

COMMENTS ON  
“STOP RUINING MATH! REASONS AND REMEDIES  
FOR THE MALADIES OF MATHEMATICS EDUCATION”  
BY RACHEL STEINIG

ALEXANDRE BOROVIK

*Introduction*

This paper is made of my very personal comments on a very personal paper by Rachel Steinig<sup>†</sup>. Rachel Steinig is a 16 years old student and writes about school mathematics education from a position of a student. For many months she has been surveying people around her about how math was ruined for them. She says in her paper:

*I've asked my friends and relatives, posted on Facebook, and asked teachers and parents. Even though everyone's story was different, there were some common themes running throughout. [...] Just to be clear, these are not my opinions of what ruins math—these are the results of surveying many people of all ages, education levels, and attitudes. [pp. 128–129]*

Rachel Steinig's observations are fresh and incisive. On reading them, I have been struck by realisation that I became a professional mathematician only because, in my school years, almost in every situation described by Rachel Steinig, I had experiences exactly opposite to the ones reported by her. In short,

*I became a mathematician only because **nothing** had ruined my mathematics.*

Thanks to Rachel Steinig, I was able to formulate explicitly something that I knew, for myself, all my life: I was simply lucky to grow up in the right place and the right time. Still, I feel myself as a wild Pacific salmon (say, *Oncorhynchus nerka*), the only survivor of 5,000 eggs in a spawn. The rest 4,999 had been less lucky. I am afraid the same cruel probability of survival applies to mathematics education.

Some caveats are due. I am a man of a very different generation. In this paper, I describe something that looks as an education paradise. It was not. I do not claim that the education system of Russia in 1960–1970 was perfect. I was simply lucky. I repeat: nothing had spoiled my learning of mathematics. Unfortunately, I cannot

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<sup>†</sup>R. M. Steinig, Stop Ruining Math! Reasons and Remedies for the Maladies of Mathematics Education. *J. Humanistic Mathematics*, 6 no. 2 (July 2016), 128–147. DOI: 10.5642/jhummath.201602.10. Available at: <http://scholarship.claremont.edu/jhm/vol6/iss2/10>.

say the same about music, physics, and – the last but not least – English language; my teachers in these subjects were pathetically incompetent (but they were good and kind people).

What I describe is an exception, and therefore I do not offer any advice on education policies – the specific cultural and socio-economic environment of Soviet Russia no longer exists, and I doubt that it can be reproduced anywhere in the world, including Russia herself. It suffices to say that I describe primordial times when TV had barely reached my home land, Siberia: I got access to TV when I was 11 years old.

A prominent expert in mathematics education wrote to me in relation to my views expressed in my recent paper<sup>†</sup>:

*At least you should realise that you yourself (just as I am) are moulded by your experience and others may have differing opinions that may have a validity in another context.*

This paper can be seen as one huge disclaimer: of course I realise that – this is why I carefully avoid giving any policy recommendations.

Still, Rachel Steinig’s and my papers, taken together, show how fragile the process of learning mathematics is – and how easily it can be ruined for a child.

### *Point-by-point comments to Rachel Steinig’s paper*

In what follows, I go point by point through Rachel Steinig’s paper explaining why, in my life, everything was different. I use very brief quotes from Rachel Steinig (RS) only as pointers to her text – please read my paper having the text of her paper in front of you.

So what, in Rachel Steinig’s opinion, ruins maths for children?

**RS: *Having people of mixed math abilities in the same class, and having the class move too slow or too fast for you.*** [p. 129]

In my time in my country, a “school class” was a social unit of a remarkable cohesion, it was the second family for children. First of all, it remained the same from Year 1 (age 7) to graduation after Year 10 (age 17). There were three stages of school education: Junior (Years 1 to 4), Middle (Years 5 to 8) and High (Years 9 and 10). Some students left the school and moved to vocational training after Year 8 – but stayed in touch with old friends. The same teacher taught all subjects in Years 1 to 4; in Years 5 to 10 lessons were given by specialist subject teachers.

