus. I do find calculus mechanical and algorithmic. Analysis is actually pretty intelligent mathematics, so I like that. But that's the only 200-level course I've taken so far.

From your education in Romania you know a lot of stuff that you're supposed to do here in your first years, like real analysis, linear algebra, calculus, and other stuff. That basically covers the 200-level courses.

This semester I'm taking differential geometry and Fourier analysis, which are 300-level courses.

*Do you think you'll take graduate-level courses here?*

I don't think there are enough really interesting undergraduate courses to fill up my whole four years. But it will probably take me until my junior year to find that I'm out of courses. When that moment comes, I'll look into graduate courses.

*Do you have any doubts about being a math major?*

No, especially because you can do a lot of stuff as a mathematician. My greatest interest, and the one that I'll most likely pursue, is pure math, so it's unlikely that I'd make a career in applied economics, computer science, or physics. But I'm still interested in keeping those options available. It would be interesting to apply a background of pure math to the theoretical aspects of all those things.

*Melanie [Wood] has told me that she felt that there is some prejudice against graduate students who have a background in competitive math. Have you ever felt that at the undergraduate level?*

I have not encountered that. I think that professors realize that competition mathematics has the very good quality of shaping your mathematical sophistication and your ways of thought. It doesn't teach you tools like analysis, but it involves pure thought, and that's very important for mathematicians.

That's one of the most amazing things about the IMO -- that it promotes fairly fundamental features like creativity. You don't find that in regular school education.

The problem with regular school education is that it can get mechanical and algorithmic, and the only thing that is expected of you is to apply what you've learned. In competition mathematics you're inspired to create for yourself, which is like doing research in a way.

I think some professors consider competition mathematics immature and childish. And perhaps it is, but nevertheless it's the backbone of mathematics, to be able to think clearly and logically. I would really encourage students to focus much more on this kind of activity, whether they're from the U.S. or Romania or anywhere else. It's a really great experience to be a part of these competitions.

*But there must be many different ways of getting interested in and doing mathematics?*

Being an IMO gold medalist is not a requirement for being a mathematician. Many mathematical geniuses never participated in these competitions. There's a difference between competition mathematics and research. Competition mathematics obviously helps a lot in shaping your character as a mathematician, but it's not a requirement. You can easily get around it. IMOs don't create mathematical skills -- they just hone them.

*Andrew Wiles spoke at the 2001 IMO about whether competitions were good training for mathematicians, and my view is that he was skeptical that they are.*

Obviously, but the creativity required in solving an IMO problem is midway between school work, which is just mechanical, and actual research, in which you are practically lost in a whole world that you don't really understand. Competition mathematics comes between these and is a really good stepping stone to research.

From the mathematicians' viewpoint, competition mathematics is just the means for getting people to think better. And it's a very efficient and effective way to do this.

Competitions require a lot of patience. If you don't have a passion for mathematics, you won't survive in competitions.

*Have you encountered any negative opinions from people not in mathematics about doing mathematics?*

I have not encountered any such reactions here or in Romania. People are usually understanding about my passion for mathematics, even though it's not going to make me financially well off. Even if people don't see mathematics as constructive, they still respect me for doing this, so I can't say that I've had any negative reactions from anyone.

*In the United States there is the stereotype of kids who do mathematics as nerds.*

That's just wrong. The students who I've met at mathematical competitions were very interesting people. Most of them had artistic inclinations, some were athletes, and so on. And on top of that they did math.

*What are your interests besides mathematics?*

Photography. I play bridge. I also like some sports like tennis and table tennis.

*Is math such a difficult major that they don't have time for other things?*

Definitely not. I've been spending more time this semester on my photography course than on both my math courses. I'm also taking philosophy and physics.

*How did you learn to speak English so fluently?*

We've been exposed to American culture for our whole lives, so knowing the language is not such a big deal. I started studying English around the sixth or seventh grade, but I also know this language because I have encountered it in everything from films to music to computer games. That exposes you to the culture and the language.

Romanian television uses Romanian subtitles, and foreign films are mostly in English, so I got the chance to hear the language being spoken quite a lot. Almost all of the people in Romania who are my age know English and could handle it here.

In mathematics, my only problem is that I don't know what most of the concepts are called in Romanian. When I go back, I'll have to learn them again.

## Interviews at Harvard

**Steve Byrnes** grew up outside Boston in Lexington, Massachusetts, where he attended public schools through sixth grade and Roxbury Latin, a private school in West Roxbury, for grades seven through twelve. He attended the Program in Mathematics for Young Scientists (PROMYS) in 2000 and 2001, MOP in 2001, the Research Science Institute (RSI) in 2002, and the U.S. Physics Team Training Camp in 2002 and 2003. In the 2003-04 school year he placed first in the Siemens Westinghouse Competition and was a finalist in the Intel Science Talent Search. This year, as a sophomore at Harvard, he received an honorable mention on the Putnam.

*Do you remember when you first started doing mathematics outside school?*

In fifth grade I was doing very well in the regular curriculum. My mom ended up talking to the mother of Reid Barton. Reid's mother suggested getting the set of Barron's books called "Algebra the Easy Way," "Calculus the Easy Way," etc. -- of course Reid had read them in kindergarten or something. I also read them and found them to be very good and entertaining. The premise of the book is that you're following the leaders of this imaginary kingdom and they're trying to solve various engineering problems. It's quirky and odd, but entertaining.

That's where I got my start. Then I started wandering through bookstores and getting my parents to buy me math books I was interested in. That was in seventh and eighth grade.

Also in seventh and eighth grade I did Mathcounts. I got to know one of the teachers in my school, a guy named Sam Vandervelde. My school was Roxbury Latin in West Roxbury, which is for grades seven through twelve. Mr. Vandervelde was the coach of the Mathcounts team, so he taught us all sorts of cool and useful math that was relevant for Mathcounts.

After that I went to the PROMYS program at Boston University -- the Program in Mathematics for Young Scientists. They sent everyone brochures, and it looked really interesting. The summer after my freshman year I ended up going. That was my first taste of higher math and doing proofs properly.

I guess the key thing, in terms of qualifying me for MOP, was that Mr. Vandervelde lent me a book that he had of old Olympiad problems from around the world, and he went so far as to look through the solutions I wrote up to some of the problems. He went through them and suggested ways to improve my solutions, so that at the end of my sophomore year I was able to qualify for MOP.

*Did you like doing competitive mathematics from the very beginning?*

I liked competitions to the extent that I did well at them. Whenever you're good at something, you tend to like it.

*But doesn't it get frustrating sometimes to have other people do better at competitions?*

I never felt that I was stupid because I wasn't number one. I think getting seventh or eighth is plenty inspiring. I was never really frustrated.

*Did you keep going to MOP after freshman year?*

I went to MOP after my sophomore year and I also went to PROMYS that year. After my junior year I qualified for MOP -- in fact I was top 12 on the USAMO -- but I went to RSI instead [the Research Science Institute, a six-week program at MIT and Caltech for high school students doing research projects].

*Was that a hard decision?*

When I was at PROMYS, BU was right across the river from MIT, so we all knew a lot about RSI. And I knew people who had gone there and had really enjoyed it. I wanted to go to RSI because I expected it to be an extremely fun and productive experience, and I'd already been to MOP.

*Did you stay active with the Math team at Roxbury?*

Roxbury Latin didn't really have a traveling math team in the same way that a lot of public high schools in the region did. We had a math club, the Mad Puzzlers Society. We would gather after school and Sam would show us a really cool math thing, a useful, interesting, kind of random mathematical result. And we would do the AMC tests. I guess there were a couple of smaller competitions, too, but we didn't do any traveling competitions.

*Did you have any negative experiences in middle school or high school that made it more difficult to pursue your interest in mathematics?*

I can't think of any. The school was very flexible about my taking math classes that I thought were interesting.

I did stop putting time into practice competitions after MOP. At that point I knew enough higher math to know that that was what I was most interested in. Competition math was fun for a while, and I knew I could continue to get better at it, but I was sort of tired of it at that point, so I stopped. I put away my books and competition problems and pretty much stopped practicing.

*But you're still doing well on the Putnam.*

Yeah, but I haven't really learned anything in my math classes that would have helped me on the Putnam.

*Are you a math major here at Harvard?*

Yes. Harvard doesn't let you double major in the same way as at MIT. There are joint concentrations here. For example, I was thinking of switching to math and physics, and I was also thinking about switching to physics and math. There are two different joint concentrations, with slightly different requirements. I'm a math concentrator right now because that gives me the most flexibility, but the overlap between the concentrations is substantial enough that I don't have to decide yet.

*How are math students here at Harvard viewed by other undergraduates?*

I think it varies a lot from person to person. I have math undergraduate friends who spend all their time with other math undergraduate friends. But I'm rooming with biologists and government people and social scientists, and most of my social life is entirely unaffected by my major.

*I'm assuming that you took math 55 your freshman year.*

Yeah. Math 55 is designed for people who already know the basics of calculus and algebra very well, and know how to write difficult proofs, which is something you get from competition math. The course basically presents some of the same material that introductory courses would but in a very abstract way. It would be hard to understand if you hadn't already seen some of this material already.

*Where do you go from that class?*

There are lots of logical next steps you can take. I only took one class last fall, a graduate course in higher algebra, math 250. And then I spent a lot of the rest of my time fulfilling requirements in physics.

*Have you been thinking about physics because your math classes have been unsatisfactory?*

No, this department has been great. All of my classes have been interesting. I'm enjoying them and learning a lot. As it turns out, I really don't want to be a mathematician as a profession. That's why I'm taking a lot of physics courses. But I still find the math courses to be enjoyable.

*At this point, are you thinking about graduate school?*

I think I want to go to physics grad school.

**Inna Zakharevich** immigrated with her family to the United States from Russia when she was in the second grade. She attended the public schools in Palo Alto, California. While at Gunn High School, she attended MOP in 2001 and 2002. This year, as a junior at Harvard, she was among the top 15 finishers on the Putnam.

*I've heard that you come from a very mathematical family.*

I've always been interested in math and my family has always been interested in math. I've always been given math problems and I've always been interested in technical things. It's what people in my family do, so I assumed that that's what people do -- they do math.

My father is a mathematician. My grandfather is a mathematician. Actually, my grandparents on my mother's side met at a math conference. So pretty much everyone in my family does math.

