

Carmen Bruni (David R. Cheriton School of Computer Science, University of Waterloo)

Les Notes pédagogiques présentent des sujets mathématiques et des articles sur l'éducation aux lecteurs de la SMC dans un format qui favorise les discussions sur différents thèmes, dont la recherche, les activités les enjeux et les nouvelles d'intérêt pour les mathématicien.ne.s. Vos commentaires, suggestions et propositions sont les bienvenues.

John McLoughlin, University of New Brunswick (johngm@unb.ca)
 Kseniya Garaschuk, University of Fraser Valley (kseniya.garaschuk@ufv.ca)

Teaching is a cornerstone in the career of any academician. For mathematicians especially, teaching can play a huge role in shaping one's professional career. For this reason, it is necessary that we give the next generation of mathematicians a solid foundation for teaching mathematics courses. In this article, I want to outline one such endeavour currently underway at the University of Waterloo.

The Big Picture – A Three Stage Program to Graduate Student Training

Graduate students at the University of Waterloo are expected to take on Graduate Teaching Assistant duties over the course of their graduate degree. These include grading assignments and examinations, proctoring examinations, running tutorials and possibly teaching courses. As such, the need for several training programs for each of the main tasks a graduate student might undertake is vital for quality control purposes.

The idea at the University of Waterloo, originally due to Brian Forrest, was to have three stages of training. The first stage would be a session to discuss basic graduate student expectations, give training on how to grade papers and inform them on some policies relating to examinations, work training modules and so on. This is done in the very first week students are on campus. The second stage is a training session preparing students to give tutorials in the classroom where topics including basic presenting skills, scenario training and content preparation are discussed. Stage three is the Instructor Training Seminar which is the focus of the paper. This was an idea I had come up with independently from Brian and approached him about it in 2017 (based on something similar done at the University of British Columbia – see [2] for more details).

Stage Three – Instructor Training Seminar

The idea was to create a seminar that really delved deep into the nuances of teaching. The seminar itself is broken down into 12 weeks where we meet for 1.5 hours per week. Vital to the success of this seminar is the focus on practical advice and in-classroom practice. The seminar was primarily focused on graduate students, though occasionally post-doctoral fellows and some novice instructors with no prior teaching experience also participated. For the purposes of this article, we will call those participating in the seminar *participants*.

In the three offerings of this seminar that have been completed, participation has ranged between 20 and 30 participants. Participant disciplines have varied across the 5 major departments of the faculty of Mathematics at the University of Waterloo, namely Applied Mathematics, Actuarial Science, Combinatorics and Optimization, Computer Science, Pure Mathematics.

The following section outlines the 12-week seminar with descriptions of some weekly activities.

Week 1: Introduction and Good Teaching

In this week, we introduce everyone and discuss what good teaching is. One important thing we want participants to realize is that good teaching isn't always about a person standing at a board lecturing. This can be a part of good teaching, but in fact good teaching is so much more than what is done in front of a class. It involves selecting good and meaningful assignment and examination questions, having a broad vision for a course, and even picking engaging activities to do in the classroom. Good teaching has many different components, and we spend some time in this first week identifying some of these points in preparation to go into further detail later.

One task we do in week 1 is discuss the Wason Selection Task [6]. Briefly, students are presented four cards each having a letter on one side and a number on the other. Students are told that they want to verify whether or not the following statement is true:

"If there is a vowel on one side of the card, there is an even number on the other"

The four cards display a consonant, a vowel, an even number and an odd number, and students are asked which cards must one flip over in order to determine whether or not the above statement is true.

(If you've never seen this before – it might be a good time to pause and try to solve the above problem!)

We arrange the activity for our graduate students much like we would do in a classroom using the Think Pair Share method – think for a minute, discuss with your neighbour, share as a class. Most graduate students get the above answer (that you should flip the vowel and the *odd* number!) However undergraduate students at all levels often make mistakes here. Additionally, there is a video that we show them from the *College Math Video Cases* site that shows how an organic discussion might work in a classroom [3]. A fun twist to the above is changing the problem context to drink orders at a bar with people who may or may not be minors in a city with a minimum drinking age and using this exercise as a lesson in abstraction. While it is effectively the same problem, students do much better when reasoning about alcohol (for reasons I'll let the current reader ponder!).

Lastly, we show two examples of real live lecturers in the classroom and discuss some of the things they did right and some they did wrong. This exercise is also extremely valuable as it provides many great insights into watching a class not for learning content but rather to really focus on how to present. The videos can be found in the references below [4][5].

