

UTTER ELITISM: FRENCH MATHEMATICS AND THE SYSTEM
OF *CLASSES PRÉPAS*

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Vergäß' ich alles, was du mir gabst . . .

Prelude. I do not think objectivity is a mathematician's virtue. Although I firmly believe mathematics is an observational science, with all the need for modest honesty it implies, I never observed any particular form of ability to be objective among my colleagues, nor in myself, nor even thought it necessary. There is no need for the subtleties and circumspection of dialectics in institutional mathematics: neither in seminar, nor in class. Actually all one can hope from a mathematician, is an aggravated subjectivity clad in rationality: a mere opinion in olympian disguise.

This text is no exception; being aware of it I shall try and give not the personal opinion I may have, but the idealized opinion one might have. It is outrageous, snobbish, delightful, and salutary; anonymity is a natural consequence. I wish to thank two anonymous colleagues.

1. *What are prépas?*

1.1. *The French system: guidelines*

French children must by law be taught from age 6 to 16. They may however not go to school and learn at home; this is infrequent and not our concern as home-taught children can hardly survive prépas for reasons which will be obvious.

- Age 6-11: École primaire
- Age 11-15: Collège
- Age 15-18: Lycée

- 18+: Université, or Grande école, or (Prépa then Grande école)

Both words *Collège* and *Lycée* describe a set of grades (corresponding to Advanced Level) and the school where they physically take place.

There are a couple of examinations along the years. One at the end of Collège (“*Brevet des collèges*”: no value), and one at the end of Lycée. This “*baccalauréat*” does not mean much, since a preposterous 85% taking it gets the degree. Actually 65% of the global generation gets the degree[†]. This results from a policy started in the 80’s (when only 25% of the generation eventually obtained baccalauréat) of sending virtually anyone to higher education: more than half a generation now goes on to higher education. This was done in order to prevent the unemployment rate of the young from exploding, and under the pretext of democratisation of knowledge in a wealthy society. It succeeded in considerably lowering unemployment among the young and university level.

1.2. Grandes écoles *and* classes prépas

Classes prépas stands for *classes préparatoires aux grandes écoles*, that is CPGE in the acronym-oriented language of the French administration. A *grande école* (eg. École Polytechnique) is a small competitive college where one gets specialized education[‡]; it might be attached to a ministry other than the Ministry of Education.

Admission to an école can take place either right after baccalauréat or after a two-year preliminary course. The latter is to be completed in another type of school in order to prepare for the entrance competition: *la prépa*, to which we’ll come in a moment. But in the first case as well, an equivalent two-year preliminary course (though with no final competition) is completed: it is called “*prépa intégrée*”. From this structural observation we deduce that what really matters in the system is not the grande école, but the prépa.

Grandes écoles for which the competition takes place after prépa thus run parallel to the University starting at year 3: years 1 and 2 are the prépas years. There are around 90 such science grandes écoles (a hundred more with prépa intégrée); there also are around 30 business grandes écoles, and exactly four grandes écoles for humanities. The best

[†][2, p. 5] or INSEE. http://www.insee.fr/fr/themes/tableau.asp?reg_id=0&ref_id=NATTEF07252.

[‡]<http://www.dsi.cnrs.fr/RMLR/textesintegraux/volume4/43-adu27-08-1992.htm>.

science grandes écoles are public which in French means free. Business schools have imposed a counter-cultural specificity: one has to pay in addition to passing the entrance competition.

There are around 350 prépa institutes of all types on the territory, covering 2000 classes with an average of 40 students per class[†]. These institutes are usually paired with lycées, actually forming one entity, though some purely-prépa institutes do exist. (It is an interesting observation that in any case, students from prépas and from A-level hardly mix: prépas students are forced into quick maturity, and have little time anyway for extra-class friendships.)

