Our local mathematicians – Dr Chin Chee Whye

by
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Dr Chin Chee Whye is an assistant professor at the Department of Mathematics, National University of Singapore. He is a Singaporean and he received his primary, secondary school and junior college education here in Singapore. After finishing his national service, he was awarded the Loke Cheng-Kim foundation scholarship to study at the University of California at Berkeley in 1993. Dr Chin received his B.A. from Berkeley in 1997 with highest distinction in general scholarship at graduation (equivalent to summa cum laude), with triple majors in mathematics (highest honors), computer science (highest honors) and statistics. He also received departmental citations in mathematics, computer science and statistics. (Each citation is awarded by a department in recognition of distinguished undergraduate work by a student; only one citation is awarded by each department each year.) In recognition of his exceptional scholarship in mathematics, he was also awarded the Dorothea Klumpke Roberts Prize in 1997. After graduating from UC Berkeley, Dr Chin pursued his graduate study in Mathematics at Princeton University. He graduated with a Ph.D. in Mathematics in 2002 and joined the Department of Mathematics at UC Berkeley as postdoctoral researcher and lecturer from July 2002 till December 2003. From January 2004 to May 2005, Dr Chin worked as a research scientist at the Broad Institute of MIT and Harvard. He joined National University of Singapore in June 2005.

Q: Can you tell us a little about yourself?

I was born and raised in Singapore, and I went through the usual secondary school and JC education here, as with most Singaporean students. But my professional training was done in the United States. After finishing my full-time national service in 1993, I went to Berkeley for undergraduate studies, then to Princeton for graduate school in 1997. I returned to Berkeley in 2002 for post-doctoral work, and then to MIT as a research scientist. I moved back to Singapore to join NUS in the middle of 2005.

Q: What do you mean by working as a research scientist?

Well, I was at the Broad Institute, which is a research collaboration of MIT, Harvard, its affiliated hospitals, and the Whitehead Institute. I joined a team of colleagues working on the problem of genome sequencing and assembly. It was quite a multi-disciplinary collaboration. The scientists at the institute want to understand genomes — all the the biological information encoded in the DNA of organisms. That is a tremendous amount of data to handle. We want to squeeze the useful information out of these genomic data, but to do so requires us to come to terms with the sheer quantity and complexity of the data involved, and that leads to serious mathematical and computational problems. So the biologists collaborate with mathematicians and computer scientists, and we work on the problems together. That is what goes on at the institute daily.

Q: What's the nature of your job now?

Now things are quite different. Most of my time is spent on teaching classes and interacting with students; this is especially so during the academic semesters. I spend the remaining time working on my research problems.

Q: You mean you spend the semester doing full-scale teaching?

Yes, more or less that's true. At least that was the case during this past semester, mainly because I spent a significant amount of time on going through the homeworks of the students in the course I was teaching; add to that the time needed to prepare the lectures and set homework problems for the students, there wasn't much time left! I still managed to find brief occasions to think about my research, but those were intermittent. Having a stretch of uninterrupted time is important for research work, especially in mathematics, but I only got that during the vacation weeks.

On the whole, however, the distinction between teaching and research is not all that clear. For instance, this current semester I'm teaching a course on an advanced topic which is quite closely related to my research work; so while I go through books and journal articles to prepare my lectures, I'm also consolidating in my mind all the materials needed to further my research. One cannot say that I'm "just doing research" or "just doing teaching", because it's really both of them together.

Q: How did you start getting interested in math?

I don't remember the exact details... probably it started in early secondary school, when I began to do better in math. I realized that because of my strength in math, my other science subjects got better as well. My teachers encouraged me to take part in mathematics competitions, which made me learn on my own more than just what was taught in school, so I think my interest in mathematics was aroused around then. But I don't think I really understood at that time what I would be getting into when I thought I wanted to become a mathematician.

When I became an undergraduate, I had to choose a major, and I chose mathematics because I knew that was I was good at, and I liked doing it anyway. But because of that, I was exposed to what (advanced) mathematics really is about, and it appealed to me very much. It was a virtuous circle: as I learned more about mathematics, I became more interested in the subject, and that made me want to find out even more about it.

Q: Mathematics in university is very different from mathematics in secondary school and JC. What would you advise students to prepare them for such a change, should they decide to pursue math further?

