SEAMEO MEETING

UNIVERSITY OF TSUKUBA, TOKYO 2020, FEB 13

MATH EDUCATION IN CHANGING WORLD

Math vs MthEd. Conflict or collaboration?

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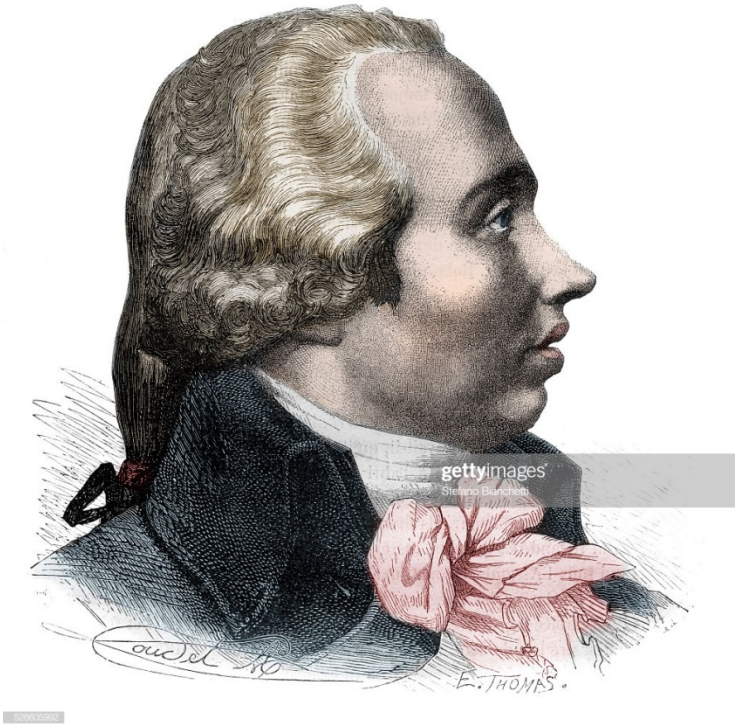
AN INTRODUCTION AND A HISTORICAL REVIEW

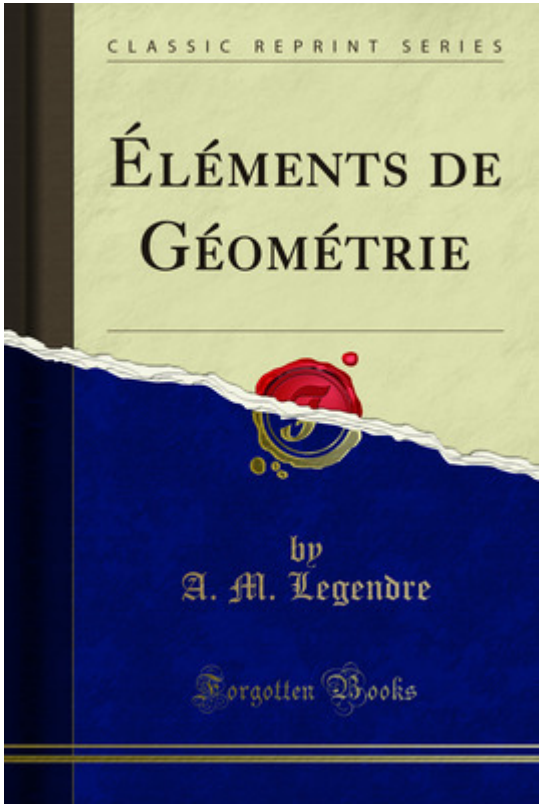
In the modern world of school education, one can see a significant gap between the scientific and educational communities, which has developed over the past 150 — 200 years. 200 years ago the situation was different: in an era when classical, in particular mathematical, education was the destiny of a few, school mathematics was based on the enthusiasm and enlightening activity of leading contemporary scientists.

HISTORICAL REVIEW

It is enough to recall Legendre, who wrote «Eléments de géométrie», which served as the basic geometry textbook in all educational institutions not only in France but also in other European countries, in particular in Russia, until the beginning of the 20th century. Legend claims that it was Legendre who introduced the division sign «:» or «÷». Another striking example is Leonard Euler. His textbook, «A Guide to Arithmetic», translated into Russian by Vasily Adadurov (1740), was written for the gymnasium opened at the St. Petersburg Academy of Sciences and for many decades was one of the main textbooks of Russian gymnasiums.

HISTORICAL REVIEW





HISTORICAL REVIEW

Speaking about the Russian school in the 19th – 20th centuries, one must not forget the contributions of P.L. Chebyshev, A.N. Kolmogorov, A.Ya. Khinchin, I.M. Yaglom, V.I. Arnold. Recently, much attention is paid to school mathematics by the Fields prize winner S.K. Smirnov. He is one of the authors of the modern Concept of the development of mathematical education in Russia (2013).

CURRICULA AND TEXTBOOKS

Figuratively speaking, if curricula and textbooks were written only by educators and professional educational specialists, then school mathematics would degenerate into scholastic knowledge, full of errors, incorrect interpretations of mathematical facts, and artificial problems.