Prépas institutes are not directly related to specific grandes écoles; one might therefore be advised not to think about those as prep' schools. More or less matching the types of grandes écoles, there are officially three types of prépas: science, humanities, and business. Around 90% of classes prépas are public, that is free; theoretically they are open with no entrance examination but the real selection arguably takes place at this stage which serves as a sociological sieve.

1.3. *History of prépas*

The system of classes prépas is huge and old, and goes much beyond preparing the happy few to the joys of algebraic geometry. It never was meant to train mathematicians but originally engineers on a large scale. Of course an impulse was the creation, under *la Convention*, of *École polytechnique* and *École normale*. But a myriad other grandes écoles were created afterwards, e.g. *École centrale*.

One could trace the tradition before the *Révolution* to elitist military schools: it appears that Monge was conducting an entrance examination at the French Navy academy, and Laplace at the School of Artillery. In any case the system in its current form already existed 150 years ago: elitist grandes écoles, an entrance competition, and some form of a prep' school for candidates. When one considers all the political changes France has been through ever since, one sees that the classes prépas-grandes écoles system is – at least was – the backbone of meritocratic bourgeoisie.

[†]Ministère de l'Enseignement supérieur et de la Recherche. <https://www.sup.adc.education.fr/cpgelst/>.

1.4. *Heterogeneity*

Virtually every Frenchman working as an engineer in the last two centuries went to a *grande école* in the broad sense: although the University now delivers degrees in engineering (a rather recent phenomenon since it seems to be post-World War 2; only 20.000 students currently following this course[‡]), few are as highly considered as would one from a *grande école*, even a modest one.

It goes without saying that the prestigious *grandes écoles* are those where the entrance competition takes place after *prépa*. Here is an implicitly admitted hierarchy of science *grandes écoles*: the top are clearly *Ulm* (École Normale) and *l'X* (Polytechnique). For pure mathematics, the place now is Normale; a hundred and fifty years ago it was Polytechnique. Poincaré went to Polytechnique. Galois was forced into Normale because he failed at Polytechnique! Using the privilege of being anonymous I would say that Polytechnique is no longer research-oriented; it is not its goal anyway. In addition to *rue d'Ulm* there are two other *écoles normales*, one in Lyon and one in Cachan; they are not as elitist as the one in Paris.

Interestingly enough, students at Normale and Polytechnique are paid (Normale: gross 1.500 euros/month[‡]; legal minimal wage in France for a full-time job: gross 1.400 euros/month[‡]); they do not perform any kind of work but study. One may explain the case of Polytechnique by observing that after all, it is a military school; it is not the case of Normale. Creating a moral debt to the system is part of the idea; after all, not every young researcher will resist the sirens of a non-trivial integral factor in salary by simply crossing the Alps or the Atlantic ocean.

Coming back to our hierarchy, then come Centrale, les Mines, les Ponts. Then, the rest – a huge load of them. One may think that with the devaluation of engineering jobs, the stream of students will be deflected to business schools and dry up; on the other hand, diplomas from prestigious schools are still held in high consideration, so famous *écoles* remain very attractive. Many polytechniciens and centraliens hold expensive positions in banks. As a consequence one, especially if anonymous, may argue that Polytechnique is now a business school.

All this – engineering, not to say banking – relates to mathemat-

[‡]INSEE. http://www.insee.fr/fr/themes/tableau.asp?reg_id=0&ref_id=NATTEF07113.

[†]ENS. <http://www1.ens.fr/entrer/statuts.php>.

[‡]INSEE. http://www.insee.fr/fr/themes/tableau.asp?ref_id=NATnon04145.

ics and research. Prépas supposedly train for all schools, from modest provincial engineering schools to écoles normales. The entrance competitions to the top schools are not common: this enables various levels. But the global programme is – it is, as everything in France, enacted by national laws[§]. Hence being trained more specifically for a given, prestigious competition, will strongly depend on the prépa institute one goes to.

1.5. *The tip of an iceberg*

There is nothing extraordinary in small grandes écoles and obscure prépas. On the other hand no one can question the amazing success prépas are in terms of manufacturing French mathematicians.