I think the key difference is the need to really understand the mathematical concepts, rather than to merely learn the methods to do computations. In secondary school and JC, you learn certain methods and algorithms, and when you see a certain type of problem, you simply pick the appropriate method or algorithm and apply that, and you will solve the problem. You are not really expected to understand why the methods work, or why they are appropriate to those problems. This level of understanding is perhaps acceptable at the level of secondary school and JC, but it is woefully inadequate for doing mathematics at the university level.

In higher mathematics, you absolutely must understand the concepts involved — "understand" in the true sense of the word! It may sound surprising but it is actually quite common to find students who do not understand some very very basic mathematical concepts, or worse still, who are not even aware that they lack that understanding. Let me give an example. Most students would think that they know what a real number is, but if you probe them, you might find that they are imagining a real number as just something on which one can can perform arithmetical operations; but those properties alone do not characterize the real numbers! If you have to prove a theorem about real numbers, you must know what they really are before you can start to give an argument to prove the theorem. And proving theorems is what you do a lot of when you do mathematics at the university level.

Q: What is doing mathematical research like?

I remember asking people this question when I was a student, but I did not get a satisfactory answer then; I'm not sure I can give one now, but I will try. Generally speaking, doing research means finding answers to questions, and mathematical research focuses on mathematical questions. You are curious about something, and you want to know what it is, whether it is true, why it is the way it is, etc.; in other words, you have a question. It could be that the answer to your question is already known but you don't know it; so you start by digging into the published literature and doing so-called "library research". Nowadays with the internet search engines, information on the web is also readily available for this purpose. You chase through a series of publications (reference books, journal articles, websites, etc.) and you learn something. Sometimes you learn the answer to your question; other times you learn that nothing has been written about the question. You can then turn to the relevant experts on the topics related to the question you have, and ask them if they have any information that can help you. Occasionally these experts have also thought about that question and may have an answer readily available to give you; more often, you realize that nobody really knows much about that question. Then you find that you have a research problem, or in plain words, an open problem.

Open problems abound in mathematics, and if you are genuinely curious about something in mathematics, it is not difficult to discover (or re-discover) an open problem. You eventually have to work on such a problem when you do research. It may sound a little over-ambitious to try to solve a problem that even the experts don't know much about, but that is quite far from the truth. Very often the reason that nothing much is known about a problem is that no one has actually spent time to think about it! So even though you may not know much about your problem, you may already be the one person in the world who knows the most about it, and you are the one with the best chance to solve it. Anyhow, whatever is the case, you are curious about something, you find that you have (re-)discovered an open problem, and so you try to solve it --- that's what it is like to do research. And it can get very exciting, especially when you started off with something that was no more than wishful thinking ("hmm... wouldn't it be nice if such-and-such a thing were true?") and after a lot of work, you discover that what you have hoped for is in fact true!

There is, however, a big difference between working on research problems and doing homework (or exam) problems. When you are assigned a homework problem by your teacher, the problem is fixed, and you have to do it one way or another. In research, the problems are actually very "fluid"; they can change as your research work proceeds. When you work on a research problem, you deepen your understanding about it, and perhaps you might realize that the problem that you started out with is really not the "best" problem to work on, that a variant of it is perhaps much more interesting (to you) or more important. In that situation you are completely free to abandon the original problem and turn to the new, better, more interesting variant of the problem. Your ultimate aim is to gain some understanding of what is true, and you don't have to stick yourself to one particular problem. In fact, to a large extent, the quality of one's research is more influenced by what problems one chooses to work on than by how difficult those problems are. Knowing how to ask the right questions, and how to pick the right problems to work on, is a big part of the art of doing research.

Q: What do you do when you get stuck on a problem?

That happens most of the time (more than 99\% of the time for me!). Roughly speaking there are two things that you could try when you get stuck. You could ask yourself: what is the simplest instance of the problem that you still don't know how to do? You specialize to this instance, and you try to solve that. Another thing you could do is to ask yourself: among all the instances of the problem which you already know how to do, what is most general thing you can say about them? You re-examine the methods for these known cases, pick out the essential features of these arguments, and try to generalize that as much as possible. You see, by experimenting with special cases, you get your hands dirty with the problem and you understand it better; and by generalizing the arguments, you might obtain a method that is applicable to more instances of the same problem. If you are lucky, the problem might just get solved that way. That's how you can wiggle your way out of getting stuck.

