Sasha Rubin

Teaching Statement *June 2017*

The most influential course I've attended was a graduate level introduction to mathematical logic at the University of Auckland. It was taught by a topologist, David McIntyre, based on Moore's method — we were given basic definitions, followed by statements of fundamental theorems that we were to prove ourselves and present the following lesson. The material was to form the background of my graduate study. I probably did my best learning when my classmates presented a proof that I was unable to produce beforehand. Identifying the points in the proof that I did not think of trained me to get a focus on why and where my own reasoning had fallen short. It is these sorts of insights that I try generate in my own classroom.

Undergraduate teaching

I have had ample opportunity to improve my teaching. I taught three semesters of Calculus for Engineers at Cornell University, essentially a second course in calculus for first year students that follows a textbook very closely.

After each lecture I reflected on how I could improve presentation of the material. This usually involved improving the pace, refining what to write on the board, and finding better ways to break up the material into chunks that students could follow.

My students were generally capable of acquiring, on their own, the skills to work routine problems. Consequently my main goal was to get them to reason mathematically, both verbally and in writing. I noticed that students are very sensitive to the wording I use. I keep a list of phrases to which they seem to respond, such as 'can anyone help A with her answer?', 'can you explain B's idea to me?', 'what do you mean by X?', 'are you sure?', 'who will summarise today's class?', 'if all I do is teach you computational procedures I'm short-changing you'.

I worked hard finding angles on the material that would engage my students. This invariably involved finding a question that sounded fun to try to solve. My favourite moments in class were those that involved discussing the big ideas in calculus. After writing a theorem on the board I asked: 'why should we believe this?' (a soft version of 'how do we prove it?') and the often overlooked 'how is this theorem useful?'.

I also learned to ask questions that probe student knowledge and understanding. For instance 'why would you say that?' and 'tell me more' helps to diagnose their logic, while asking easy recall-level questions lets me see whether students have been listening.

Although my students were most comfortable with being given algorithms to solve problems I instead focused on problem solving techniques *ala* Pólya: 1) identify the unknown, 2) if you can't solve the problem find a problem that you can solve that has a similar unknown.

I experimented with small group work in class to alter the pacing of lectures and encourage my students to think and reflect on what they had and had not understood.

Early in 2010 I gave the undergraduate course on logic and computation in the mathematics department at the University of Cape Town. Student abilities in the class were very mixed which meant I had to structure the course and pace very carefully. I slowed the lectures down a bit and moved harder questions to the tutorials. One of the strongest students sent me an email at the end of the term:

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I have enjoyed your maths course the most of all the maths courses
I've taken so far at UCT. Even more than the content, your delivery
was excellent.

I made the decision during one of your lectures to do honours in
mathematics and computer science next year at UCT.
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Undergraduate Supervision

My usual approach to supervision is to discuss possible problems with students and let them pick one to work on. If the student lacks confidence or is unsure about how to proceed, I create a mini-proposal and timeline for them to follow. I meet with students once a week to discuss progress and troubleshoot. I consider undergraduate research successful if the student a) has fun, b) is challenged, and c) produces and publishes novel research.
In 2007 I started collaborations with a number of graduate students, two of which resulted in publications at STACS 2008.

In 2009 I supervised six undergraduate students for a two month research experience (REU). The student selection process was very competitive and so I received exceptionally talented undergraduates. The students formed two groups and worked on two projects. During this time I learned the value of giving students a few days to brew and filter their ideas before group discussions. Overall it was a rich experience for both me and, I gather, for my students. One exceptional student expressed to me that the experience helped him decide to pursue a career in research. The results were subsequently published in the journal *Theoretical Computer Science* and the conference *GandALF*.

In 2012 I co-supervised an undergraduate summer project which led to a publication in the conference *LATA*. While the student was writing up I realised that a proof required some formalities that the student did not know. At that point the student was keen to learn *how* I came to realise there was a problem. This episode taught me the value of modelling good mathematical thinking for learners.

I am currently supervising an undergraduate student in theoretical and practical components of a project on “graphical games”, a topic at the interface of game-theory and graph-theory.

I recently worked with three junior PhD students, resulting in papers published at VMCAI’14, IJCAI’16 and AAMAS’16. In all cases I learned the value of helping graduate students to structure their thinking so they could contribute more to the collaboration than they otherwise might.