Except for Grothendieck, every great mathematician in the country went to Normale or Polytechnique. But not only great mathematicians: actually most French mathematicians went to an école normale or Polytechnique, and almost surely to a classe prépa. From them, every single one will have recollections from his time in classes préparas. This behavioural feature is yet another, psychological, hint of how important prépas can be in one's intellectual development.

It should therefore be borne in mind that I shall not describe the norm of the system, but its extreme case: the making of mathematicians on the tip of an iceberg.

2. *(Shameless) Elitism*

2.1. *Geography*

What is Quartier Latin?

Quartier Latin is the skull of France.

At its center, la Sorbonne, established in 1253. On Montagne Sainte-Geneviève, in the 1450's, François Villon then a student erected barricades. In the late sixteenth century, the mighty Jésuites were bred on rue Saint-Jacques. A little further west, near l'Odéon, stands *le café Procope* where Danton and the *club des cordeliers* would meet during the French Revolution. In 1794 the Convention transferred the body

[§]for the case of mathematics, <ftp://trf.education.gouv.fr/pub/edute1/bo/2003/hs5/annexe1hd.pdf> and <ftp://trf.education.gouv.fr/pub/edute1/bo/2004/hs3/annexe1.pdf>.

of Jean-Jacques Rousseau to Panthéon, on top of Montagne Sainte-Geneviève. The nineteenth century saw the discoveries of Louis Pasteur in his laboratory of École normale, on rue d’Ulm. Later Pierre and Marie Curie would install theirs not far. In 1875 young Henri Poincaré moved from Polytechnique, then on Montagne Sainte-Geneviève, to École des Mines, on Boulevard Saint-Michel by the garden of Luxembourg: a ten minute walk. Fifty years later, Louis de Broglie worked on rue Pierre Curie, in Institut Henri Poincaré. A little downhill, in the seventies, Michel Foucault and Gilles Deleuze taught at Collège de France.

This is immense; this is not one square kilometer.

2.2. *Louis-le-Grand*

Rue Saint-Jacques, in front of la Sorbonne, stands a lycée.

The French Jésuites were once educated there. Louis XIV was so proud of it that he wanted it named after him. Napoléon was so proud of it that he wanted it named: lycée impérial.

Here are a few former students of Lycée Louis-le-Grand: Molière, Voltaire, Diderot, Robespierre, Sade, Hugo, Delacroix, Baudelaire, Degas, Jaurès, Sartre.

Half of the French Fields medalists went to Louis-le-Grand. Poincaré and Galois before them.

In France we do not ask: “Trinity”? – we ask: “Louis-le-Grand”?

The prépas system goes well beyond training a few for the top schools. But Louis-le-Grand, almost an official purveyor to all Grandes Écoles ever since the latter were founded, makes a specialty of training students specifically for Polytechnique and Normale. In a sense going to a math prépa in Louis-le-Grand is precisely the experience of a mathematical prep’ school; it is much deeper. In Louis-le-Grand there is an A level, and there are prépas for Humanities. And every stone of it whispers more memories than historians can tell. Rabelais dreamt Abbaye of Thélème; Paris built Louis-le-Grand.

Personal recollections will not refer to what an average prépa can be but to the author’s years at Louis-le-Grand. It is a small elitist world. From my second year classmates, a half entered Polytechnique; half a dozen went to Normale. My office mate in my math department was a classmate in A level and in prépa. The chair of my math department,

a gentleman who could be my father, had the same teacher as I did in second year – then a young professor, already at - Louis-le-Grand.

May these lines be the opportunity to thank Jacques Chevallet, a noble mathematics master. His austere attitude to us was more caring than any hypocritical friendly behaviour. He saw beyond our present the future and respected it. Was any greater lesson ever taught?

