Teaching Statement

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1 Methods and practice

Mathematics starts with noticing patterns, asking questions and formulating problems; it goes on with finding reasons and explanations; and finishes with stating definitions, theorems and constructing proofs. With experience we find analogies, and through abstraction we obtain general techniques and theories, which may then be applied to various problems and domains.

As professional mathematicians, we then have the task to pass on the acquired knowledge to the new generations. Thus to fulfil this task efficiently, we should do our best to provide some intriguing examples and encourage the observation of patterns; arouse questions which are both interesting and susceptible to be addressed by mathematical reasoning; teach the art of formulating rigorous conjectures which express our intuitions; propose appropriate definitions and find the steps to construct the proof of our statements; and finally take a step back, look for the hidden assumptions, criticise the well-fondedness of the proof, and ask for simpler approaches. Of course all this process is non linear, and a course in mathematics seldom covers all these steps, but I believe it is important to include as much as possible, and we must appeal to the psychological learning process while presenting the logical development of theories.

We have at our disposition a whole spectrum of teaching practices and methods, and it is appropriate to adapt them for the kind of mathematics involved. The institutional courses often contain a core program consisting in the theoretical background the students are expected to master. But from my personal experience, I find that there is no better way to learn mathematics than to do them, and I have retained much more from my own investigations than from the academic courses. So if I am to be honest with myself, my teaching practises should involve my students as much as possible with the material, for instance by proposing them individualised projects alongside the course, which they can present at the end. Such projects can ally bibliographic investigations, presenting historical developments, working on a specific problem, et caetera.

The students assimilate the material much better if we involve them in the creative process. In the long run, many forget most of the content, but they retain the main ideas and especially the method, as well as the confidence gained by successively solving the problems and the enjoyment they found by leading their own investigations. These are the qualities they will need to contribute, in due time, to the progress of science and its legacy, and our job as teachers is to foster them.

That being said, and despite my convictions, I can very well adapt my own teaching methods to the requirements of the hiring institution. Indeed, some coordinated courses given at a large scale have a strict program, which we are responsible to cover to avoid introducing some bias between sections. In such situations, I have learnt to find a balance enabling me to cover the material properly while remaining faithful to my practises, distilling the methods of discovery.

2 Experience

2.1 Preparing advanced exercise sessions

From 2016 to 2018 at the école préparatoire du Parc in Lyon (France): I organised weekly oral examinations preparing for the "concours des grandes écoles", dealing mostly on linear algebra and real analysis. As a farewell, it was a pleasant experience to introduce these undergraduate students to Arnold's combinatorial study of plane curves in surfaces, during an informal evening lecture.

From 2019 to 2021 at the Université de Lille (France): I have directed exercise lessons in calculus and in probability at an undergraduate level; those included periods of online teaching which went quite well. The challenge was different to the previous: it required much more patience and effort in the explanations than preparation of astute exercises.

2.2 Teaching courses (coordinated and independent) at PSU

I was in charge of several courses from 2022 to 2025 at The Pennsylvania State University (USA).

First, I taught several iterations of a coordinated course in calculus for second year students majoring in various domains (such as biology, computer science, engineering sciences, humanities or natural sciences). After the second iteration of the course I had a better idea of the students difficulties and desires, and I learnt to adapt my discourse to their various needs. Then, I was in full charge of a course in discrete mathematics (combinatorics and the art of writing proofs) for third year students. I had more liberties and was able to implement a little more of the ideas and methods described above in section 1, with variable success depending on the students.

Finally, I was in full charge of a course in enumerative combinatorics for third and fourth year students (which was optional). This was thrilling experience, both for the students and me. Indeed, I made the most of my freedom to fully implement the ideas and methods described in section 1, as we followed the "inquiry-based learning" approach proposed by [Pet19]. More specifically, after an introductory lecture about the goals and methods, I invited the students to form groups for the whole semester (which were variable at the beginning but they stabilized very soon). Every week in class they worked on the problems of the current chapter in their group, while I was turning around guiding them through this problem solving approach ([MBS12]). Sometimes I gave a short lecture at the board, to introduce some general material useful for the current chapter or to present several solutions to some of the problems. Their homework was to hand in properly written solutions of a selection of problems that they worked on in class.

2.3 Prompting and responding to students

While teaching, I constantly encourage students for their questions and solicit their participation. I observe various modes of interaction between the students and with me: these social dynamics depend on their past and backgrounds, and while they are rather complex we can observe similar patterns and certain codes. With this in mind, I try my best to distribute the speech and focus on those who have the most difficulties while still providing snippets of thought for the most advanced.

2.4 Interaction with graders

For all these courses I was accompanied by a grader or learning assistant, who helped me grade assignments or guide students during exercise sessions. It is gratifying to hear from some of them how much they benefited and enjoyed from the experience: they remember the examples, analogies, anecdotes, references or viewpoints I propose about the content, but especially the methods discussed in section 1 which we tried to put in application. Meeting them in the corridors always lifts a smile.

2.5 Supervising undergraduate research experiences

From 2023 to 2024 at The Pennsylvania State University (USA): I supervised a student as part of an undergraduate research experience. This student majoring in computer science attended my calculus class during the Fall semester 2022, and came at the end asking for further references about Taylor expansions. I proposed him H. Wilf's book "generatingfunctionology" [Wil90], of which he read the first couple of chapters. He came back to me in spring 2024 with the desire of pursuing an REU project, so I proposed him a thread of investigations in algorithmic and combinatorial graph theory with applications to the topological study of plane curves. We used to meet every week between 1 and 2 hours, including during vacation. Our motivation for the project remains and we are still working on it, meeting online from time to time. It should soon lead to a common preprint. My role so far has been to explain the general context and goals while teaching him the mathematical notions he needs along the way, to propose some precise questions and more open directions of research, to guide him through the literature, as well as to share general strategies and methods of investigation. As we are both thinking about this, he also feels privileged to be part of a common project: we are making our way though discovery.

3 Resources

I have regularly reflected upon my own learning and thinking process, from an early stage. In particular, this led me to read the book by Mason about thinking mathematically [MBS12] in 2013, the volumes of Polya on plausible reasoning [Pol54a, Pol54b] in 2015, along with a few essays on related topics such as [Sch94], as well as Klein's historical presentation of the development of mathematics in the 19th century [Kle28] in 2019.

Moreover, as I often read material to complement the courses in the curriculum or to learn about topics of my own interest, I gradually gained a fairly good idea of the existing literature in several domains. I can thus propose references adapted to various demands including online resources, and use some as teaching material.

References

[Kle28]   F. Klein. *Development of mathematics in the 19th century*. Springer-Verlag, 1928. Translation by M. Ackerman.

[MBS12]   John Mason, Leone Burton, and Kaye Stacey. *Mathematisch denken. Mathematik ist keine Hexerei*. München: Oldenbourg Verlag, 6th updated and revised ed. edition, 2012.

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[Pol54a]   G. Polya. *Mathematics and Plausible Reasoning. Volume I: Induction and Analogy in Mathematics*. PUP, 1954.

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[Sch94]   Alan H. Schoenfeld. Reflections on doing and teaching mathematics. In *Mathematical thinking and problem solving*, Stud. Math. Think. Learn., pages 53–75. Erlbaum, Hillsdale, NJ, 1994.

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