Teaching statement
Darij Grinberg

Before enrolling as an undergraduate at the LMU (Ludwig-Maximilians-Universität) Munich, I was exposed to mathematical teaching and education from various sources: I had attended mathematical seminars organized by the German mathematical student contests (such as the BWM and the DeMO), training camps for the International Mathematical Olympiad, as well as meetings of the QED club (a society of highschoolers and undergraduates interested in mathematics, organizing student-led minicourses and meetings with talks given by both professors and students). At the latter, I also had my very first experience giving talks (a skill I greatly enhanced during my time at MIT), as well as writing expository papers (some of which can be found on my website).

In Fall 2007, as an undergraduate, I led a recitation for the first time. My job involved discussing some problems (mostly preselected by the lecturer, Hans-Jürgen Schneider, but including a few of my own) with a group of (approx. 20) students in a weekly session; the solutions were presented by students or by myself, or, more commonly, it went halfway between these two extremes. I still have fond memories of these recitations; the interaction in the classroom was highly constructive, and I think I have genuinely gotten important ideas across.

I had a similar assignment in Fall 2009 on Rudolf Fritsch’s Elementary Geometry course; it additionally had me create some homework problems and write up solutions. This class, tailored to schoolteachers in particular, explored some lesser-known parts of (mostly) elementary mathematics. I believe that this kind of course (of which more could be imagined, covering, for example, basic combinatorics, classical cryptography, coding theory, or many other topics) are more useful to prospective schoolteachers than much of the standard calculus sequence.

Since starting my graduate studies at MIT in Fall 2011, I have been a teaching assistant to several classes, with duties ranging from grading homework and exams to holding office hours to leading recitations. In Spring 2013, I was an assistant in Neil Olver’s 18.301A class (Principles of Discrete Applied Mathematics); I graded homework, held office hours and took part in the preparation of the problem sets. In the same term, I graded homework for David Spivak’s experimental 18.S996 class (Category Theory for Scientists)\(^1\).

\(^1\)This was a rather unusual course, whose goal was to acquaint students in STEM fields (particularly those other than mathematics) with the basics of category theory. Spivak was teaching out of his own notes, which later became an arXiv preprint and subsequently a book. Seeing the book take shape (based on lively interaction between Spivak, the students and myself) was a memorable experience, and has taught me various ways of encouraging and absorbing student feedback.
In Fall 2014, I got to lead recitations once again, for two sessions of Alexander Postnikov’s 18.06 (Linear Algebra) class; this time, it involved a considerable creative leeway, as I made my own recitation materials and invented my own exercises. I believe I managed to help and improve the performance of many of my students, although the students came from varied backgrounds and had rather different levels of familiarity with mathematics. Besides the recitations, I held office hours, took part in the grading of exams, wrote solutions to some problem sets and some extra review problems, and dealt with some contingencies of grading.

In Spring 2015, I was a teaching assistant in Ju-Lee Kim’s 18.781 (Theory of Numbers) class. Again I held office hours, wrote solutions, and graded homework (there are no 18.781 recitations at MIT).

Apart from this regular teaching, I have been mentoring students within the MIT’s PRIMES program every year since 2012. The program (started in 2011 by Pavel Etingof at MIT, and expanding ever since) focuses on promising high-school students with a serious interest in mathematics, and lets them work on real research problems under the supervision of graduate students. The rather young history of this program already boasts several publications. In my first two years, I mentored a student named William Kuszmaul (now a Stanford math/computer-science major) on two highly successful projects, leading to one published and two submitted papers and several awards for the student. In 2014, I mentored a project by Eric Neyman, leading to a preprint as well which will also eventually become a paper. In 2015, due to

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2I received highly positive evaluations (on a 1–7 scale): 6.2 (“Simulated interest”), 6.7 (“Displayed thorough knowledge”), 6.3 (“Helped me learn”), 5.8 (overall rating), 6.3 (“Presentations were well-organized”), 6.6 (“Instructor encouraged participation”), 6.1 (“Instructor used good examples”).

One student evaluated my recitation as a “great job” and wrote that I “Picked good problems, answered questions, reviewed areas of confusion”.

3Here (http://web.mit.edu/18.06/www/Fall14/Midterm3ReviewF14_Darij.pdf) is an example of a review problem set that I wrote. It illustrates the “double bottom” approach that I like to take, in which I both give basic material that should help struggling students (e.g., there are some explanations of how to substitute things into polynomials in the solution to Exercise 0.2) and some advanced/nonstandard material so that the high-riders don’t get bored.

4In more detail:

The 2012 project led to a paper:


which also won William the Davidson Fellows Scholarship in 2013 ($10,000). The project also contributed (jointly with another PRIMES project with another mentor) to the writing of another preprint:

the time constraints of my final year of graduate studies, I have downshifted to a PRIMES reading project, which aims not for a publishable result but for a learning outcome; in this project I am teaching two high-school students the basics of algebraic combinatorics and determinants. I am one of the three “2015 Lusztig mentors”.

In teaching, I believe in the use of student feedback to improve the course and to address the needs of the students; and, in turn, I believe in the use of the internet and other computing technologies to facilitate student feedback. As an example of the former, some of the exercises I have been giving in my 18.06 recitations were targeted at addressing common (student) misconceptions that I had become aware of previously, and at clarifying material that I had found students shying away from. When posting solutions to the 18.781 problem sets, I updated my solutions after seeing the students’ homework to discuss interesting ideas and common mistakes found in the latter. I good experiences with using an MIT-managed LMS (Learning Management System) to manage homework (for the 18.781 class) in a fully paperless way, with the benefit that students would receive the feedback on their work as soon as it was graded. I also think of computer algebra systems such as Sage (to which I contribute code and documentation) as great tools in teaching. In further teaching, I aspire to apply these and other techniques to improve teacher-student communication.

I am a strong proponent of open access and semi-expository writing (lecture notes and “handouts”). I regard an ideal lecture as one accompanied by publicly available lecture notes, as well as (coming back to the issue of student feedback) a forum for student-lecturer and inter-student communication. I strive to achieve this ideal in teaching.\footnote{The latter is actually made possible by the MIT’s LMS, although the usefulness of the forums is highly dependent on whether the lecturers and teaching assistants actually visit the forums to provide expertise. In 18.06, such a forum appeared to be rather successful. Even without handy tools like this, a rudimental question-and-answer feedback channel can be established using email and a website, and the greatest benefit to the students comes from the availability of the lecturer to answer questions and clear up misconceptions, rather than from the use of a specific system or toolkit.}

\begin{itemize}
\item The 2013 project led to a preprint: \begin{itemize}
  \item \textbf{William Kuszmaul, A New Approach to Enumerating Statistics Modulo }n, \newline\texttt{arXiv:1402.3839},\end{itemize}
\end{itemize}

which has been submitted to Journal of Combinatorial Theory (Series A). William has earned the third place in the 2014 Intel Science Talent Search (coming with a $50,000 award) using this paper.

which is currently under review in Electron. J. Comb., and which made William and Ziling Regional Finalists in the 2012–13 Siemens Awards.

The 2013 project led to a preprint:


which has been submitted to Journal of Combinatorial Theory (Series A). William has earned the third place in the 2014 Intel Science Talent Search (coming with a $50,000 award) using this paper.

The PRIMES 2015 reading project I have been mentoring led me to writing a set of notes, which are available on my website. I furthermore co-authored Victor Reiner’s lecture notes on Hopf Algebras in Combinatorics, roughly doubling their size by adding exercises and a new section.