2.3. *Sociology*

After the A level (*le baccalauréat*), students interested in sciences have two possibilities. The university, or the classes préparas. A few good ones with an advice will go to prépa (currently around 80.000 students in all categories of préparas; 50.000 in science prépa; almost 1.500.000 in all universities[†]). One can hardly imagine how poorly considered French university is in France. A reputation for uselessness among the mass, for disobedience among politicians; for idleness, seen from grandes écoles. The upper-middle firmly knows it: a student in sciences who goes to university will spoil his talent.

Many préparas students were in an elitist lycée, where teachers passed them the information. Of course one needs good baccalauréat grades to be admitted to a prépa, and an excellent academic record to be admitted to a good prépa. But one mostly needs to belong to the social component where préparas are known to exist[‡].

As a consequence préparas are the exclusive preserve of the upper middle - due to relative secrecy of information, inner codes and pressure, and simply requested time and money. They are perfectly free but one needs: time, independence, a little money for books, and a quiet room in the parents' flat. Some even pay fairly expensive private lessons taught by former, successful students. What is the use of a scholarship if you're an outsider? What is the use of a scholarship system if potential candidates are but seldom aware of it? Sociologically speaking, préparas are thus for teachers' sons: the statistics are almost obscene.

One sees in France dynasties of polytechniciens, from great-grandfather to great-grandson. A normalienne friend of mine dated, in a row, five normaliens, and is now marrying one. A snobbism not worse than the

[†]http://www.insee.fr/fr/themes/tableau.asp?reg_id=0&ref_id=NATTEF07113.

[‡]Ministère de l'Éducation nationale. <http://media.education.gouv.fr/file/28/2/6282.pdf>. A complete study is [1].

one in say Columbia University, but it is shocking to the French taste to see snobs who did not pay.

Foreign students are few: a global 2.6%[†]. A French baccalauréat, or analogue, is required to apply: as a consequence, and also because classes follow an amazing pace, no student enters if not a master of la langue de Molière. Every year, Morocco and Tunisia send their best to Paris in order to prepare Polytechnique. They are of course perfectly fluent, and since their governments waste no time peneloping the clever, old school programmes, they usually come in with knowledge above the average.

However the typical profile of the math prépas student in Louis-le-Grand is that of a male kid of the upper-middle, aged eighteen. He comes from Paris or province (the word for France without Paris); there are several high quality prépas institutes in province, but Louis-le-Grand has a reputation. If from province the student can be boarded by the institute (there is no boarding for A-level students, who all come from Paris and the suburbs). In any case being an insider with daily family comfort helps, especially at this age.

Our typical student is there because in post-World War 2 French society, kids are judged after their mathematical abilities; being clever means being able to learn trigonometry at age 12 (a century ago it was Latin), in which case Polytechnique is your share. Some are there of course because they like mathematics. The upper middle do value, after all, pure knowledge: and consider themselves wealthy enough to have their kids follow their own tastes – especially if intellectual.

Hence people go to prépa: out of ambition, out of sheer social imitation, or out of early taste for science. It is one of the few places I can think of where the latter are not deemed insane. As a result, every student has a reason to be there, and everyone works quite seriously. It is not abnormal not to celebrate New Year's Eve because one must finish le DM de maths (math homework). – We were seventeen and despised Rimbaud's verse: *On n'est pas sérieux quand on a dix-sept ans*.

Some quit. The global rate for science prépas is of 20%[‡]. In Louis-le-Grand it was much lower, under 10% – everything was so quick that one hardly had time to consider quitting, unless the teachers themselves advised to; besides everyone knew that going to prépa is a commitment.

[†][3, p. 32]; compare to University.

[‡]Ministère de l'Enseignement supérieur et de la Recherche. [3, p.39].

The suicide rate in *prépa* may be comparable to the average among teenagers. I have no statistics to support this impression, and I doubt such statistics do exist.

An interesting proportion of boys (around 85% in my institute; national average for science *prépas* is 70%[†]). Quite fortunately, there were classes *prépas* for Humanities. And there always is la Sorbonne.