Week 2: Presentation Skills

If you have never treated yourself to a Dan Wolczuk lecture, I highly recommend you once again stop reading this article now and open the link from the BIRS conference in Innovations in New Instructor Training in the references [1]. The aforementioned link gives you a sense at how dynamic Dan is in the classroom. His talk on presentation skills is enlightening and helps novice and even experienced instructors to think critically about their presence in the classroom. His talk includes notions about using one's voice (including paralanguage, pitch, pauses, intonation, enunciation), knowing your lines, movement and positioning, eye contact and overall body language. To many of us who are currently university instructors, a lot of this is second nature but to a novice, these insights can be extremely important. Again, I highly recommend listening to Dan's talk even if you are experienced as it can very much improve one's own classroom teaching.

Week 3: Mini lectures Part 1

Many of my colleagues who have helped in this project were invaluable resources for helping to administer the mini lectures. Participants broke out into groups of 3 participants and one or two invigilators. Participants would take turns giving 15-minute talks and then receiving 15 minutes of feedback from the other participants and instructors. Participants choose topics based on a course they think they might teach in the future (which at Waterloo can be anything from Calculus to Group Theory). In the first mini lecture, we get participants to focus on the first 15 minutes of a lecture near the beginning of the term (we focus our feedback on presentation skills at this point).

Week 4: Assessments Part 1

In this talk, we discuss assessments and present two different viewpoints. One is from the perspective of Bloom's Taxonomy – writing an assignment or exam that hits many different levels of learning. The second viewpoint, which I first learned from Brian Forrest, is one that assessments can be used to foreshadow upcoming topics (that is, looking at the course more holistically instead of as isolated modules). We do this with the intent that participants can use this information to come up with problems for next week's activity.

Week 5: Assessments Part 2

Participants between weeks 4 and 5 will write their own sample assignment to bring this week. In groups of 3 with one instructor per group, we discuss the pros and cons of the assignment. We probe why certain problems were chosen and how they fit together in the grand vision of the course. This feedback is meant only for the small groups that participate together.

Week 6: Mini lectures Part 2

In the second mini lecture, we get participants to focus on the middle 15 minutes of a lecture (here we focus on keeping or regaining student attention). Students focus on the feedback received in the first mini lecture and work to improve on their second talk.

Week 7: Visit a lecture

This week, we encourage participants to visit a first-year lecture. We ask that participants of the seminar watch the undergraduate students to see what they're doing, how they're responding to the instructor, how are they asking questions and what questions they're asking, how are they interacting with the instructor and any different technologies the instructor is using. Participants are also asked to watch the instructor to see some of the skills we are teaching them be put into action. Given that there is not a need for participants to be focusing on the content, this provides a great opportunity for students to get a sense of what the classroom is like from an undergraduate's perspective and to focus more on the pedagogical aspects of the classroom. This kind of activity is even good for seasoned professionals to partake in by going to visit, and be visited by, colleagues to debrief their teaching.

Week 8: Round Table Discussion

Here we discuss the previous week as a group. Participants discuss what happened in their classroom observations including but not limited to noting what the undergraduate students were doing, what the lecturer was doing, the interactivity of the instructor and so on. Important to this are some subtle things like bring a water bottle to class (stopping for pauses in class) and how the instructor reacted to something bad happening (if anything bad did happen). Discussions are always enlightening but vary based on what was observed.

Week 9: Mini lectures Part 3

The last 15-minute mini lecture is given for the last 15 minutes of a topic near the end of the course (we focus on answering questions and classroom feedback). Extra challenges can sometimes be inserted into lectures here (for example, most participants in computer science will have a slide deck they must cover and sometimes this is added as a restriction here).

Week 10: Questions

WEEK 10: PRACTICUM

We pair up each of our participants with an instructor teaching a similar course to the one our graduate student participant has been thinking about and we get the graduate student to deliver a live lecture in front of real students. Seeing 200 people in a classroom, answering real student questions, making live mistakes, trying to recover and so on: there is no substitute for an in-classroom experience. We debrief the student afterwards on their lecture and give them constructive feedback on what to focus on next time.

Week 11: Scenarios

In this week, we discuss a variety of situations (see [1] for some more examples). Some topics include handling student complaints, reacting to poor midterm performance, getting teaching assistants to mark on time and other important topics. This activity can be run as a gallery walk – break up participants into small groups say of size 3 or 4 and give them each a chunk of chalkboard space to write down their answers to what they would do in a select collection of scenarios. Then have participants move around the room until they have attempted each scenario.

Week 12: "How to Get a Job"

In this final week, we discuss next steps for participants with a focus on how to set themselves up for a competitive job market. We discuss creating a webpage, a *curriculum vitae*, a teaching dossier, asking people for reference letters (and in particular getting people to watch you actually teach a real class) and activities you should participate in to help boost your chances of getting hired.

Future Steps for the Seminar

In terms of content, the above outline has worked very well for the needs of the University of Waterloo. One of the biggest downfalls to the above is the issue of scaling. As we have somewhere in the neighbourhood of 800 mathematics graduate students (across all 5 departments), we have a large desire to want to make this bigger without adding too many additional resources. The current model can handle 20-30 students per term offered which pales in comparison to the potential demand.