I've always talk to my dad about math. I assumed people did that until about high school when I learned that, no, that's not the way things worked.

On the other hand, when I got really interested in doing math in my free time and pursuing it on my own was in eleventh grade, because I met some math people and I got really involved. I learned how to learn math from them, and I started doing it in most of my free time.

*Where was that, at MOP?*

No, these people came and gave a guest lecture at a math camp I was attending called the Stanford University Mathematics Camp [SUMAC]. The camp was fun but it didn't particularly inspire me to do math. It was meeting these other people that inspired me.

*Before that, were there particular teachers who motivated your interest in math?*

Yes, my ninth grade teacher at high school, Josh Zucker, who's really involved in the Olympiads in the Bay Area. It was his first year teaching at my high school, and he was just great. I would say he's the best math teacher I've ever had. If not the best, then one of the top three. He ran the math circle at my high school and really encouraged everybody to do math. When he taught math classes, he didn't just teach people how to do the problem, he talked more about how to think about the problem, and from that followed how to solve the problem.

*Were you on an accelerated math track when you took that class from him?*

Yeah, I was two years ahead, so he was teaching the eleventh grade honors class. In my high school you learn geometry and a little bit of trigonometry in ninth grade, then you focus on trigonometry in tenth grade, and in the twelfth grade you do calculus. In eleventh grade you do everything that you really ought to know but have sort of missed in these other classes. So you learn about three-dimensional vectors, statistics, a bit of precalculus, even group theory.

*How were you able to skip over the geometry and trigonometry classes?*

In sixth grade I did EPGY [the Educational Program for Gifted Youth] for algebra, and Josh Zucker was my tutor, though I didn't really know him well then. Then, for all of middle school my best friend's mother taught the two of us math, outside of class. By the end of middle school we had already covered more geometry than is covered in ninth grade and most of the trigonometry covered in tenth grade. I did have a couple of holes in my knowledge that I had to fill, but it was something like just three or four topics and I could do that better on my own rather than being bored for the entire year.

In eighth grade, in school, technically I was doing independent study for geometry, but I ended up skipping it mostly and going to the computer lab to learn how to program. The geometry textbook we were using I thought was fairly stupid, and I wasn't very interested in it. The teacher realized that and was very flexible. He said, okay, that's fine, you can go to the computer lab if you want, just come by and tell me that you're going to the computer lab. I learned C that year.

*Is the friend you were studying math with still interested in math?*

We're still best friends. She goes to MIT and is studying math and linguistics. She was never as actively interested in math as I was. She was good at it, but she was more interested in history and poetry. She's planning to go to graduate school in linguistics.

*If you didn't start doing serious problem solving until eleventh grade, did you not go to MOP before then?*

The thing is, I never knew there was a MOP. My complaint about the entire AMC program is that it's not advertised enough. If I had known there was a MOP, I would have worked harder to get there earlier. I'm a little more clueless than most people. I took the AMC because it was a math test, and I think math tests are fun. But when I got to the AIME, I didn't realize that doing well on the AIME was needed to take the USAMO. I just said, "Oh, another math test, I'll take that as well." I didn't know about the USAMO or about MOP. If I'd known about them I would have worked harder at it.

The way I found out about MOP was by meeting these guys at SUMAC. After that I started working harder because I knew there was something to work for. But before that I never knew about it. It's listed very clearly on the back of the AMC test, but frankly after you're done with the AMC you don't keep the tests, and during the AMC you're not going to be sitting there reading the back.

I think the AMC should make posters to advertise the test. Even if some teachers know about it, it won't occur to them to tell some students. But if there were a poster hanging up, students can find out on their own.

*In lots of schools, no one takes the AMC tests.*

Yeah, mostly the kids in Calimass take it.

*Calimass?*

Every year something like half of MOP is from Calimass. The San Francisco Bay area and the Boston area. There are good schools in southern California, and you should be getting many people from there, but you aren't.

*Do you think more kids have been taking the AMC tests in recent years?*

That's another thing that upsets me. In movies right now it's really popular to have a smart kid as your main character. They don't even need to be pretty. They're often ugly at the beginning and get prettier as they go along.

Plenty of movies have shown math competitions, but they're all stupid competitions -- they don't show problems that people would be interested in. For example, there a competition here in the Bay area called the Senior Olympiad, which is not really an Olympiad, but it is only for seniors. You're given an hour and a half and 30 really stupid problems. I'd say two-thirds of the problems you could do with a calculator, problems like "given a polynomial, how many positive roots does it have." You use your calculator to graph the polynomial and count the positive roots.

I got third and my friend Neil got first in this competition. Kids came up to us afterward and asked, "How did you do so well at this?" I said, "You practice." They got a sort of scornful look on their faces and said, "You practice for this?" And I said, "No, this is stupid. You don't practice for this. You practice for better competitions. And as a consequence of practicing for more interesting competitions, you also do well on these."

The problem with easy competitions that are more computational is that it's boring math, it doesn't let you have any scope for thought. Obviously people are going to find it boring and aren't going to want to do it.

In eighth grade I'd seen the first few rounds of Mathcounts and I thought, "How boring." I went to a math teacher and asked, "Are there any other kinds of competitions, ones that involve thinking?" He said, "No, not really." So I said, "Well, to hell with that, I'm not going to do math anymore." And frankly I didn't even think about math

competitions after that. In the ninth grade I found out that there were interesting competitions, but that's mainly because I had a good teacher who knew about them.

That's my biggest criticism about most math competitions. Kids'll say "This is boring. I want to go do something more interesting like computer science or physics or history, because it involves thought."

*Would you consider the various AMC tests boring?*

There are usually a couple of fun problems on the AMC, but it is bordering on boring. The AIME is more interesting, although some of the problems in it verge on the annoying, in that a lot of the time there is a clever solution but the obvious solution involves a lot of computation. Also, you're not allowed a calculator. My theory is that they should provide a four-function calculator with the AIME. My friends used to call the AIME the "stupid mistakes" competition. On the IMO the judges will say, "Oh, they clearly know what they were doing, they just multiplied these two numbers incorrectly." But on the AIME, the first year I took it I got a four when I solved six or seven problems. A four-function calculator would be a big help.

I like the USAMO -- the USAMO is good. But I think there should be easier competitions that are structured like the USAMO. The main problem is grading them. You can't have a nationwide competition like the USAMO with 400,000 people taking it. You can do it on the local scale, like the Bay Area Math Olympiad, which is a very good competition, in my opinion. But you can't grade a test unless you have the people to grade it. It's easy to grade the stupid competitions.

I'm sure there are teachers out there who might not be fully qualified to be graders but who should be able to grade a competition like that if you provided them with solutions to the problems and what to look for. In my high school there were obviously a lot of teachers who didn't know what they were doing. But there were also a few teachers who might not be as well prepared mathematically but were honestly interested in teaching their students. Even if it weren't graded in the best style, such a competition would be good for the students because it would give them interesting math problems and things to think about.

The idea that there are really cool problems in math, that's what's missing, people aren't seeing that. People in my high school never understood why I liked math. I would tell them, "High school math is boring. That's not what I like." But they never really understood what I meant.

*Do you think they were also asking you because you were a girl who liked math?*

Frankly I don't like this whole focus on girls. In my experience, girls just aren't as interested in doing math. On a math team you sit for a long time and think about a problem, you hyperfocus. Girls are significantly less interested in hyperfocusing. Girls are more interested in other subjects. Even among my friends who are good in math most of them don't end up doing math -- not because they encounter discrimination or any lack of encouragement from their parents or their surroundings, because in the Bay area girls

are very strongly encouraged to do math. They're just not as interested. Isn't that allowable? Seventy-five percent of psychology Ph.D.'s are women, but no one complains that men are underrepresented in psychology. Why couldn't it be the same with math?

*But there must be a history of discrimination in mathematics, because ten years ago almost no girls were doing math.*

My dad said something interesting. He said that at Berkeley they have all these female math students who are very good. But they have almost no postdoc applications who are female and good. That's interesting, and I don't know what's causing that. I think that's a problem.

I honestly think that people talking about it isn't going to help. If you want to show that women are as good as men, make applications for tenure-track positions without names, give people ID numbers, and have committees only look at the records and not the names. Then look at who's qualified and who isn't.

*But wouldn't that make the problem worse because men would be setting the rules?*

But math has been a field for a really long time, and there's a well-defined idea of what it takes to be good at research in math. What you want for tenure-track positions are people who are good at research -- or teaching, and that's another huge debate that I'm not going to talk about. But you know what you want. Yes, it often turns out there are more qualified men. But what does it mean to make the rules? You can look at the number of published papers and the quality of the papers. That's independent of the gender of the person.

*So say that I'm staffing a math department, and I get an application from you and from a man who is slightly more qualified, I'm nevertheless going to pick you.*

But that would be wrong, because it perpetuates the stereotype of woman as being less qualified than men. What kind of a department do you want? Do you want a balanced department, or do you want a research department? There's a difference. Clearly, there are incredibly fewer women qualified by the usual standards for tenure-track positions, which is why this whole hullabaloo is going on. And if there are fewer women and you hire more women because you want more women, the women on average will be less qualified than the men that you pick. But you'll clearly pick your women from the top of the women and your men from the top of the men, and if there are more men than women you'll have more men than women.

*Maybe I don't want a balanced department. Maybe I want a diverse department where people have many different kinds of skills.*

Why are you saying that having women is more important for diversity than having, say, a variety of very well-developed mathematical talent? If you look at the qualified pool of men and women, you want the proportion of women in your department to be the same as the proportion of women in this pool.

*No, I might want the proportion of women in the department to reflect the number of my female undergraduate math majors.*

Why?

*Because maybe in my department I want to contribute to the general trend of more and more women doing mathematics.*

I might turn around your argument and apply it to psychology. Why aren't you pushing to hire more men in psychology?

*At some point I might. If it were 75 percent women, I might try to get more men.*

Why? Are you saying that female students relate less well to male professors and that you need the same number of male and female professors?

*I think there's some truth to that. I think women undergraduates would, for whatever reasons, look on a math department that has more women in it more favorably than they would on a department that was entirely men.*

I frankly don't notice. That's the last element on my list in a field where things are as measurable as they are in math.