2.4. *The social lift*

Remember that *prépas* and science grandes écoles are free; that students at Normale and Polytechnique are paid. The use of giving a scholarship to sons of the upper-middle who could well afford an expensive education seems uncertain; fortunately the fact is not too widely known. Apart from the upper-middle, the French do not know about Normale. They know about, and have respect for, Polytechnique – I suppose mostly because of their parading on Champs-Élysées on July 14th. In short, taxpayers of the lower classes pay for a system their children cannot have access to; they pay twice, so that young normaliens and polytechniciens can drink cognac instead of wine.

We say that the social lift is out of order; before the upper middle cornered *prépas* and grandes écoles, things were different [4]. A peasant's son, if spotted by a clever school teacher, could go study. In one generation one could become a professor; in two, an eminent statesman. Élie Cartan's father was a blacksmith. Lebesgue's was a typesetter. Painlevé's: draughtsman. Baire's: taylor. Things have changed, not only because of school teachers: every system of social production turns into a system of social reproduction. The question of the legitimacy of classes *prépas* is an issue in France: the system costs money (a University student costs 10.000 euros a year; a *prépa* student 15.000[‡]), and is in sociological terms a real high-jack, for disputable global results. Moreover the system of grandes écoles is sometimes accused of capturing the interest in R&D, thus keeping the University and its numerous students afar from industry.

It must be added that despite these obvious drawbacks, the classes *prépas*-grandes écoles system is fair *within its range of application*. No money can buy admission to Polytechnique; although competition is sociologically restricted to a small stratum, personal merit makes sense.

[†]INSEE. http://www.insee.fr/fr/themes/tableau.asp?reg_id=0&ref_id=NATCCF07112.

[‡][3, p.4].

And anyway, in some sense the upper-middle are now being chastised. A characteristic feature of the very recent evolution of French politics, is that France is no longer governed by former students of grandes écoles. Disdain between the world of politics and the world of research has grown mutual.

But enough for sociology.

3. *Organization*

I focus on science prépas with a math major (a physics major also exists, leading to parallel competitions: one may enter the same schools).

3.1. *The teaching*

No semesters; there are two years: *mathématiques supérieures* and *mathématiques spéciales*. In case one fails at the competitions, one may double the year of spéciales, and from $\frac{3}{2}$ become a $\frac{5}{2}$. (Entering a grande école is called integrating it; Polytechnique is l'X: if you enter between spéciales n.1 and 2, you are therefore a trois demi. No one knows how old this typical piece of slang is; along the years a very tasty underground language has developed, and I presume Chasles already spoke it.)

There are around 40 students per class. One studies mathematics, physics, chemistry, and engineering or computer science. There are 12 hours a week of mathematics, all carried by one teacher. Also 9 hours of physics + chemistry, 2 of engineering/computer science. I shall focus on mathematics, but bear in mind when estimating the load of work that one works almost as much in physics. A survey among students[†] indicates that students in prépas work 58 hours a week, class inclusive. In Louis-le-Grand it is a priori more, but the most brilliant elements work less – a talented classmate of mine mostly composed piano music at home.

I can think of two ways to understand a branch of mathematics. 1: first learn the theory, then do the practice. 2: do the practice, then learn the theory. The French system definitely is 1, where the theory is exposed in full details but at a demanding pace, and the student is

[†]<http://www.ove-national.education.fr/medias/reperes2011.pdf>, slide 8 for the average weekly amount of work.

supposed to work out lots of exercises. So classes are taught the French way: Definition – Theorem – Proof, on a blackboard at amazing speed. (No book. We would have despised a teacher who needed a textbook: one week after a lecture, we could have taught the material without notes.) It is not Bourbaki: there are examples and numerous exercises, though mostly “left to the reader”. But in no case are the students asked to expand, conjecture, or simply experiment. After all, the system was meant to build engineers.