And here comes the punchline: there was a tradition (or, I tend to think, an officially recommended policy) that the teacher followed the class; mathematics in

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<sup>†</sup>A. V. Borovik, Economy of thought: a neglected principle of mathematics education, submitted to *Simplicity: Ideals of Practice in Mathematics and the Arts* (R. Kossak and Ph. Ording, eds.). Springer, 201X. The last pre-publication version: [bit.ly/293orpk](https://doi.org/10.1007/978-1-4939-9830-0_1).

my class was taught over 6 years, from 5 to 10, by the same teacher – so we had only two teachers who taught us mathematics over 10 years.

Therefore the situation typical for modern day British state schools and described in one of the posts in *The Guardian*'s "Secret Teacher" blog<sup>†</sup> was simply impossible:

*It's [...] parents' evening. The dining hall is alive with the buzz of conscientious parents ready to hear how their children are getting on, and whether the 13 years of love, worry and encouragement they've invested in their offspring are bearing fruit.*

*I've got back-to-back five minute appointments, and halfway through the evening a queue has built up. As a mother and daughter get up to leave, my stomach drops. Uh-oh. Blond hair, long face, pointy chin. Next is either Tom or Tim ... but I can't tell them apart unless they're in the classroom.*

There was not any streaming by ability, the whole class worked at the same carefully set pace. Stronger students could always be given harder problems from a special collection on the last pages of a textbook. Helping a classmate was the expected behaviour – and helping others was an efficient way to consolidate mathematical skills. Well, with the benefit of hindsight, I can say now that this early school experience helps me to work as a teacher.

The society in which I lived was not ideal, to put it mildly. For example, by the end of Year 8 four or five my classmates (out of 30 or 35 students in the class) had suspended prison sentences – but this did not affect the supportive learning environment in the class, because even young offenders respected the school – and they were my good friends.

Why? At that time, life in Russia was still powered by the tremendous uplifting force of social mobility.<sup>‡</sup> Education *really* gave a chance in life. There were no dead ends in the school system: every girl or boy leaving school at age 14 retained the option to return to the "mainstream" education and get an university degree. This could be achieved by studying in a vocational school and then in a technical (or agricultural, or medical) college, or in an evening school for mature students. Almost all universities and other institutions of higher education were running preparatory courses, evening classes<sup>§</sup>, and part time and correspondence study programmes. Completion of a technical college gave the same credential for applying to an university as graduation from a high school. Oh, I have almost forgot: education was of course free at all levels.<sup>¶</sup>

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<sup>†</sup>Secret Teacher: Your child is our lowest priority unless they're exam-age. THEGUARDIAN, Teacher Network, The Secret Teacher, Saturday 12 March 2016 07.00 GMT, <http://www.theguardian.com/teacher-network/2016/mar/12/secret-teacher-child-lowest-priority-exam-gcse-aleve>.

<sup>‡</sup>I analyse social mobility in my forthcoming paper *The Golden Age of Soviet mathematics education: The Ponzi scheme of social mobility*.

<sup>§</sup>I started my career as a teacher in higher education by giving evening classes to mature – and full time employed – students in a technical university. It was much more rewarding than many of the teaching jobs that I later did in the West.

<sup>¶</sup>Two of my young offender classmates both had two concurrently running suspended prison sentences. Their fates were very different: one of them (a bright boy, actually) eventually got into prison and was murdered there, aged 17. Another one went, after Year 8, via vocational route: vocational school – technical college – additional training and

I was a bit of an “academic” child; but this abundance of education options for *everyone* created a safe and comfortable school environment for *me*.

**RS: *A lot of people say that math was ruined for them because of “mean teachers.”*** [p.130]

I did not have “mean teachers.” As I have already mentioned, some my teachers (luckily, not in mathematics) were not very competent – but I followed my mother’s advice:

*“Teachers are human beings; do you really think that they have no right to be stupid? If you know that your teacher is thick, live with it, keep your mouth shut and treat her with respect, as you would treat any other person”.*

I respected all my teachers, and, in return, was treated by them with respect and kindness.