*What if I want a department where people lead somewhat more sensible lives -- where people can take time off in their 20s and 30s to have children to demonstrate to their students that professors can still have a full life?*

I think that people pay too much attention to gender and not enough attention to intellectual qualifications. I think more things should be done gender blind.

*You could very well be right. I don't know for sure if my arguments are correct. But I've certainly enjoyed talking about this with you.*

I think that not enough attention is being given to making more people in general -- not just girls -- more interested in math. If you attracted more people to math, you'd get more girls as well.

*Are you a math major?*

Not yet. I'm math and computer science at the moment, but I'm changing back to just math. I'm done with all of my requirements this semester, except for my thesis, and it's really hard to do a math and computer science thesis, which is what I'd have to do for a joint major in math and computer science.

**Mark Lipson** grew up in Lexington, Massachusetts, where he attended Diamond Middle School and Lexington High School. He attended MOP in 2001, 2002, and 2003 and was on the U.S. IMO team in 2003. This year, as a sophomore, he earned an honorable mention on the Putnam.

*When did you start doing math that wasn't part of the regular curriculum?*

It was in sixth grade, when I got to middle school. There was a math team there that I joined right away. I had some interest in math beforehand, or I wouldn't have jumped right into it. But before that I didn't really have any extracurricular materials I could use.

Every month or two we had a meet with other schools. Also, everyone in our school took the first round of Mathcounts. Having been on the math team I was very aware of Mathcounts and had practiced for it. In middle school Mathcounts was obviously the big thing, but it wasn't the only thing.

*I've never heard of a school where everyone in the school did the school round of Mathcounts.*

The coach at the middle school was a very good teacher and he had some sort of clout, so he was able to convince everyone that this is a good thing for everyone to do. He takes one or two class periods to do the competition.

*What's his name?*

Vaag Mosca, at Diamond Middle School. I think he's often the coach of the Massachusetts Mathcounts team.

*Did you do well in the competition right away in middle school?*

Pretty much. Even in the sixth grade I was in a seventh grade class, so I took the school round with everyone else. I wasn't eligible to be on the school team [this rule was later changed], but I think I was fourth or fifth in the school in sixth grade, and first or second in seventh grade.

*Were you on the Massachusetts team that year?*

Seventh grade I didn't make it, which was very disappointing, but in eighth grade I was. In seventh grade, I think the team was second nationally, and we won when I was in eighth grade, so it was a very strong team.

*Were you in the top ten at nationals and in the Countdown round?*

Yeah, we even had a Countdown round in school to determine the school team. Lots of people came down to the auditorium and watched the Countdown round. The whole school didn't watch, but a lot of people did.

I had mixed experiences with the Countdown round. Somehow I got worse with age. I always sort of liked it because I was good at it. In seventh grade, when I didn't make the state team, I was like seventh in the written competition, but I was second in the Countdown round, to Ricky Liu [who was the top Mathcounts finisher in 1998]. So it was always a strength for me.

Then when we got to nationals I was in third going into the Countdown round, and I got bumped down to fourth, which kind of sucked. I don't remember that very fondly.

*Did you have any negative experiences with mathematics in middle school, the kind of thing that might have driven you or your friends away from math?*

Nothing really comes to mind. Most of the people who did well in math in middle school were people who were on the math team in high school. I remember it pretty fondly.

*Were your experiences in high school that good?*

My experiences with classes weren't as good. In ninth grade I was in a tenth grade geometry class, which I didn't particularly like, though probably for different reasons than other people who didn't like it. Then in tenth grade I took calculus, and that was it for classes.

After that, there were a fair number of people in my school who were ahead, and a number of them came here to Cambridge and took multivariable calculus and linear algebra at the Harvard extension school. That's a tried and true strategy.

I actually didn't do that. I did independent studies both years with an advisor who was a grad student. I learned some extra geometry and some inequalities and combinatorics-type things, and also I did problems, including some Olympiad problems.

My junior year was fairly problem oriented, and then my senior year I did advanced things, like complex analysis. The school didn't have the resources to do this, so we have a friend of the family named John Weinstein who was on the IMO team in 1994, the team that got the perfect score. He was an MIT graduate student then, so I would come in once a week and work with him.

*Did that work well?*

It wasn't essential to my problem solving preparation. It was pretty low key.

*Is it the case that people on IMO teams pretty much have their pick of colleges in the country?*

Pretty much.

*Do you know why so many IMO people go to Harvard? For instance, hardly anyone ever goes to Yale?*

It goes up and down. For me, it's a bit different, because I grew up around here. So I sort of eliminated other places that I might have been interested in.

I knew that a lot of people who had been to MOP had gone to Harvard, so that was something of an endorsement. I also knew that I'd know a lot of people here. I never did give much thought to the strength of the math department.

Not all the math concentrators that I know here like Harvard because of the humanities classes. That can make a difference in deciding between here and MIT. But I liked the academic diversity and also thought that the student body was appealing.

The way I look at it is that Yale would be very much like Harvard, and I would rather be close to home. I know maybe one person from MOP who has ever gone to Yale in my whole time there.

*Do they encourage you to do the Putnam here, and do you prepare for it?*

No, there's no preparation. It's not a huge priority here. For one thing, there's an attitude that we'll just win, so we don't need to emphasize it. I guess it's a combination of assuming that people are busy and a sort of amateur spirit -- we won't prepare but we'll just do it and still do well.

I don't really talk to people about it, but I doubt people prepare much. I mean, this year I looked at a few old Putnam problems, and thought about it in the shower a little, but that's about it.

*Do you think your high school could have offered you something that would have been better than what you did?*

Maybe if the high school had some sort of more advanced class. Even if they just had a geometry 2 class that had some combinatorics, for example, or if they had some sort of problem-solving type class. One of our big math team rivals was Canton, and I think they had a for-credit class where you learn things relevant to problem solving. That would have been nice, especially if it were geared toward Olympiad-type problems. Of course, it would need people who were committed to math. If you're only talking about

10 or 15 kids in the whole school, it's hard to justify. And that particular group of people doesn't really need to be encouraged to do math -- they'll do it anyway.

*Are you a math concentrator?*

Yes. I wasn't sure when I got here whether or not I was going to do math. I looked around a bit. I don't really know where I'm going, and I know even less about what I'm going to do afterwards. I really like problem solving and math team and that kind of stuff, but the classes we have here have a different feel.

For now I'm happy enough concentrating in math. I need about one more semester to finish my requirements. They're not particularly onerous.

**Gabriel Carroll** grew up in Oakland, California, where he attended Claremont Middle School and Oakland Technical High School. He went to MOP after ninth, tenth, and twelfth grades and to RSI the summer after eleventh grade. He took the Putnam at Berkeley when he was a senior in high school and became a Putnam fellow. He then was a Putnam fellow for the next three years while at Harvard, becoming just the fifth person in the history of the exam to be a Putnam fellow for four straight years.

*When we talked during the 2001 Olympiad, you said that you felt you hadn't gotten much support for doing math from the public schools in Oakland.*

I may have felt that at the time, but I actually had a large number of opportunities for involvement outside the classroom living in the Bay area. The East Bay high schools had little local meets that they organized every month, and my school participated in the AMC stuff, and we had the Bay Area Mathematical Olympiad and the Bay Area Math Meet that Paul Zeitz organized at the University of San Francisco.

*What about opportunities in middle school?*

In middle school I didn't think of myself as especially inclined toward mathematics. Actually, I had done quite a bit of mathematics, but I didn't realize it.

*Had you done lots of mathematics in elementary school?*

It's all kind of blurry. I remember that my dad tried to teach me calculus when I was in fourth grade. He got me a textbook that was basically divided into half pages, each of which contained either an explanation or a problem. I learned how to execute the mechanical operations, like how to take derivatives, pretty well, but I didn't really understand what was going on until later.

I went to a private school from prekindergarten through fourth grade. My family had spent a year in France when I was two and they wanted me to continue speaking French after returning, so this was a bilingual French-American school. Then, for various reasons, that wasn't feasible after a certain point, so I went to a local public school in fifth and sixth grade.

*Tell me a bit more about the mathematical environment you encountered in high school.*

People there were extremely supportive. The curriculum only ran up through calculus BC, so I took that in ninth grade. But after that the calculus teacher was very helpful. He was more than happy to help administer all the competitions I was interested in participating in or having other people participate in. He drove us to the meets, and some of the other teachers, like English and physics teachers, did too. I think he also

made me aware of the current enrollment program for taking classes at UC-Berkeley. We had a supportive administrative structure at the high school.

*How did you get through geometry, algebra 1, algebra 2, and precalculus in middle school?*

I don't really know. I think I had absorbed a lot of it studying at home, sort of informally. My parents taught me random things when I was young and got me textbooks in various subjects. I didn't go through high school textbooks. And of course I learned stuff from like taking the AHSME. I don't remember having a geometry textbook. Wait, that's not true, I did take geometry in eighth grade, with a couple of classmates in middle school. We went to Oakland Tech, so I took geometry classes there. The ensuing classes I guess I just sort of acquired.

In ninth grade I was placed into precalculus, and the precalculus teacher was the same guy as the calculus teacher. We had met the previous year through some of the competitive events, and he said I don't know if you should be in this class. Let me give you a calculus diagnostic test and see how you do. And it was clear that I should be taking calculus.

*So when did you first take the AMC 12?*

In the eighth grade. I don't believe that our middle school administered the AJHSME.

*And when was the first year that you took the AIME?*

Also eighth grade.

*And when did you take the USAMO?*

Also eighth grade. At that point I figured out that something was going here. I was doing well enough that I should keep it up.

*How were you ever able to qualify for the USAMO in the eighth grade? That seems impossible.*

I don't know exactly how it works, but I think they are more generous to younger students. They say, "We'll take people with a certain combined AMC 12 and AIME score, and we'll have a certain number of further slots for people who are in tenth grade and below." I don't remember if there was such a criterion for eighth grade.

*Did the Berkeley math circle play a big role in the mathematics you did in high school?*

You could say that. I think that things would largely have turned out the same if the circle had not been there. But it kept me involved and gave me something to do. I definitely learned some things in the math circle that I would not have encountered elsewhere. I'd say it is functionally similar to a competition, or like *Quantum* magazine, which is now sadly defunct. You cover topics that are accessible to advanced high school student but outside the regular curriculum, and you do so in more of a lecture format than just reading through a book of contests.