If the teacher feels he can afford five minutes off, he will ask a student to come to the blackboard and explain an example; one may not decline. Intuition and creativity are thus devoted to solving exercises – but these can be quite tough, so bookish work can’t suffice. It is an option to learn as many exercises as possible: with a good memory, enough to enter Centrale, but Normale should require more than that.

To give an idea, I was never asked to invert a matrix or solve a linear system, even in physics. But it was important, in year 2, to be able to prove that unitarily-diagonalizable endomorphisms are precisely those which commute to their adjoint endomorphisms.

3.2. *Supervision*

A specificity of classes préparas, which makes them more expensive for the tax-payer but so remarkably efficient, is the heavy supervision. There is a written examination every two or three weeks (and another one in physics); it lasts four hours and is usually a past subject of some grande école compétition. You know not only your grade but also your rank. Homework, of the same nature, is assigned with similar frequency. And there are *les khôlles*, officially named interrogations.

Every week, for one hour, the student goes with two classmates (a *trinôme* for the year) for oral examination. They divide the blackboard into three, and are cooked by someone who can be a professor of the prépa, of some other prépa, or even some researcher (I give khôlles). It goes without saying that proofs from the course are to be given without a moment’s hesitation. Then they are asked to solve exercises off the cuff.

It is normal not to solve exercises without a help from the examiner. Beyond mathematics, one learns how to be quick and efficiently cope under high pressure with problems one has no idea of. Being helped,

one then gets familiar with solving unexpected difficulties at the worst moment: a school for cold-headedness.

Bad grades are an essential ingredient of the system. It teaches students not be self-satisfied. In Humanities, decades ago, Latin and Greek themes would even be graded decreasingly, following the count of barbarisms and solecisms: hence a 0% was quite honorable. Mathematics teachers never used negative numbers and a 60% at a khôlle is extremely decent. If the first grade the student gets at a written examination is above 50% (“dix sur vingt”: in the French tradition, grades are out of twenty), it is likely he’ll go to Polytechnique. If it is above 80%, he’ll go wherever he wants. If it is above 100%, his path is obvious: he’ll go to Normale, learn deep mathematics, write a brilliant PhD, and end up in CNRS. This will take a couple of years, but no one doubts that as the case is well documented – at least it was in Louis-le-Grand. The trick is to have excellent teachers with a respect for talent.

3.3. *The spirit*

One might be afraid that so much supervision can produce only childish minds, used to being permanently taken care of. This is actually not the case: childish minds naturally break down under such pressure, so immature kids usually dare not even go to prépa, where their ego would meet other egos. In short, the upper middle, which in France were powerful enough, had found a remarkable way of producing civil servants. Former students of classes prépas can work non-stop for years without any risk of burn-out. They are highly reliable.

Crazy pace, permanent ranking, and the ghost of the final competition: this might sound like a totalitarian nightmare. It is not; a gifted young lad of 18 and willing to learn, can bear many unbearable things. The idea of asceticism is around. Moreover tradition has imposed a form of chivalry. There are many grandes écoles, and a decent number of positions (with a math major, Polytechnique has 180 positions): so you may think you are not in direct competition with your classmates. Our idea was simply to have a better entrance rate than Henri IV, the rival institute on the other side of Montagne Sainte-Geneviève. There was a final competition after all, and I presume this is what kept the purely ambitious working, but the challenge was to remain the best as an institute: so-called *esprit de corps* starts here.

3.4. *The programme*

Although the official programme might change once in a while (mostly because A-level is being made empty), teachers at Louis-le-Grand know better: I presume a century ago they did mostly the same in a different language, though with more geometry. The teachers still remember the scandal it was when Lebesgue's dominated convergence theorem was introduced in the late 80's – without a proof, whence the scandal: it is the only unproved result along the two years, and despite a few attempts, unprovable at this level.

You learn how to write a proof during the first week. (Many of us already knew: just go to a good lycée. This is not too surprising because of a strong tradition of mathematical education. I learnt rigorous proofs in collège, but already was in Quartier Latin. Sadly enough one can pass baccalauréat cum laude without having the faintest idea what rigor is.)