A more strategic way to find an analogous problem, one that is different from but similar to the one you are stuck on. As I have said above, in research, it is a common thing to change your problem as you work on it, and when you get stuck, modifying your problem might be very helpful, or even necessary. What's the use of having an analogous problem? Well, suppose you want to prove a statement, say: "A implies B". You want to show that given the hypothesis "A", you can deduce from it the desired conclusion "B". You don't know how to do that, but you do know that the statement "A implies B" is analogous to another statement "C implies D"; perhaps the two are related only in a special situation, or in a totally different context, or whatever, but you know that the two statements are close cousins of each other. Now look at the statement "C implies D". Perhaps it is plainly false, in which case the analogy is useless. But maybe it is a statement that you suspect might be true but which you don't know how to show either, and you find it easier to think about "C implies D" than to think about "A implies B"; then you could switch to working on "C implies D" instead (see what I mean?). Or, in very good situations, the statement "C implies D" might already be something you know how to prove, in which case you could examine the proof and try to apply or adapt the argument to showing "A implies B".

Q: Do you enjoy teaching mathematics? Do you have a 'philosophy' of teaching mathematics?

I do enjoy teaching mathematics; that is in part why I prefer to be here in NUS teaching (and doing) mathematics, instead of working on genome research. It is quite a challenge to explain mathematical ideas precisely and accurately, and an even greater challenge to also convey across to students the sense of beauty in these ideas. But I get great satisfaction when I manage to explain mathematics well, and I like to keep doing it.

I don't really know if this can be called a "philosophy", but in the general teaching--learning process, I do insist that the ultimate responsibility of learning lies with the student. I see my role in teaching as just a facilitator, providing the necessary help to the students (in the form of lectures, repeated explanations, homework problems, etc.), but it is the students' job to educate themselves. I'm adamantly against spoon-feeding or not challenging the students. Mediocre students generally prefer their teachers to give them an easy time, but I believe doing so would be a total waste of everyone's time. There are about 12 weeks in a semester-long course; for the time to be well-spent, the students (and teachers as well) really ought to put in their efforts to push themselves beyond their intellectual limits. Needless to say, the weaker students don't particularly like the fact that I push them hard and set a very high standard for them, but I think they are the ones who will benefit the most in the long run.

As for teaching mathematics at the undergraduate level, the general rule I follow is to demand that students know exactly and precisely what they are taking about. Pick your favourite theorem and write down its statement; you should be able to explain every single term that appears in that statement, and every single term that appears in that explanation, and so on, recursively. It sounds rather simple, as it appears that knowing how to prove the theorem isn't required! But it is actually not that easy: if a "real number" appears in the statement of the theorem, you should be able to define precisely what a real number is, and there already you'll find many students panicking...

Q: If a secondary school/junior college student were to ask you: "Why bother to learn so much math? What's the purpose of it?", how would you respond?

I think it depends on what you mean by purpose. If your purpose is to become, say, the next Singapore idol or superstar, then you don't need to know the precise definition of a real number! For most jobs, you need only basic mathematical skills (such as doing calculations with numbers) to get by. Many areas of advanced mathematics are quite abstract in nature, and they do not have immediate real life applications. In that sense, advanced mathematics is pretty "useless" to most people, and they won't want to learn it.

However, if you're interested in mathematics as an academic discipline, it offers (at least) two rewards. One is the truth of things, the conviction of the validity of a statement given by a rigorous mathematical proof. For mysterious reasons many mathematical truths have very elegant and beautiful proofs, and it takes work to be able to understand and appreciate the truth and beauty of these things. The other reward that studying mathematics offers is that it sharpens your mind. You learn the pain of having an argument destroyed completely by a single mistake, and so you learn to be very careful in your reasoning and very precise in your writing.

But I believe ultimately a mathematician does mathematics not because of any potential reward of any sort, but simply because he likes it, just like a painter would paint a painting, or a composer would compose a piece of music, because he has an idea and wants to express it. Pure mathematics is comparable to fine arts and music in that none of them has any real life (financial?) application, yet they are all interesting disciplines in their own right. But it's hard to make the appeal of mathematics comprehensible to non-mathematicians. A layperson knows something about music and art, and he could decide whether he likes them or not from his awareness of what these things are. That is not the case with mathematics. To understand what advanced mathematics is, you have to work a fair amount on it, and that usually requires you to first enjoy doing it; so unless you already enjoy doing mathematics, it is hard to convince you that mathematics is interesting!

Q: Any final advice you'd like to give to the students?

Pursue your own interests. Remember that only you yourself are responsible for your own education; no one else is. You will probably find yourself quite miserable if you are doing something which you are not interested in; you will learn less and do worse. So, identify your own interests, and pursue them as much as you can.