It also was a social outlet. I had a lot of friends who became involved in the math circle who were fellow Moppers. We hung out each Sunday afterwards for a while.

The math circle draws from a very large area, so there were people from the South Bay and also from Davis. There were people like Austin Shapiro from Davis -- he took the train every Sunday and then walked 45 minutes from the train station up to campus. And Tiankai [Liu] also was involved -- that's how I met him.

*Was the mathematics you began doing at Harvard a departure from the kinds of things you were doing in high school?*

It's difficult to make comparisons. At some point the competitions run out, and one outgrows them in any case. When I came to college there was the Putnam and not much of anything else. There is a mathematical modeling contest, and there is also an international competition that not many American universities participate in, though a lot of schools in Europe participate.

The other thing is that the mathematics itself gets more advanced, the style is different, and competition is not really appropriate for learning material past a certain point. Research is really what is relevant. I knew that, so I participated in a number of research projects while I was here. I was involved in a program called REACH -- that is, Research Experiences in Algebraic Combinatorics at Harvard. I was involved in that for three semesters.

More recently I've been involved with a research project with the program in evolutionary dynamics, which is a new joint venture of the math and evolutionary biology departments. Mathematical biology is a very new and open field, so we have no idea whether we'll be able to say anything relevant and the models I've been working on are very primitive. But it's still exciting.

*Did you do the Putnam in high school as part of the math circle?*

Not separately. I just sort of showed up for it. I had been planning to take it because I'd taken practice Putnam exams in the course of my USAMO training, and I said I might as well participate in this now because I'm not likely to get any better and at some point during college I might have something else to do that weekend. I had missed

the signup deadline in October, so I just walked in on the exam. Naturally they had some extra exams for people who had signed up and weren't there, so I took one.

*And you were a Putnam fellow that year, as a high school senior?*

Yup.

*Had there been other high school students who had been Putnam fellows?*

I don't know. Somebody gave me the answer to that question once but I've forgotten it, because I tend not to be too interested in that kind of trivia.

*Did you do anything to prepare for the Putnam in the years you were taking it?*

Each year I did a few practice problems over the course of the preceding week, but not much more.

*What do you plan to do with your math major?*

I'm actually a joint mathematics and linguistics [major]. We have these joint concentrations where you take some number of courses in each area and then write a thesis that combines the two. Because of the nature of the requirements I did all of the math major but just half of the linguistics major.

*How do you think you'll apply this unusual background that you've acquired over the past four years?*

Over the past few years I've been getting disenchanted with academic mathematics, or with the academic world in general. Partly it's itchy feet, because I've been in school for a long time. Partly I look at people who are doing very abstruse and esoteric things and ask why anyone should care. I've been feeling that I should do something more socially relevant, so I've been thinking about going into economics or perhaps statistics -- something that uses math skills but is not pure math.

It was a bit odd for me to go in that direction, because there's a bit of snobbery among mathematicians. When I was in high school at the USAMO awards, the representatives of all the sponsors were there, and a number of them were organizations like actuarial associations or the American Statistical Association. I remember thinking, "Do they really think that they'll manage to convert me." Now I understand.

I don't know exactly what I'm going to be doing. The time to apply to graduate schools rolled around and I thought, "I don't know exactly what area I want to apply to,

let alone where.” So next year I’m going to China to teach English for a year. Hopefully by the same time next year I’ll have a clue what I want to do afterwards.

At this point I need to do more thinking than talking, figuring out where my own priorities are. I’ve done some things in the past. For example, a lot of people with a problem solving background go into finance, so I worked last summer at D.E. Shaw, a hedge fund that hires a number of past IMO and Putnam winners. They pay well, and I had a great time there. Some of the work I did there was interesting, some was not so interesting. But in the end I said, “What am I doing? I’m just sitting here making money out of thin air. Can’t I do something more useful?”

I’ve gotten the feeling that what I’ve done has been a product of the specific opportunities that happened to be available to me. It doesn’t follow that it is necessarily the most productive or the best thing for me to be doing.

In view of the difficulty of predicting one’s own future, I don’t feel that bad about not knowing where I’m going right now.

*Have you encountered any resistance from your friends about not going to graduate school right away?*

Actually I haven’t. Something that I’ve discovered over the past four years is how many people take time off before college or during or immediately after. I had thought about applying to the Peace Corp, and I discovered that most of their volunteers are older -- the average age is 29. So people do this over the entire course of their lives. Sometimes people need to do something different for a while and get some perspective. I didn’t think that that was going to happen to me, but it did.

## Interviews at Stanford

**Shaowei Lin** grew up in Singapore. He was on the Singapore IMO teams that competed in Argentina in 1997, in Taiwan in 1998 and in Romania in 1999. This year, as a junior, he was on the Stanford team that finished with an honorable mention in the Putnam.

*Do students in Singapore begin doing mathematics competitions about the same time as students here?*

I think I started on competition mathematics when I was in grade six. In Singapore there's a famous competition for elementary school students. Back then, I knew that I liked math, but I didn't know that I was good at it. So my math teacher put together a math team, and I wasn't on the math team at first. But she came to me and said, "You know, maybe you want to take this competition for fun, and you can train for the math team." I went for the training and did all the problems and when I went for the competition I came out second.

*In all of Singapore?*

Yes. It's a primary school math Olympiad. Then, when I went to middle school, I started to do more competition math, and that got me into this national math training team that brings in people who are in the eighth grade and starts training them for the international math Olympiad. I joined that group in the ninth grade, and the year after that there was a selection test for the international team, and somehow I got onto the team that year. I was in the tenth grade -- that was the 1997 IMO, which was held in Argentina.

At that point, I wasn't sure that I was good enough to be on the team. I've always been interested in math, but I didn't think I was good enough to be on the national team. So when I got in that year I went to the professor and said, "You must have made a mistake, you must have graded some of my problems wrong, because there are obviously a lot of people better than me." He said, "No, you got in fair and square, and you should enjoy your opportunity." That was very encouraging for me.

After that I went on to do the IMOs in 1998 and 1999.

*What kinds of preparation did you do for competitions?*

The national training team is organized by the national university in Singapore, so they look for kids who are interested in math at a very young age. They start teaching them things like the pigeonhole principle and other problem-solving techniques, and encourage them to do problem solving. We typically spend three hours every Saturday doing the training.

*How many kids do the training?*

Typically you have 10 to 15 people from each grade. It might be 50 or 60 people altogether, but not everyone comes. On a typical Saturday you might see 20 or 30 people at the training.

Actually, a lot more of the real training goes on in the schools themselves. In Singapore we have a couple of schools that are well known for having the best math team, so the teachers at these schools give their students tougher problems to solve and encourage them to go for the national training sessions. I think the teachers in these schools did a lot more to help the students in terms of encouraging them.

*How many boys as opposed to girls attend the training camp?*

It's mostly boys. I think it's about one to eight right now. There have been more girls in recent years. I'm not really sure why there is an increasing trend for girls. I know a couple of girls from my age group who are really really good at math, but some of them went into other areas because they saw math as a very guy thing. But in recent years, girls are more open to it. I think it's that the research culture is growing in Singapore and the government is trying to promote the idea that girls can do research, too.

*Have there been any girls on Singapore's IMO team?*

In 2000, 2003, and 2004 there was a girl on the team. Before 2000 I think there was only one other girl who had been on an IMO team.

*How do you get into the schools in Singapore that focus on math and science?*

In grade six we have a national examination, and after that you get to pick the middle school of your choice. Your success in getting the school of your choice will depend on your performance in the examination.

*How much do those schools focus on math and science as opposed to other subjects?*

The school system in Singapore is very different than the U.S. system. I don't know if you're familiar with the British system. There are six years of elementary school, four years of middle school, and two years of high school. The elementary school is the primary school, the middle school is the secondary school, and the two years of high school is called junior college.

In junior college you don't really get to choose what classes you want to take. You just say, for instance, that you're interested in geography, and they plan out a whole

syllabus for you. You go to your geography class and they teach you everything you need to know about the subject.

In the United States you get to choose if you want to do algebra or geometry. But in Singapore you just say, "Okay, I want to do math," and they teach you a standard package. In high school I took the basic math course that everyone has to take, and then I took further mathematics where they teach you more calculus. By twelfth grade we had done as much as AP calculus covers, but not much more than that.

*Are there things that you didn't like about that approach to education?*

One problem is that they're pretty inflexible about what you have to take. For example, if you say you're interested in math, you're pretty much locked into that package. You couldn't say, "Okay, I think I know this area very well, I'd like to drop out of it." There are also situations when you would want to take more advanced classes but they don't offer that. You have to do that on your own, so that's one inflexibility.

Another problem is that when you go for training at the national university you don't get credit for it. In Singapore the education system is very competitive, and not just in terms of grades. You have to get involved in a lot of activity clubs to show that you have initiative or to show your leadership skills. When you go to the university, or out into the workforce, that's what they look at. So a lot of students who are interested in math actually give up after a while because it doesn't pay off in terms of what you see on your transcript.

*Did you ever feel that you were hurting your prospects by doing lots of mathematics?*

I think I was more fortunate. There were other people who were really good at math, but because they did badly on one test, they didn't get in. You only get recognized if you're on the IMO team itself. They don't really recognize your participation in the training camp as an accomplishment. So for me it wasn't really a question of whether I should spend more time on it, because I was on the team and I would get recognition for it.

*What did you do right after high school?*

I did two and a half years of military service. In Singapore it's compulsory for all men to do that. I graduated in December 1999 and started my service in January, so I finished my service in May 2002. Right after that, in September 2002, I came to Stanford, and now it's 2005 and I'm a junior.

In Singapore, they allow students to go straight to university after high school and do their military service after they're done. But you have to take a special scholarship to do that. The rest of us who decide not to take that scholarship do it the other way around.

*Did you apply to other colleges in the United States?*

No, I only applied to Stanford. When I finished high school, I was pretty sure that I wanted to do research. But all of the scholarships in Singapore are non-research scholarships. So the only way I was going to be able to do research was if I did my undergraduate studies in Singapore and then come here for grad school.

I was prepared to stay in Singapore. Then, after my first year in the military, I decided to try applying to Stanford and MIT to see whether I was accepted. Stanford accepted me and MIT rejected me.