**RS: *Teachers who aren’t okay with saying “I don’t know” or legitimately just don’t know enough math.*** [p.131]

At the first lesson in Year 8 (I was 14) my mathematics teacher, among other standard announcements about arrangements for homework, etc., said (publicly! in front of the class!):

*“And for you, Sasha – I cannot teach you any longer, you know mathematics best. Try to teach yourself.”*

I cannot imagine a teacher in the UK saying something like that. My teacher added that homework was no longer compulsory for me. However, I continued to do and submit homework, and continued to attend all lessons, where I was sitting in the back row at the corner of the room, next to the window, reading books and writing Russian literature essays,<sup>†</sup> and occasionally helping my deskmate. My teacher never again asked me a question, never again invited to work at the blackboard in front of the class – I was left in peace.

**RS: *Sadly, in a lot of elementary schools, to become a math teacher you don’t actually have to know that much math.*** [p. 132]

Perhaps I should quote my own paper<sup>‡</sup>:

*As a child, I learnt the “questions” method [of solving “word” problems] in my primary school [...] and I describe it here as it was widely and routinely used in all primary schools in Russia in the 1960s. A colleague,*

service in the Navy – achieving excellence at every stage. After that he started a respected and well paid professional career as a ship diesel mechanic in the Merchant Marine.

<sup>†</sup>Actually, I did my mathematics homework during literature, history, and geography lessons.

<sup>‡</sup>A. Borovik, Relationality of teaching, the Khan Academy, and word problems. Selected Passages from Correspondence with Friends, 1 no. 6 (2013), 45–50. ISSN 2054–7145. [http://www.borovik.net/selecta/wp-content/uploads/2013/08/Selected\\_1\\_6\\_Word\\_Problems.pdf](http://www.borovik.net/selecta/wp-content/uploads/2013/08/Selected_1_6_Word_Problems.pdf).

*responding to an earlier version of my notes on the “questions method”,<sup>§</sup> indicated that I was lucky to have an “excellent mentor” who was using “the richness of the Socratic questioning”. I loved my teacher – but it needs to be explained that she was a village school teacher in Siberia and was educated (up to the age of 16) in the same village school and then for two years (up to the age of 18) in a pedagogical college in the town of Kyakhta – look it up on the GOOGLE MAP! Places more in the middle of nowhere can be found only on the Central Antarctic Plate.*

If “policymakers” will ever read my paper, this is my message to them:

*My teacher’s skills in arithmetic were a guaranteed and enforced minimum compulsory for every teacher.*

**RS: Parents wanting you to be a genius at math. Or forcing math down your throat.** [p.132]

I was a sickly child and a fussy eater, and maybe for that reason there were absolutely no attempts to force anything down my throat. But when I was about 8 or 9, I had a chance to see how my father was explaining to my big brother (my brother was perhaps 13 or 14 years old) something from his mathematics homework. Father expressed a word problem as a system of two simultaneous linear equations in two variables – and solved it with obvious joy. He had good handwriting, and I got a powerful lesson of how beautiful and enjoyable mathematics could be, and that abstract formulae could have real life meaning.

My father was a professional artillery officer by training, and a veteran of World War II. He loved mathematics. He also explained to me that, during WWII, it took 6 months to train a young man with secondary school education as an artillery officer – but a university graduate with a degree in mathematics could be trained in a week. Some of his comrades-in-arms had happened to be mathematics graduates from the Moscow University – and he described them as excellent officers.

**RS: A lot of kids face parental pressure to achieve in math.**  
[p.132]

In my case, there were no parental pressure to succeed academically, neither in mathematics nor in other subjects. I was maybe 12 or 13 when my father was appointed to a post which could be described, in Western terms, as a juvenile court judge. He told me that he expected that I would not undermine his position by any kind of misbehaviour. Then he took my school report book where my marks (and any comments and/or complaints from teachers) were recorded and which parents were expected to sign every week – to confirm that they had seen it – and signed empty pages for a year ahead. Was this pressure? No, it was not. For me, it was trust.