- Year 1 (“maths sup’ ”):
 - * Real analysis: limits, derivative, Taylor series, integration (Riemann; mostly computations), linear differential equations (mostly computations).
 - * Algebra: equivalence relations and quotients, definition of groups, rings, fields. Vector spaces (the abstract point of view), matrices, dimension theory, determinants, a little diagonalization. Polynomials and rational fractions.
 - * Geometry: conics.
 - Year 2 (“spéciales”):
 - * Real analysis: metric topology (notions of completeness, compactness, connectedness), real series, power series, Fourier series, linear differential equations; multivariable analysis until local inversion.
 - * Algebra: reduction of endomorphisms (diagonalization, trigonalization, Jordan form), bilinear algebra (adjoint endomorphisms, simultaneous reduction).
 - * Geometry: quadrics.
- All this is theory-oriented.

The purpose of this tedious enumeration lied in its very obviousness. It is common sense to teach these things, regardless of fashions. They form the basis of scientific knowledge; incidently one who has learnt them in prépa, or in any system where one has to work seriously on the long run, will never forget. By the way classes préparas create a huge respect for theory among French engineers. This is not a researcher's

concern; but in a way the strength of the system and the notorious difficulty of *prépas* are advocates of scientific culture.

Briefly put, common sense rules.

3.5. *Les concours (the competitions)*

At the end of the second year, a couple of months are devoted to working on one's own, and then going to the competitions. Let us mention that some have a cost, around a hundred euros; Normale is free. There are first written tests: they last four hours for most *écoles*. For Polytechnique and Normale, there are two math exams; for Normale, the long one lasts six hours. There are examinations in physics as well. Since different *grandes écoles* have different entrance competitions, a student may spend a month, full-time, going to written examinations in several places, and hopefully another month, full-time, going back to oral examinations.

Because provided he is good enough to be selected for the second round, he goes back for the *vivas*. This is what *khôlles* have prepared him for: entering a room, with a man waiting, who asks him to solve a problem. There hardly is an instant's reflection: one must search on the blackboard, as the examiner wants to see not only the solution, but how the candidate thinks.

This is the competitions. This feared-expected moment is the peak of the student's life. For two years, he has had nothing else on his mind; he stands unbearable pressure but was gradually used to it – so he can live through it, and actually enjoy it. He believes his whole future is at stake (this belief is necessary to have ambitious students develop a taste for work). There are many cases of nervous breakdowns after entering the *grande école* of their dreams. As a consequence, for many former students, the competitions remain the peak of their entire lives, and the results of the competitions are their noble titles. The French bourgeoisie is very much like these South-American tribes described by Lévi-Strauss, where the social value of an individual is – his whole life long – entirely determined by some initiatory rites performed as a teenager.

4. *Relationship with the mathematical community*

As said above, professional mathematicians mostly come from *prépas*. Few researchers spent year 1 at the university. This leads to interesting situations: we academics teach students whom we can't really understand, not having studied at the university. We (in a statistical sense), the teachers's sons, the good students, sociologically adapted to a system we have helped building and then virtually confiscated, never were in a situation where an uncertain future would depress us into failing our exams – the standard case in university. Our first year students and we belong to different worlds.

4.1. *Where do teachers come from?*

In *prépas*, the match is perfect: teachers are former students.

One easily imagines that a teacher ready to handle a *classe de spéciales* must know mathematics rather well, especially in an institute where one might have as a student one future Fields medallist. Imagine the pride one teacher at Louis-le-Grand must have felt when, in 1994, *two* former students of his were awarded the medal.

It is a blatant truth: good teachers all come from *écoles normales*, and therefore from *classes préparas*. Many of them have a PhD in pure mathematics, but decided not to go into research. Observe that, as opposed to secondary and A-level teachers, *prépas* teachers are decently paid and enjoy good social consideration.