The next year they came up with a new scholarship in Singapore for research. That's when I took the chance and decided to go to Stanford. They sponsor you for your undergraduate studies and until you get your Ph.D. They give you a monthly allowance, sort of like a salary, on top of the funding that you get for your research.

I was one of the first groups of people with that scholarship. Today they're still in a very experimental stage. Singapore is trying to move more into research, and they're investing a lot of money into research scholarships.

It changes things for high school. I said that it was really important to have leadership activities on your resume, because all of the scholarships were for leadership positions in the government. But now that Singapore is placing emphasis on research, more people are interested in taking part in math training.

*Do a lot of people go to different countries for college?*

A lot of people do go to other countries. I think for my high school, out of 600 students, maybe 100 are overseas. They are very liberal with scholarships in Singapore. I'm on a scholarship myself. I have to go back to Singapore and work for them for six years. It can be a good system, because there are a lot of kids who are pretty poor in Singapore, and it's very expensive to go overseas. But it can be bad because, as I was saying, it can be very competitive.

*What have you found the math program at Stanford to be like?*

There are more math majors than people expect here. The math major is one of the easiest things to get, so you have physics majors or electrical engineering majors and they realize that they have more than enough credits to get a math minor or a math major. So there are plenty of math majors, but there are fewer people who are more serious about math.

The program here tries to emphasize a broad base as an undergraduate. You have to take requirements in algebra and analysis and topology, and once you have taken the basic requirements there is a lot of freedom to do what you want, like taking graduate classes or classes in physics or engineering.

Also, there is an honors calculus class here where the professors have a lot of liberty in choosing what they want to teach. I think they do very well in preparing the students to think more mathematically. After that, the professors encourage you to take

more difficult classes, even though you may not have the prerequisites for it. They're very liberal about you challenging yourself and trying to stretch yourself. That's a really good aspect of the math degree here.

*Do you have a sense of how the math department is viewed by other Stanford undergraduates?*

It's viewed as a small department. The large departments here are the electrical engineering department and the computer science department, and maybe the human biology department. Math is seen as something you have to go through during your freshman year. Each year we have only something like eight to ten honors students.

*Are there drawbacks to being a math major at Stanford?*

Only that your friends sometimes make fun of you because they think math should be your minor. When you tell people you're doing pure math, they say, "That's all?"

I really like the department here. One of the criticisms that people have of the department is that it's not as large as elsewhere. For instance, we don't have a focus on combinatorics or even on number theory. We have professors focused on analysis, geometry, and topology.

In general, I like the culture of the faculty members and the culture of the students at Stanford. They're very helpful to each other. You see each other and do problem solving together. You enjoy spending time together. And the faculty is very open and helpful in telling you what courses to take and encouraging you to take harder courses.

*Does the faculty help you prepare for the Putnam?*

We have informal sessions in the fall quarter every week to have pizza and do problems. Professor Ravi Vakil is the mastermind behind the training. He gives us problems to solve and organizes people who are interested in problem solving in general, and then he has an additional session for people who are more serious about the Putnam. He calls it a master class.

Professor Vakil is not so interested in how people are ranked. He's more interested in how many people participate in the competition. I think that's a good way of trying to get more people involved. Even if someone does really bad, that doesn't mean he's bad at math itself. That takes all the tension away.

I'm guessing 70 people take the exam here. A lot of the students take it who aren't even math majors -- I guess they do it just for fun and the pizza.

*Are you taking more advanced classes this year?*

I actually took more advanced classes last year. This year I'm concentrating on my thesis. Taking those classes was good, because sometimes you start to think that you know most everything there is to know in math, and taking those classes makes you realize that all you know is a tiny drop.

*Does everyone do a thesis?*

No, it's only for people who are doing honors in math. I'm doing something on topology and geometry. It's in an area of math called symplectic geometry. It comes up in string theory and other areas, so people are interested in finding out more about this type of geometry.

*Are you applying for graduate schools right now?*

I'll be applying this year when I'm back in Singapore. I'm actually graduating this year because of the way my schedule worked back in Singapore. I'm going to take a year off between undergrad and graduate school.

*What does Singapore want you to do when you go back?*

Most likely work in industry. They are trying to centralize a lot of the research that goes on, trying to make the research available to industry, so there are institutes that do, say, research into chemistry, or computers, or microbiology. They'll hope that I work in one of these institutes when I go back.

*After people have fulfilled their obligations to the government, do they end up staying in Singapore, or do they leave the country?*

Most people end up staying in Singapore. Among the people who have studied overseas, a percentage decide that they want to work in the United States or Europe. But most people want to stay, because of family and friends.

*Are you planning to do math research?*

If you're talking about pure math research versus applied math research, I used to be pretty certain about being a "purist." Right now, I'm undecided.

**Andrew Lutomirski** grew up in Los Angeles, California. He went to Harvard-Westlake Middle School in Beverly Hills and to Harvard-Westlake High School in North Hollywood. In 2001 he represented the United States at the International Physics Olympiad in Turkey, receiving a gold medal. He received an honorable mention on the Putnam this year.

*How did you get started doing competitive mathematics?*

I started in seventh grade with Mathcounts. Our school had a Mathcounts program and tried to get people to show up. I was thinking that I knew nothing about this, but I'll show up. So I came to Mathcounts. We practiced every Thursday afternoon.

*Who organized this activity?*

Two teachers in the school. They'd been doing it every year for a long time.

Both years I was on the school's main team. We did okay in the seventh grade and really well in the eighth grade. In eighth grade, members of our team took fourth, fifth, and sixth in the state, and hundredth or something, so we came in second overall.

I went to the national competition in the eighth grade. I also did the AHSME every year -- it's the AMC now. And I did ARML, with the North Hollywood High team, because my school didn't have a team. We went to Las Vegas for that a couple of times.

But I didn't do that many competitions. It was that and the AMCs every year in high school. I did the AIME four times and the USAMO once.

*Did you go to any summer programs in math?*

Never. Well, I did a Center for Talented Youth program in mathematics.

*Did you do these competitions as part of your regular math classes?*

Well, I was sort of off the regular math track. But in our high school classes we did some of the smaller contests -- SIGMA and Mandelbrot. The Mathcounts teachers were my high school teachers, because we didn't move to the upper school until tenth grade.

I took calculus in the ninth grade, before I moved up. It wasn't an official acceleration program. It was accomplished more by bugging people until they gave in. I tried to test out of algebra 1, which you're not supposed to be able to do in seventh grade. I failed miserably. It was the worst test I'd ever taken. So I took algebra 1 after all. Then, they let me skip algebra 2 and go into geometry in the eighth grade, which put me in line for precalc in ninth grade. After much bugging, they let me do precalc and calc in

the same year. It was a three-person class in precalc and a four-person class in calc, because neither one is normally offered at the middle school.

*So you had other people going through the same track with you?*

Yeah, the same people who did really well in Mathcounts in eighth grade. In the upper school, most of what we did was out of class. But in eleventh grade I took what was then called linear algebra and mathematics competition.

I wasn't a huge fan. It was taught out of the Zeitz book, mostly, and we did a lot of competitions.

*Why didn't it work?*

The class was too big, for one thing. This was the only post-calculus class offered. Also, a lot of the people were lazy. People had senioritis at that point.

It was okay, it just wasn't great. Now I think they're changing it around a bit, to a directed study or differential equations thing.

*How many kids were in that class?*

Fifteen or eighteen.

*When did you do the USAMO?*

In eleventh grade. I didn't make it in the twelfth grade. In the eleventh grade I did the physics Olympiad, too, which takes up very little time during the school year. It picks up during the summer.

*What did you do in the twelfth grade for math?*

Directed study in differential equations and multivariable calculus. It was a class that met twice a week. We didn't really do homework. We just learned stuff. We covered more than math 53H covered here. It's sort of sad. It was me and two other people. Andrew Schwartz, who lives across the hall from me now, is someone who did all of these things with me. He was up there in the rankings on the Putnam last year, but he couldn't make the contest this year.

*Did you have any negative experiences in high school that might have made you less likely to pursue mathematics?*

I'm sure people gave people a hard time, but I didn't really care. Class was always fun. It was always an enjoyable class. And the teachers were excellent, spectacular.

*How big is the school?*

It's about 250 per class, so it's decently large. The classes grow slightly, because they admit a few new people every year.

*Was math a factor in your decisions about where to apply?*

No, because at that point I was largely interested in physics, and math to some extent. Harvard, almost without a doubt, has the most rigorous math program for freshmen. Harvard has math 55, which is insane, masochistic, and would have been great fun. That was actually a big draw. But their engineering department wasn't so exciting.

MIT's math program is much less exciting for freshman. It's pretty much normal math. Here we have the 50H's. That's the advanced honors sequence for freshman. The first two quarters, as far as I can tell, are pretty much whatever the professor wants to teach. I'm sure there's some structure, because people learn similar things. We had professor Eliashberg, who's excellent. It was kind of insane, it moved really fast.

*Was this class like math 55?*

I think it was probably a narrower focus. We did 51H, which was a lot of multivariable, a lot of linear algebra, a lot of linear transformations, determinants, things like that, but in great depth. 52H was differential forms, which is one of the neatest things ever.

*Did you have any trouble with that introductory course? People in some other places have cited that as a problem.*

I think a big issue is the ability to get the students out of the course who shouldn't be in it. What happens is that the class is taught downstairs in the big lecture hall, and the first day it's standing room only, probably 180 kids altogether. Everyone says, "Well, it's the honors math class, I should take it." Then the professor shows up five minutes late, and he comes up in his Russian accent and says, "So, I am Professor Eliashberg. Tomorrow, there will be empty seats." And then he launches into this unbelievable lecture. I think I might have followed half of it, and that's only because I'd seen the material before. It was scary. The next day, sure enough, there're a couple of empty seats. He does it again the second day. By the third day the class is down to a reasonable size. Then he says, "Now, we will start over." He literally spent two days scaring people out of the class.

*Did it work?*

Absolutely. Otherwise he would be failing half the class. I mean, we have the 50s sequence without the H, which is the normal advanced math sequence, which is probably equivalent to MIT's sequence, or Harvard's 20s, or everyone else's math sequence. That's where most people go, and I'm sure it's a great sequence. But that course is taught out of a textbook, whereas the course we took is taught out of one of those scary little green math books.