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<sup>§</sup>I write more about the “questions method” in A. V. Borovik, *Economy of thought: a neglected principle of mathematics education*, *op.cit.*.

**RS: *Social media can really increase the pressure on kids to succeed.*** [p.133]

Luckily for me, there were no social media in my time.

Accidentally, when in 1990 I came to America and started to teach mathematics to non-math majors in a decent university, I discovered that my students had attention span of the range that back in Russia I had seen only in auxiliary schools for children with learning disabilities. Explanation? There were no TV commercials in Russia during this time, there were not these poisonous 15 or 30 seconds bursts of loud sound and blinding imagery forced into the brain against the viewer's will. And the life was, by American standards, boring. But I was unaware of American standards of entertainment and distraction, and was content with my life. For a good attention span, you need life without stress and without noise, and plenty of uninterrupted personal time – more on that later.

**RS: *Students who do not ask questions in class.*** [p.134]

Again, I was lucky. My junior school teacher had the reputation of an excellent teacher, but it was also known that her classes, when they moved to the middle school level, were noisy, unruly, and independent minded – in my opinion, this was the best possible praise to a teacher. In my class, there were no issues with questions to the teacher. Of course, some students were academically weaker, or shy, but they could always ask their peers, and, first of all, seek help from a deskmate. Traditional school desks were shared by two pupils, and in Years 1 to about 6 the teacher controlled who shared a desk with whom, cultivating strong bonds and mutual help; very soon, these customs crystallised as part of the group culture.

**RS: *Using bribery as an incentive for kids to do math (The Problem With Grades).*** [p. 135]

It is a very interesting point because it is linked to some serious issues of education policy. In Russian schools of my time, marks for homework, marks for work in class, for tests, etc., were given so frequently that they became part of routine; their emotional impact was subdued. The teacher could use marks as a way of formative feedback, and good teachers did that with precision and tact.

The key point is that assessment of a school as a whole was decoupled from assessment of individual students. Schools were assessed by regular (but not frequent) “ministerial tests”. A school received, without warning, a test paper in a sealed envelope which could be opened only immediately before the test; students' test scripts were collected, put into an enclosed envelope, sealed and sent back. Tests were marked in the local education authority (and on some occasions even a step up in the administrative hierarchy – in the regional education authority); marked test scripts, however, were not returned to schools, and schools received only summary feedback – but no information about performance of individual students.

This policy created a psychological environment of trust between pupils and the teacher, which good teachers could use to the advantage of their pupils.

There were no annual examinations in junior and middle schools with the exception of final examinations at the end of Year 8. Mathematics exams were oral, and examiners were teachers from the school. They had full discretion to adjust to all possible mitigating circumstances (and personal circumstances of a student), but these oral examinations were perceived by everyone involved as undoubtedly fair.

**RS: *Not understanding what you are learning in math class and having no one to explain it to you.*** [p. 136]

I have already said that learning, at least in my school, was a collective work – if someone struggled, he or she always had the option to ask his/her classmate for help. And teachers were supposed to keep an eye on the performance of every single student. Every single piece of homework was marked by the teacher.

Also, we had good textbooks (I claim that as someone who have had 40 years of teaching experience in four different countries with completely different education systems). In the social and cultural environment of Russia of that time, it was expected that a child sufficiently motivated to learn mathematics would be able to learn it from a textbook – without help from adults.

**RS: *When kids don't see a point in learning math.*** [p. 137]

I have already answered this question by telling about my father. But in general, mathematics was respected, and this respect came not from school, but from life.

**RS: *Having too little or (gasp!) too much homework.*** [p. 140]

This issue goes deep into the education policy. One aspect of junior schools in Russia of 1960s was a very short school day – 4 lessons of 45 minutes each, with long breaks (if I remember correctly, 10, 20 and 10 minutes). This left plenty of time for homework – as well as for play and leisure. There were more lessons in Years 5 up, but still, the pace of school work was relaxed and students had a plenty of uninterrupted personal time.