Another perhaps bigger issue is the voluntary nature of the project for everyone involved. Currently no one involved in the project is getting much credit for participating. Participants are now starting to get some credit for the Certificate in University Teaching program our Centre for Teaching Excellence offers (peer review classroom observations are part of the program). The Combinatorics and Optimization department has been allowing students to take the program in lieu of their in-house training workshop required before they can teach a class. Otherwise, students are there primarily because they want to learn how to become better instructors.

Further, those organizing the seminar and those doing mini lecture reviews are given no credit whatsoever. Many do it simply because they realize that a program like this is something they wished they had and want to contribute to the betterment of the seminar. The plan moving forward is to elevate the status of this seminar as an official course (as a partial credit course) which would serve several important purposes. First, it would allow students to get overt credit on their transcripts for the course (that is, there would be proof that they took a course and passed it). Second, it would allow those organizing the seminar to get some sort of recognition for the work that they have done. Additionally, adding it to the calendar necessarily means we would need to find someone to teach it each term which would ensure the seminar doesn't collapse should some key members find themselves too busy to participate in it. For longevity purposes, having this course on the books is an extremely meaningful step and is one we hope to accomplish in the near future.

The seminar took a year off in the midst of the COVID-19 pandemic (2021). Since most of the work involved is volunteer work and the pandemic increased many of our workloads, the team thought it best to take a year off and try to wait out the pandemic. The plan is to resume offering the seminar in 2022. We had discussed ways to adapt the seminar to the online medium, however decided that taking time off to focus on other projects was in the best interest of everyone involved.

Final Thoughts

Such a project really couldn't have been possible without the fantastic collection of colleagues we have here at Waterloo. I've asked for many favours of people and every time it seems like the call for help has been answered by a plethora of eager and willing members of the community! I cannot overstate how fortunate this project has been to have such a great set of people who are passionate about teaching working behind the scenes to make everything possible.

Another key component to making this work is having someone with institutional knowledge. I often colloquially refer to this as **clout**, having some influence and know-how to be able to get things done at a university. For this I cannot thank Brian Forrest enough for all his advice and support in helping to realize this shared vision we had for graduate student instruction.

For those of you interested in trying this out in your home institution, I encourage you to reach out as I am happy to share any of the above resources you want to repurpose. I also encourage you to try to start off with incremental change. This project has required somewhat of a culture shift to get off the ground but once more and more people see the value of giving some basic instructional tips to future professors of our trade, the snowball effect rolls into motion and it becomes easier and easier to make more and more meaningful and impactful changes to the way we train future generations.

Acknowledgements

This is a joint project with Brian Forrest and was done in collaboration with several outstanding members at the University of Waterloo over a number of years, including Andrew Beltaos, Diana Castaneda Santos, Cecilia Cotton, Zack Cramer, Edward Dupont, Paul Kates, Blake Madill, Nicholas Rollick, Victoria Sakhnini, Diana Skrzydlo, Caelan Wang and Dan Wolczuk and many others that have helped in some way with the project.

I would also like to thank the CoMInDS (College Mathematics Instructor Development Source) community, part of the MAA, for the opportunity to take part in their onboarding for helping to rethink parts of the seminar. If the reader is interested in doing this at their home institute, the resources this community provides can be a great starting point.

Carmen Bruni is a lecturer at the University of Waterloo and has been since 2015. He started with the Centre for Education in Mathematics and Computing and moved to the David R. Cheriton School of Computer Science in 2017. He obtained a Ph.D. in Mathematics from the University of British Columbia studying extension of Fermat's Last Theorem.

Reference

- [1] Banff International Research Station for Mathematical Innovation and Discovery: Innovations in New Instructor Training. <https://www.birs.ca/events/2019/2-day-workshops/19w2231/videos> Retrieved on October 12th, 2021.
- [2] Bruni, Carmen and Leung, Fok-Shuen (2020). *Authentic experiences in two mathematics graduate student instructor training courses*. Syllabus Journal Vol. 9 No. 2.
- [3] Hauk, S., Speer, N. M., Kung, D., Tsay, J.-J., and Hsu, E. Video cases for college mathematics instructor professional development. Retrieved from <http://collegemathvideocases.org> on October 12th, 2021.
- [4] Professor Leonard (2012). Calculus 1 Lecture 2.1: Introduction to the Derivative of a Function. Retrieved from <https://youtu.be/962lLfW-8Jo> on October 12th, 2021
- [5] UCI open (2013). Math 2B. Calculus. Lecture 01. Retrieved from <https://youtu.be/GtP6CUEHDhY> on October 12th, 2021
- [6] Wason, P. C. (1966). Reasoning. In Foss, B. M. (ed.). *New horizons in psychology*. Harmondsworth: Penguin Books. pp. 135-151