*How many people were left in that class after he scared everyone away?*

There still had to be at least 80. And people worked hard. I think most of those 80 people struggled. I worked hard for that class. But everyone makes it through. He doesn't expect everyone to get everything in that class, because that's not possible.

*Is there an obvious track after you take those courses? For example, what did you take sophomore year?*

I looked at the schedule and said, well, Professor Eliashberg is teaching 174A and B, which are honors analysis, so I took them. It was more crazy classes, like Hamiltonians from the mathematical point of view. None of this had anything to do with math contests. It was just fun.

I mean, I'm not a math major here.

*You're not?*

No, I'm a physics major and starting my masters in electrical engineering. There's a program at Stanford called the coterminal masters program, and you can apply once you have 120 units. Then you become a masters student at the same time that you're a bachelors students. You have two transcripts and take classes for either one.

*When will you graduate?*

I'm not sure yet. I could have graduated last quarter in physics. At this point I'm sticking around, having fun.

*Did you take any other math classes after your sophomore year?*

I took Philosophy 160B, which is incompleteness and logic, Gödel's theorem and the stuff that followed it. It's taught in the philosophy department, but it's definitely a math class. The logic sequence here is extremely rigorous.

Then I took CS 103X, which is discrete math in the computer science department. Now I'm taking elementary number theory, just for fun, with Professor Bump. We're covering some stuff that's comprehensible and some stuff that's extremely arcane in that class.

*Were you planning to be a math major when you came here?*

Oh no, not at all. I was thinking about physics or maybe computer science or some sort of engineering.

But the math department here is great. I've liked all of the classes I've taken. I've always felt that the caliber of the students in the math department has been amazing. Everyone who takes any form of advanced math here knows what they're doing.

*Is competing in the Putnam emphasized here?*

Ravi does an incredible job with it. He puts fliers everywhere, gets the word out to all the incoming nerds, and makes it fun. He'll bring Pizza Chicago, which is probably the best pizza place in the area. He'll load up the table outside this room with pizza. He gets someone to lecture for a bit about something relevant to the Putnam. Then people go out and work on practice problems.

I swear that the pizza is what keeps people coming, because the dining hall food is pretty bad. You can come here on Monday or Tuesday night and get good food and have fun doing math. That's how he trains people.

There's also this thing called the master class, where you stay a bit late. That's where people present things that they find interesting.

There might be 40 or 50 people who come for the training sessions. I don't know what kind of training he does for the top people, since I've never been one of them.

*Is it expected that math majors will sit for the exam?*

No, it's entirely optional. Professors will announce it, but nobody will say, "You should take the Putnam." They'll say, "It's fun, do it." Actually it's pretty bad for us, because it falls right before finals.

*Have you ever considered not taking it because of finals?*

No. I don't care about the finals.

*Do you have a sense of how the math department here at Stanford is viewed?*

I know that the electrical engineering people, and the engineering people in general, often teach their own versions of the math classes. So we have the 50s sequence, which is a lot of theory and some practice. And then there's the engineering version, which is pretty much all practice, taught in the engineering department.

It's a fairly easy major. It's extremely doable in three years. If you come in with APs and take the 50s sequence, you're halfway done.

*What are your plans when you leave here?*

I don't really know. I used to think that I would go for a Ph.D. in physics or some kind of engineering. But now I'm thinking that I might go into industry for a while, do something productive, and maybe come back for Ph.D. It's hard to say. I'll have a Stanford electrical engineering degree, which is worth something. And I'm working at Google this summer as an intern. There's plenty of stuff to do in this area. At this point I feel that I want to get my hands dirty.

**Robert Hough** grew up in Midland, Michigan, where he attended Jefferson Middle School and Dow High School. He was the top finisher in the Michigan Mathematics Prize Competition and attended MOP in 2002. This year, as a sophomore at Stanford, he received an honorable mention on the 2004 Putnam.

*Where are you from?*

I'm from Midland, Michigan. It's right in the middle of the state. I guess the most notable feature of the town is that it's the corporate headquarters for Dow Chemical.

*Did you become interested in mathematics through your school?*

I wouldn't say that my school is particularly strong. I took classes on the side at place called the Indus Center for Academic Excellence in Detroit. It's about 100 minutes driving from my house. I'd go once a week, on weekends. I went once or twice in sixth grade, and then I started going regularly in eighth grade.

A guy in Detroit started it. Originally I think it was just his son and a handful of other kids at the local high school, and he would hold practices in his basement. Then more and more people started joining, and they started offering a wider range of classes and moved into a separate building.

The classes were definitely geared toward competitions. The teacher would give lectures on selected topics, but they were always relevant to competition problems. His name is Raghunath Khetan.

*How did you find out about this?*

My brother is also into math. He's a grad student at Berkeley now. He started going to the classes before I did. And he heard about it from a friend.

*Were you interested in going, or did your parents or a teacher suggest it?*

It was more us than our parents or a teacher. I don't think the teachers knew about it.

*Is that how you started doing competitive math?*

I was in Mathcounts before that. In seventh grade, we were like fourth in the state, and in eighth grade we were twelfth. I was on the Michigan state team that year.

*Were you going to the Indus Center to prepare for Mathcounts?*

Somewhat, but it was more of a general class. There was a middle school and a high school class. Dr. Khetan offered it at both levels.

*Was it unusual for you to go all the way to Detroit to take these classes?*

I guess there were two or three or four other kids from Midland who were going down, too. But they were all a year or two older than me.

*Did you keep doing competitions in high school?*

Yeah, a whole bunch. Michigan has a state competition called the Michigan Math Prize Competition, and I took that. I also took the national competitions like AHSME, AIME, and the USAMO.

*Did you go to MOP any of those years?*

I went to MOP the year they took everyone who took the USAMO. That was my junior year. Senior year I didn't go. I learned a lot there, but I think a lot of people didn't.

*At your high school did you have a teacher who organized the competitions?*

Not really. I did take the AIME tests at my high school -- there was a teacher running that.

*Did you do other things besides math?*

I like to play sports and stuff -- rec sports at the community center. But I don't play anything seriously.

*What brought you to Stanford?*

Probably if my brother hadn't been at Berkeley, I would have gone to the East Coast. I applied to MIT, Caltech, Stanford, and Michigan.

*Do you think it was a good decision to come here?*

The math department here is pretty small. I don't know if it makes a great deal of difference at an undergraduate level. But I'm kind of interested in discrete math, and they don't have a lot of classes in that here. I wasn't really sure what area I was going to get interested in while I was in high school.

Also, the CS department here is really good, and that's another reason I looked at Stanford.

*Are you taking computer science courses?*

Yeah, I'm planning on cotermining in CS, so I'll get a CS masters degree at the same time as my math degree.

*Doesn't that require taking a lot of classes?*

The math major isn't that hard. I'm basically done with it. I needed something else to do, so I said I'd do CS.

*What are you planning to do with those degrees?*

I'm still planning to go to math grad school. I don't know whether this is true or not, but there's probably more money in CS than there is in math. I thought I would take classes in CS, so that if I want to work in industry at some point I would have that background. I'm not sure that I want to be a math professor, and I figured that I would be more hireable if I could prove that my background in theoretical math has applications.

*Have you had negative experiences being a math major here at Stanford?*

I was thinking about this a while ago. A lot of the people I know are not too into math. You can feel like you're kind of all alone. A lot of people who are really interested in math go to MIT and Harvard. But more are going to Stanford now -- they've been building up the program here.

*How about in high school or middle school? Were there things about your experiences there that you wish had been different?*

I don't know. I guess I didn't have a lot of support from the school system to do math. But it turned out okay.

I was sort of the last one [who did advanced math from Midland]. A kid from Midland who was two years older than me won a gold medal at the International Chemistry Olympiad, but that was about it.

## Interviews at Berkeley

**Vedran Sohinger** grew up in Zagreb, Croatia. He was a member of the Croatian IMO team in 2001 and 2002. A junior at Berkeley this year, he was on the Putnam team that won an honorable mention in the 2004 competition.

*How did you get started in contest math in Croatia?*

I started out with elementary school contests. I had a really good teacher in elementary school. In Croatia, up to eighth grade is elementary school, and then you have four years of high school. I wasn't the best there, but I continued doing it through high school.

The IMO was something that everyone always wanted to do, and it seemed like it would be a very exciting experience. We had a very good thing in Croatia, in that we had university students who had taken the IMO who would come teach us in high school. That was a lot of fun.

When I started college I didn't do a contest for quite some time. I just resumed this year.

*In this country many seventh grade math teachers aren't interested in math competitions. Is that the case in Croatia?*

Our teacher in elementary school was quite knowledgeable. It was a big thing in the seventh grade, with several rounds at the local level and then at the national level. I guess a lot of people get into math that way.

But some people who are very good at mathematics don't necessarily do competitions. They might get interested in high school and still end up being very good mathematicians.

*In the middle school where I coach, I struggle to get 20 kids to participate in a school of 1400 kids. Do you think a higher percentage of kids participate in competitions in Croatia?*

When I took the competitions we had the school round, and maybe 6 or 10 people would show up for each grade, with maybe 100 kids in each grade.

*In high schools, do you work on competition math as part of your regular math class?*

Not really. It was more of an after-school activity. In regular math we did the regular curriculum. We also had the separate sessions taught by university students for about four hours every Saturday. That was good preparation for contests.

*And it was mostly students who taught?*

Yes. It was students who had already taken the tests, so they were familiar with them.

I came to Berkeley for my second year of college. I'd already had one year in Croatia. So I got a chance to teach in the high schools myself. That was quite an experience. I think it takes a lot of years of experience to get really good at it. It's not something where one can just start out teaching extremely well. It was exhausting. After an hour of speaking I could barely move.

*In Croatia, would you do competitive math only if you were in certain schools, or do all schools have that activity?*

I think it was quite uniformly spread throughout the country. A lot of the people who did math competitions were from the bigger schools in the bigger cities. But people from smaller cities were also very active.

We had a program where people who did well on the national round were invited to a winter preparation seminar, so everyone came to the university and we solved problems. I made a lot of contacts that way that I still have today.

*Did you apply to come to the United States before your freshman year in college?*

Yes, but I had several issues, so I stayed in Croatia for my first year. It was an interesting experience to compare the colleges here with the colleges there.