Homework involved the systematic use of a textbook. Generally, textbooks were good, readable, explicitly designed to help a child who worked on his or her own – or read, out of curiosity and boredom, the textbooks of his or her big brothers or sisters (more on that below).

And, since I mentioned personal time – we had glorious 3 months long (from 1 June to 31 August) summer vacations.

**RS: *Being in an environment that is not conducive to learning.*** [p.141]

In my view, psychological aspects of learning environment are more important than physical ones. In 1960s, Russia was a poor country; in the sense of physical environment, my school belonged to the third world. It was overcrowded and worked in two shifts. In some years of junior and middle school, I studied in the shift 1:30

– 4:30pm, or something like that; classrooms where we were taking lessons were equipped with oversized desks for bigger children.

Frequently, I woke up in the morning to discover that my parents and my big brother already left home for work and, in case of my brother, for the first shift at school. I found breakfast on the table, lunch on the stove and had to take care of myself until I met parents in the evening after school. This gave a chance to learn some self-responsibility.

For long months I was de-facto homeschooled – actually, even self-taught. As I have already mentioned, I was a sickly child, suffered persisted colds and was overdiagnosed by a doctor who insisted that I had to stay out of school for a year. A compromise was reached that I would not attend lessons and come to school only for tests. On her way to school, my teacher knocked at my window to tell me that I had to show up at a particular time for a test. There was no TV, and I was spending the rest of the day reading anything I could lay my hands on – from sci-fi (I think I had read a Russian translation of Isaac Azimov’s *Profession*<sup>†</sup> – a book highly relevant for this discussion – under these circumstances) – to old textbooks used by two my big brothers. My brothers were 5 and 9 years older than me, and I had, at home, the full set of textbooks for all subjects and all years of school. I quickly swallowed geography, history<sup>‡</sup>, literature, and even some bits from physics and chemistry but do not remember much about them. Mathematics was different – it was difficult, it had to be treated with respect, and I quickly realised that learning mathematics would take some time.

Much later, in my university years, I discovered that surprisingly many of my mathematician and physicist friends had the same experience of staying out of school, because of illness or serious injury, for months and even years.

**RS: *Fear is an overarching theme here.* [p.143]**

For me, fear of mathematics had never existed. After all, fear of mathematics is like the fear of darkness: if parents are careful enough never associate darkness with something dangerous or just unusual (in particular, never tell their child anything

<sup>†</sup>Isaac Azimov. *Profession*. 1957. <http://www.inf.ufpr.br/renato/profession.html>.

<sup>‡</sup>My paper *Calling a spade a spade: Mathematics in the new pattern of division of labour*, op. cit. (or [goo.gl/TT6nc0](http://www.inf.ufpr.br/renato/profession.html)), clearly shows my obsession with the concept of division of labour. I can trace its almost Freudian roots to my brother’s Year 6 textbook *History of the Middle Ages* (1962). Recently I have found on the Internet its electronic copy and checked that the book indeed contained an explanation of the emergence of towns and a quote from old chronicles about the origins of Brugge – the stuff that I talked about with my big brother, who was in Year 6 – and used this textbook – when I was in Year 1 (that is, I was 7 years old and my brother 12 years old).

So our conversation went that way. My brother discovered that I was reading his textbook – and asked, with some scepticism, whether I was finding it interesting.

“Yes – said I – I had just read how towns appeared.”

“And how did they?” – retorted my brother.

I started the story from the chronicles: there was a castle on a bank of a river, and a bridge next to the castle, and peasants were bringing their goods to the castle, and craftsmen were peddling their services first to the castle, and then to other people who were coming there, and inns were built, bla-bla, and the conclusion was that that town that grew up was called Brugge, which, in the local language, meant “Bridge”.

“Silly you – said my brother – towns were built because of separation of crafts from agriculture.”