It goes without saying that *prépa* teacher is a full time job, meaning you have to renounce research. There are, after all, 40 homeworks or tests to grade almost every week (not exactly multiple choice questions) in addition to the decent load of teaching. However they try and keep informed about the spirit of research: all they have to do is ask their friends who went into academia.

Borel and Lebesgue taught at Louis-le-Grand. The system with its uninterrupted, centuries-old, tradition of excellence, has gained formidable momentum. My professeur de supérieures was what? not 30; his course was remarkably clear. Quite obviously he had borrowed it from his years as a student. The same course is now taught by a friend of mine who borrowed my notes. Educational trends? computer-assisted learning? teachers knew what to do before our oldest senator was born.

Their art is a part of the mathematical world heritage. My teachers were modest and entirely devoted to their ministry. It was a shock to me when I discovered the poor quality of classes taught by some professional mathematicians.

4.2. *Side effects*

In terms of making mathematicians, the efficiency of places like Louis-le-Grand is not questionable. Some characteristic features of the prépa spirit are however identifiable. All this is quite disputable but one could suggest:

- (1) a tendency, apparent in these very pages, to organize into hierarchies. Posh contempt towards applied mathematics is a consequence. The French mathematical community obviously retains this feature.
- (2) Euclidianism, in Lakatos' sense: mathematics as a stacking of abstractions – culminating in Bourbaki's cathedral – for which applications are by-products. This is a fast and efficient approach to mathematics; and provided there are enough candidates to afford a few casualties, it is much faster than practice-oriented teaching. Afterwards it takes a while for the student to recover from abstraction; the PhD is usually the moment. (And after all, some never leave the realm of theories.)
- (3) a quest for solitude, mathematical activity being viewed as a form of asceticism, not as a collaborative practice. Perhaps a linguistic study of the use of the word “purity” would be of interest. There is no reason to change a winning team, but one may observe that French mathematics carefully hides its human dimension.
- (4) a tendency to psychoridity – which without a doubt will soon be proved to be genetically linked to mathematical abilities by some obscure north-American university. Mathematicians hate to be wrong, which is quite human; the French ones also hate to confess they do not know. Here is a tidbit of Galois: “*C'est que malheureusement on ne se doute pas que le livre le plus précieux du plus savant serait celui où il dirait tout ce qu'il ne sait pas, c'est qu'on ne se doute pas qu'un auteur ne nuit jamais tant à ses lecteurs que quand il dissimule une difficulté.*” (from the Préface to the Mémoires [5]). This does have an impact on the way we teach, publish and talk to our colleagues.
- (5) a distorted relationship to time: prépas students are sprinters

used to solving difficulties in four hours, but research often looks more like a marathon. Long run temporality is something not taught in *prépas*. (Having a *mezze*-like succession of independent semesters in a university is not ideal either.)

4.3. *Math prep' schools*

It is not easy to reflect upon one's years of learning when one owes everything to them: I am what I was coined to be on rue Henri Barbusse and later rue Saint-Jacques, from ten to eighteen. I have the clear feeling that I have been serial-produced in Paris' fifth district; not mass-produced, but carefully manufactured by a four century old tradition. It is quite remarkable that kids with no talent can be turned into mathematicians (with no talent though). Far from being ashamed of this lack of uniqueness, I find comforting to think that France is noble enough to give some such an excellent education, on the basis of personal merit. Of course only the middle class can access it, but except from Sparta, which system was ever fair?

To add my *granum salis* to the English debate, I do not know what I would think of a dedicated prep' school. During my years in Louise-Grand, I discovered German literature, Russian cinema, Italian poetry, Austrian dodecaphonism, the art of Quartier Latin *beaux parleurs*, being critical towards random studies published by obscure north-American universities, and critical towards science, including mathematics: a French *honnête homme*, exotic, outfashioned, irritating, and so on.

I doubt any of those abilities would appear on the standard curriculum of a mathematical prep' school. I use them daily in my professional practice.

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About the author

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