*What are the big differences that you've noticed?*

One typically takes more courses there. I think that the college education there is good. The professors are approachable and nice. If you asked me which place was better, I don't know what I'd say, it's difficult to compare.

*Is the teaching style any different there?*

No it's professors up in the front of the room lecturing. That's a universal thing.

*Do people in Eastern European countries engage in as many activities outside their classes as students do here?*

I think so, yes. Maybe not quite as many as in the United States. It seems to me that students in the United States have a more active social life. But even there people do get involved in school politics, go to concerts, and do other activities -- those are pretty universal, too.

*Have you had negative experiences in high school or college related to math?*

I made a lot of mistakes during contests that I probably wouldn't have made if I hadn't been under that much pressure. That can sometimes be a little unrewarding. In high school, when I spent a lot of time working on a contest and didn't win a first prize, I was always very disappointed.

Another thing is that when someone does well in contests, people expect that person to do very well later on. But there is a very small number of people who do well in contests, and many other good people come out of college. I think sometimes people find that to be frustrating. They say, "These people weren't there when I was taking contests, but now they're better than I am."

But those are just general observations. I didn't have any extremely negative experiences.

*Are you a math major here?*

Yes.

*Is it difficult to be a math major here?*

Sometimes. However, the math department at Berkeley is very good and if one puts in substantial amounts of effort, one can proceed quite well.

*Have you taken any graduate-level courses?*

As far as I can see, a lot of the graduate schools expect people to take graduate-level courses, so this year I started with the earliest graduate course. Most of the students there are also undergraduates -- I guess this course is aimed mostly at undergraduates who want to go to graduate school.

Hopefully I'll go to graduate school. I'd like to go to graduate school here at the United States, possibly here at Berkeley.

*Do you have to go back to Croatia at some point?*

That's a long ways away at this point.

*If you became a math professor, would you try to get a job back in Croatia?*

Maybe so. As I said, it has a good math university. To be a professor there would be quite a nice position.

*Do people with Ph.D.s in Croatia ever teach at the high school level?*

I think they would be more likely to teach at a university than a high school. Although when I was in high school I had a few teachers who had Ph.D.s.

*What was it like taking the Putnam after taking some time off from competitions?*

I felt a little rusty. But we have a really good seminar here taught by Olga Holtz and Ioana Dumitriu. It has a very nice atmosphere. It was twice a week for two hours -- you enroll in it as a regular class.

That seminar helped a lot. It keeps one in touch with problems every week, and you practice more than people usually do. If I tried to do it on my own, I don't think I would have done as well as I did.

It was interesting to re-create that high school social thing. I have always thought of contests as having a social element.

**Carol Hua** grew up in Shanghai, China, where she attended a high school associated with Jiao Tong University. She began college in Beijing, transferred to a college in Hong Kong, and then came to Berkeley as an exchange student for her junior year. She was on the Berkeley team that received an honorable mention in the 2004 Putnam.

*How did you get interested in mathematics?*

I got interested in math when I was still in middle school. Somehow my mathematics teacher thought that I had a gift in math, so he wanted me to participate in mathematics competitions. I thought, "Hmm, that was a lot more fun than class." I usually learned things a lot faster than other kids, so I wasn't very satisfied with what we were taught in class. I learned more by myself.

I went off to high school and did a little bit of physics, chemistry -- a little bit of everything. In the national competitions I won first prize in physics, or something like that, and second prize in math.

There was a point when I was thinking, "Should I chose math or physics?" I finally decided on math, because I felt that as a field it was so pure. I really enjoy thinking.

*Did your high school specialize in math and science?*

There are four high schools in Shanghai that have a special class in math and science, and I went to one of those four. But actually at that time I was more interested in physics than in math.

*When did you switch your interests from physics to math?*

While I was in college in Beijing. I was aimed in a more practical direction, so I started out trying a few electrical engineering classes. But I felt that math was more fun, because it was more pure.

*Are math competitions in Chinese high schools extracurricular activities, or are they done in the regular classroom?*

In some schools they are done as compulsory classes. But in my high school it was extracurricular, after school.

*I've heard that many of the teachers in China know a lot about competitive mathematics.*

That's true. And there's a system that identifies outstanding students. Every year we have a junior middle school mathematics competition. Everyone can do it. If you get to the last round, people know you are good. Then the high schools will look for you and talk to you to see if you're interested.

*Do all middle school students do the competitions?*

No. Everyone has a choice. But students in China are encouraged to participate in Olympiads.

Also, there's a kind of school, not a high school, a weekend school held every Sunday, where you do two hours of math classes. That was in junior middle school. I met people from different schools there, so we sort of know each other, not only in junior middle school but in high school and college, too.

*Were there many girls who went to that school?*

No. I would say it was less than 10 percent girls.

*Did you feel it was harder for you as a female to do math in China?*

Yeah, more or less. Because the winners are always boys, you feel like you're disadvantaged.

But I want to be different. Why should I do the things girls should do? I want to try new things, like math, which is supposed to be a man's field. I want to try it.

*Do you think it's also because fewer girls like to compete?*

I don't like to compete. I just like problem solving.

*But you always have done lots of competitions?*

Yeah, but it's different. Like if you want to do really well on the Putnam, you have to be really quick and really well trained. That's something that I'm short of, because I haven't gone through that kind of systematic training for a long time, so I'm kind of slow. But some problems are fun just to look at.

*How does the system work for choosing the IMO team in China?*

It's very complicated. First you had the nationwide competition. You take that competition in your own province. If you do well in your province, like top 10, they will

pick you out and send you to the national team. There you compete again. There are 40 provinces in China, so 400 kids, and then the 400 kids compete with each other again. Finally they choose 6 out of 400 to be put on the national team for the IMO. It's very systematic.

*Did you participate in that process?*

Yes, I won the first prize at the province level. Then I went to the national level, but there the kids are just so talented. So I did physics instead.

*Did you do the physics Olympiad?*

No, I didn't get that far. I did it just for fun. Plus toward the end I felt that my interests were sort of drifting toward math.

*You've now gone to three colleges. How have they been different?*

In China and in Hong Kong, every student has to take some courses that are compulsory. Here people are able to choose what they like. You start out having no major, so you can take whatever classes you like. But in Hong Kong and China, when you first get into college, you have to decide at the very beginning, and it's hard to change your major afterwards. That's a huge advantage for students here, because they have two more years to be exposed to college education.

*There must have been distribution requirements at your colleges in China and Hong Kong.*

Yeah, definitely there are.

*Some people who are really interested in math want to devote more time to math classes and not bother with their distribution requirements.*

I don't like taking classes that much. I want my schedule to be more flexible. I would prefer doing more extracurricular activities than taking classes. One really good thing about Berkeley is that undergraduates get many chances to do research. Universities in China and Hong Kong don't really offer that. This year I'm enrolled in something called the Undergraduate Research Apprenticeship Program. I get to work with people doing biological mathematics. We're working on DNA topology, so you need to know a little bit of topology, like how we can model DNA in a simple cubic lattice. There are some mechanisms that somehow unlock DNA, and we want to model that.

This is something very good about the math department here, because applied and pure math are very well integrated. You can do both at the same time.

*Is research what you mean by extracurricular activities?*

Not just that. Also things like taking a piano class, or a folk dancing class. I have time to do that here as well.

*How does that compare with China? Are there opportunities to do extracurricular activities there?*

There are, I think.

*Why did you decide to take the Putnam this year?*

There's a math class called H90, organized by the math department. I went to that class. I didn't enroll in it, because I didn't know that much about the Putnam before I came here. I audited that class and had a lot of fun. I wasn't trying to do all that well. I just like problem solving.

*Did you know you were on the team?*

Actually, I didn't know that, because the teacher didn't tell us. She didn't want to discourage other people who might want to be on the team.

*You're a math major?*

Yes.

*Do you know what you'll do with that degree?*

I want to go to math grad school. So far I have no idea where, because I haven't sent out my applications. I will definitely apply to the United States. I definitely like Berkeley a lot. Coming back here would be great. The math department is really big, and there are a lot of first-class professors here. I've already met some professors who I would be really happy to work with. But as an international student, funding is always a problem, especially at a public school like Berkeley.

*What areas of mathematics are you interested in?*

I'm interested in a lot of different subjects in math. I don't want to narrow down too soon. I want to go to graduate school first and talk to different professors and work on different subjects before I decide.

**Boris Bukh** grew up in St. Petersburg, Russia. His family moved to the United States after his junior year in high school, and he attended McAteer High School and City College of San Francisco before transferring to the University of California, Berkeley, at the beginning of his junior year. This year, as a senior, he was a member of the Berkeley Putnam team that received an honorable mention.

*Were you on the Russian IMO team?*

No. I wasn't all that interested in mathematics when I was back in Russia. I did more science and chess in Russia.

*But I'm assuming you were doing competitive math in Russia.*

Not really. In sixth grade I went to a math circle for a year, and I took some competitions now and then. I did reasonably well, fourth or fifth place in the city back in the sixth grade. Then, in something like the tenth grade, I went to a computer science circle, and I took a few math competitions then. But I didn't practice or anything. Sometimes I solved some problems, but that's it.

*How does the circles system work?*

There were some smaller circles at the district level, and there was a central organization that is called the Center for Youth Activities, or something like that. There are a bunch of different circles, some sciences, some arts, some performing, some engineering, sports. Basically, whoever wants can go to them. You can go to the local one, or students who have more ambition and desire can go to the central one. It's free, at least it was free when I was going.

*Who are the instructors?*

It depends. Some are permanent people. Math and science also employed some students and graduate students from the universities. For instance, one of my best instructors was a student at the Institute of Fine Mechanics and Optics. He recommended to me a good book on mathematics, called "Concrete Mathematics," and that was probably the turning point where I started learning a lot of mathematics.

*Does every city in the country have these circles?*

Every reasonably large city. It was a well-developed system back in Soviet Union times. Now there is less funding, so some of them are dying, though I don't know exactly the situation. Certainly they used to be quite common.

*Do people get involved in competitive mathematics through the circles or through their schools?*

Not just through the circles. There were specialized schools, and some people would have done competitions through those. Some of those schools are very very strong.