I was dumbstruck. I was deeply pained because my brother again proved to me his intellectual superiority – but also astonished by the discovery that a few words: “*separation of crafts from agriculture*” explained and summarised everything that was in the story. I was even more pained by the realisation that I had actually seen these words in the text, but had not paid attention to them. I had taken the lesson in immediately: I decided, from that point on, always look for these kind of special words which summarised everything.

like “do not worry, there is nothing in that corner”), children do not develop fear of darkness. Luckily, no-one ever told me: “Do not be afraid of arithmetic, it is not that difficult.”

I will tell you now about one of the most formative experiences of my childhood. I think I was 4 or 5 at that time. I woke up at night and discovered that my parents were not in the house. I was puzzled; after some thought I recalled my parents mentioning a family celebration at Uncle Gregory’s house. It was summer, it was a warm bright night. There were no light in the house, and I could see stars shining through the windows. I put some dress on and walked to Uncle’s house; it was about 400 meters away. There were virtually no street lighting, but light from the stars sufficed. I was walking very slow, stopping all the time and looking more at glorious stars in the black sky than at the road under my feet. I can still feel, physically, that sense of awe.

Obviously, as a child, I had never had fear of darkness.

### *Conclusions*

I reiterate: nothing in this paper should be seen as recommendation for mathematics education policies or practices.

Rachel Steinig’s paper highlights difficulties students face in learning mathematics; in my comments, I tried to add additional colours to the picture drawn by her.

One thing is obvious: many social, economic, and cultural factors which were conducive to mathematics education in the past do not exist any longer.

This is why, I think, the mathematics homeschooling movement which gathers strength in the USA, needs attention and support from mathematicians and mathematics educators. Homeschoolers have interesting ideas, and I discuss some of them in my paper *Calling a Spade a Spade*<sup>†</sup>. You will find there a quote from Maria Droujkova, one of the leaders of mathematics homeschooling movement in the USA:

*“When I use the word “deep” as applied to mathematics education, I approach it from that natural math angle. It means deep agency and autonomy of all participants, leading to deep personal and communal meaning and significance; as a corollary, deep individualization of every person’s path; and deep psychological and technological tools to support these paths.”*

In my case, the word “*autonomy*” is all-important even if my understanding of it differs from the way Maria Droujkova uses the word; for me, “autonomy” meant physical, real life autonomy as well. Mathematics was not ruined for me because, as a child, I was given a remarkable level of autonomy in a safe and supportive environment. And the words “deep mathematics” is associated in my memory with a shelf

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<sup>†</sup>A. V. Borovik, *Calling a spade a spade: Mathematics in the new pattern of division of labour. Mathematical Cultures: The London Meetings 2012–14* (B. Larvor, ed.). Trends in the History of Science. Springer, 2016, pp. 347–374. ISBN 978-3-319-28580-1. DOI 10.1007/978-3-319-28582-5\_20.

with the full set of school textbooks in arithmetic, algebra, geometry, trigonometry, and stereometry, which I could browse at will when I was 9 year old.

## 1. *Acknowledgements*

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### *Disclaimer*

The author writes in his personal capacity. The views expressed do not necessarily represent the position of any other person, organisation, or institution.

### *About the author*

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His principal research lies in algebra, model theory, and combinatorics. He also has an interest in cognitive aspects of mathematical practice and recently published a book *Mathematics under the Microscope*<sup>†</sup> which explains a mathematician's outlook at psychophysiological and cognitive issues in mathematics.

Some of his papers on mathematics education can be found in his personal online journal/blog *Selected Passages From Correspondence With Friends*<sup>‡</sup>.

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<sup>†</sup>A. V. Borovik, *Mathematics under the Microscope: Notes on Cognitive Aspects of Mathematical Practice*. Amer. Math. Soc., Providence, RI. 2010. 317 pp. ISBN-10: 0-8218-4761-9. ISBN-13: 978-0-8218-4761-9. <http://www.ams.org/bookstore-getitem/item=mbk-71>.

<sup>‡</sup>Selected Passages From Correspondence With Friends. ISSN 2054-7145. <http://www.borovik.net/selecta/>.