*Do you think there were more opportunities to become involved in this kind of mathematics in Russia?*

Percentagewise I don't know. For example, the circles I went to were not that populated for a city of something like five million people. The particular circles I went to might have had a few dozen people. But there were also local circles and activities at the specialized schools, so there may have been more.

*In this country most of the top problem solvers come from just a few areas.*

The problem is that to win at one of these competitions one needs quite a lot of preparation. Certainly someone who has had that preparation in Russia or here has a better chance of winning a competition. Places where there are strong circles I would expect to produce more of these students.

*Did you come to Berkeley right after high school in Russia?*

No. I came here to the United States and I still had one year to spend in high school. I spent a year at McAteer High School in San Francisco, which was a terrifically terrible experience, but that's another story for another day.

*Actually, I'm interested in that story.*

It was a much less challenging school than the one I attended in Russia. Of course I also had problems with the language, which added to the problem for me. Also, in a certain sense, the atmosphere was kind of prison-like. There was a huge fence around the school and a guard who tried to keep people from getting out. One could not get out, and one could not walk within the school without permission.

On the other hand, discipline was much better. Certainly there were no physical assaults, which did occur in my school in Russia. The social atmosphere in Russia these days is very very rough, so that might account for that.

I didn't take any math classes at my school here. I was sent to the math instructor and he said, "Okay, do you know derivatives and integrals?" and I said, "Of course." He said "You don't need to take anything here," so I didn't. I took some American history classes, government classes, English classes of course, some economics, drivers ed, health, and some other civics classes.

I couldn't take any science classes either. The only thing I could take was basically classes I couldn't take in Russia.

*Was there a math instructor at your high school who could help you take high school competitions?*

Yes, there was a math instructor who was a very nice and friendly guy, and I took several competitions with him. He's the one who recommended that I seek out the Berkeley math circle, which is where I started going in my last semester of high school.

*Why did your parents move to the United States?*

Basically, the life in Russia got worse and worse. There was not really anyone left in Russia who would keep us there -- we had no relatives left. My mom and father were accountants. We could immigrate, so we did.

*Did you study English in Russia?*

Yes, I had a fair amount of instruction in the language. Officially it was from first grade, but we started over in fifth grade. I was never a very good student. I didn't see the purpose of learning a foreign language when I was in Russia -- everyone spoke Russian.

I knew some English when I came here. But I certainly could not hear what I was told. I couldn't speak well. I spoke poorly and used improper conjugations, and whenever I spoke I spoke with a British accent, because that's what is taught in Russia.

I took an ESL class first semester and some literature classes. I watched TV for three hours a day that first year.

*What was the process that brought you to Berkeley?*

I wanted to stay near my family, so I looked at colleges here in the Bay area. Berkeley rejected me when I applied. But when I appealed I got an offer that if I completed all the work at a community college, I could transfer. So I decided to go to

City College of San Francisco, where I spent two years. Then I transferred. I applied as a math major for transfer admission, and this is my second year at Berkeley.

*What were your first two years of college like?*

I couldn't take many sciences there. I took the exams for physics, statistics, calculus, and something else, so I got those out of the way. What was left, of course, was humanities courses.

I did take some science courses. I took chemistry, physics, introductory astronomy, and I had to take a math class. I took differential equations and linear algebra, followed by discrete mathematics and calculus 3. But in all those classes I had an arrangement with the instructor so I just had to submit the work and come to the exams. There was nothing I could learn in the classes. Though I did get a B in differential equations and linear algebra, which is the only B I've ever gotten in a math class. But that's another story for another day.

The instruction at City College was not bad at all. The problem was that I already knew most of the material. That's the reason I didn't come to the classes. I had to complete these courses to transfer to Berkeley. I had to have them on paper.

*Are you a math major here at Berkeley?*

Yes. First semester I took H90, the problem solving seminar. I took 185, complex analysis. I took 191, a seminarish type of thing on discrete geometry. I took 202A, which is analysis, 275, which was combinatorial game theory, and one more class, linear algebra, H110. That's what I took in the first semester.

*Did you do the Putnam here last year as a junior?*

Yes. I also did it while I was a sophomore at City College. I enrolled in H90 at Berkeley through the concurrent enrollment program and took the Putnam as part of Berkeley's Putnam team. Unfortunately for its students, City College does not participate in the Putnam.

*What are your plans after you graduate from here?*

I'm going to graduate school in the fall, to Princeton. I'm probably going to study something like analytic number theory, but I don't know for sure.

**Jeremy Tauzer** grew up in Davis, California, and went to Davis Senior High School. He excelled in the Bay Area Mathematical Olympiad and attended MOP in 2000. A senior this year, he received an honorable mention on the 2004 Putnam.

*How did you get involved in extracurricular mathematics?*

I probably started with my dad kind of motivating me and quizzing me when I was really young. Then there was some math test in the sixth grade, and then in seventh or eighth grade there was Mathcounts.

At Mathcounts I connected up with another student named Austin Shapiro, who was at MOP with me. He also went to my high school and came to Berkeley with me. I think he was an honorable mention on the Putnam the year before this. We became friends after meeting at Mathcounts in the eighth grade, and in ninth grade we took BC calculus together.

*You'd already made it through all those other middle school and high school classes?*

I did geometry in seventh grade and algebra 2 and trig in eighth grade. Then in the eighth grade I did analysis, which was precalculus, I guess.

But competitions are the really interesting part. In ninth grade, at the high school I started connecting with other people who were interested in competitions, and we did a regional California math league. There was the ASHME, which is now the AMC 12. I took that, and I'm pretty sure I took the AIME. I might have even taken the USAMO that year, in the ninth grade. I was still in the junior high, but I came over to the high school after my classes to do these things.

In eleventh grade I did well enough to go to MOP. I also did well on a national write-in test, the USA Mathematical Talent Search. But that's not as prominent as the AMC tests. There was also the BAMO, the Bay Area Mathematical Olympiad.

The Olympiad problems are the problems I enjoy the most -- difficult problems that take maybe an hour to solve, not so much the quick type. ARML is more the quick type of question -- I didn't do as well on that. I remember one year for ARML we didn't have enough people in northern California to put together a team, because you need 15 people. So Austin and I were part of the Bay area team, and that year we won the national competition. We were finally able to take out the Massachusetts people.

*How difficult was it for you to accelerate in mathematics in middle school?*

I think my year was the last year that they allowed special cases like me to take junior high courses in elementary school. I heard that people after me weren't allowed to change schools. Then it would be really hard for students to take algebra before seventh grade, so they'd have to take algebra in seventh and geometry in eighth. It would be more difficult for students to get ahead.

*I've heard from some people that the social pressures can be worse in middle school than high school.*

In middle school there's not the same academic environment that there is in high school. There's a lot more leeway in high school to take classes or go and take college classes. In junior high they want to keep everybody safe.

*But you must have had some good teachers who allowed you to accelerate, or was it your dad pushing on the school systems?*

I think both were factors. My parents were major encouragements from the beginning. And in junior high I had the same teacher in sixth and seventh grade, Chris Garrett, and he helped me put together the algebra 2/trig course, which wasn't there before. There were like 15 or 20 of us taking that course.

*Did you do any other summer programs besides MOP?*

I guess not. I took college courses [in the summer]. Also, I did Research Experience for Undergraduates at UC-Davis. I didn't do any of the math camps.

In high school, the academics weren't the main thing that got me into problem solving. One thing that helped me a lot was my friend Austin; we used to talk about problems and solve problems by ourselves in high school. For a couple of hours we'd sit on a bench and work on some neat thing that we'd never seen before but we thought was simple, like number theory, which comes up a lot in competitions but never in academics. So we were more self-motivated.

In eleventh and twelfth grade there is a class in our high school called independent research, where you didn't have to go to class. That idea was really inspiring. For this independent science research project, I said, "Okay, I'll go out and start looking for math problems." So I started looking at these problems on the web. One was a maximizing problem in geometry. Another was a number theoretical problem. After I researched these problems and worked on them by myself I got to present them to the calculus class that I'd taken before.

*You did that research on your own?*

Well, there was a teacher who was my mentor. But in reality I just told the teacher about my research every once in a while. I was definitely on my own.

*Could you work on problem solving at the same time?*

At that time I was working more on researching skills. It's one deep problem that you look into for a long time, which is more than what you do in contests. But the competitions I'd taken in the past helped me for that.

*Did you enjoy MOP?*

It was very interesting to spend all that time with these 30 unique fellows -- not all of them are geeky in one way or another, but all of us had different sides. Definitely you can learn a lot about different kinds of problem solving -- I think too much to really remember. The training was definitely good, but it was so intense.

*Were you a rookie or a veteran?*

I was a rookie, since it was my first time there.

*Why did you decide to apply to Berkeley?*

After taking math classes at UC-Davis in high school, I wanted to go to a college that offered more classes. Berkeley definitely looked like it offered a lot of great classes. There are so many professors here and opportunities to go in whatever direction you want. My other option was Caltech, but Caltech required you to take all these biology courses and chemistry and stuff -- I thought it would be too constraining.

*So the math classes were your major consideration?*

I've always been into math and problem solving. I'm not really into computer science or modeling.

*Did that stay the same once you got here?*

Actually I kind of got tired of math classes. I finished up the major and haven't been taking many math classes. I took some computer science and some physics classes. They were pretty interesting, but I definitely didn't get into them like I did into the math.

Part of me just got burned out didn't want to do hard-core math. It's funny that I scored better on the Putnam this year than I had before.

*Why did you get tired of the math classes?*

They're not that challenging for me. And they're not as much self-directed. I wanted to explore new things. Having done so much math I was interested in taking

other classes, like economics, a film class, English, comparative literature, Chinese. I've been trying to learn about a lot of different things, and Berkeley offers courses on a lot of subjects.

*What are you thinking about doing next?*

I'm not ready to decide firmly what I'm going to do.

*Have you become interested enough in these other subjects to go in those directions?*

Nothing has really grabbed my attention completely, so I'm still pretty unsure. Physics is a little interesting. I'm thinking about maybe going to grad school in physics or math.

*What do you think you're going to do next year?*

That's a hard question to answer. Part of me wants to keep learning things by myself without having any of the pressures of school, like turning in papers. Part of me wants to travel, I think to Asia and to China. I've made a lot of Chinese friends here. I'm rather uncertain about what I want to do.