SCHOOL MATH AS AN ALGORITHM

Mass school education is based on using and combining algorithms: long multiplication and division, multiplication, opening brackets, factorization etc.

A teacher who does not see the global goals of mathematical education naturally seeks to fill the content with algorithms that are easy to teach, not fully understanding or taking into account their real value.

It is easy to imagine that there are teachers who dream of teaching schoolchildren solely how to solve quadratic equations because this is an easily achieved and easily controlled goal.

SELF-CLOSED DIDACTICS

We observe a lot of biases towards the technological effectiveness of training both in Russia and in other countries.

Just an example of a "self-closed didactics". In a mass school, logarithms appeared for practical computational needs.

Since the 1950s, the practical importance of logarithms began to shrink rapidly. At the same time, a whole genre of mathematical didactics “logarithmic equations and inequalities” appears and develops, where the properties of the logarithm are used as a way to create sophisticated puzzles that have nothing to do with actual applications of logarithms.

NEW MATH WAVE GIVE NEW SCDs

Here is an example from a modern collection of tasks for preparing for a university entrance exam:

$$\frac{2\log_{1-3|x|}\left(42x^2-|x|+1\right)}{\log_{1-3|x|}\left(x-\frac{5}{6}\right)^2}\le 1$$

RETROSPECTIVE

We will not comment on this, we only say that in the classic textbook by A. P. Kiselev “Algebra 1” you can find many tasks “reduce the expression to a form convenient for taking a logarithm”, natural for that time, and that exactly one page of the textbook is devoted to the logarithmic equations and just mentions that the equation

$$\log(x+a)+\log(x+b)=\log(x+c)$$

can be easily reduced to quadratic.

SIMPLIFICATION AND SLOWDOWN

This is not the worst. Better that than simplification which grows from the same root of “professional approach” to math education instead of approach of mathematicians to education.

Excluding professional mathematicians out the education accelerates another harmful tendency we observe in the world: there is excessive slowdown of the learning content, bias towards the basic component, an attempt to “remove stress” from the learning process, dangerous simplification and gamification.

Teachers and curricula developers give up to populist trends.

ROLE OF PROFESSIONALS

For these reasons, the role of *professional mathematicians* in the formation and ongoing support of mathematical education is extremely important.

Not only curricula and textbooks but also the preparation of teachers should take place in close cooperation with professional mathematicians. They must lead future teachers toward they profession.

People can argue endlessly about the competition between classical universities and specialized pedagogical educational institutions in the field of teacher preparation.

HOW TO GET PROFESSIONALS TO SCHOOL?

Our experience shows that both trajectories are needed and find their rightful place. The most qualified teachers that work in specialized schools and are able to intellectually load motivated students often come from the academic environment.

An analogy seems appropriate here: a good farmer does not sell the best fruits but replenishes his seed fund with them. So, in the field of teacher training, some of the best specialists should return to school.

DON'T YOU KNOW LETTERS?

Let us give just one example: in elementary school, equations traditionally appear in the first grade in the form of the task

Find an unknown number x if $x+1=3$.

In the modern textbooks, letters are for some reason replaced by boxes:

Insert a number in the box: $\square+1=3$.

The task did not become either simpler or more complicated but ceased to bear an important propaedeutic load, taking the time and doing harm.

DISGUISED SABOTAGE

Simplification processes are usually presented as a common good that ensures “equal rights and opportunities”, “universal access to quality education”, etc. In fact, the availability of high-quality education and the very quality of education suffer, because both the general educational background and the level of rational thinking are reduced in society.

VICIOUS CIRCLE

In addition, the process of simplification is unstoppable: the lower the final requirements in mathematics, the lower the prestige of mathematical knowledge for the next cohort, and the lower the final requirements are.

This is a vicious circle that is difficult to break. This can be broken out only by joint efforts of all the forces acting in education: professional mathematicians, educational organizers, methodologists, teachers, children and parents.

DID PCK WIN THE FINAL VICTORY?

In recent decades the idea that the knowledge of mathematics is not the main thing for a mathematics teacher has been rooted in many societies. The balance of CK (content knowledge) and PCK (pedagogical content knowledge) is clearly leaning towards the latter.

Moreover, it was inclined to such an extent that many young teachers who come to school have a vague idea of classical calculus, cannot form an image of a mathematical object corresponding to a definition, and have no idea of how different sections of school mathematics are connected with each other.

CONCLUSION THESES

The gap between mathematics and mathematical education is extremely dangerous at any stage of society's development — whether it is society #3 or #8.

Now we are harvesting the bitter fruits of this approach.

The mathematical Outlook of a math teacher should be broader and the knowledge deeper than that of an engineer.

For the teacher brings mathematical culture to people, while the engineer brings only a wrench with him.

MUST TEACHERS KNOW MATH?

What is from the fact I don't know mathematics? But I know how to teach!

An old non-joke

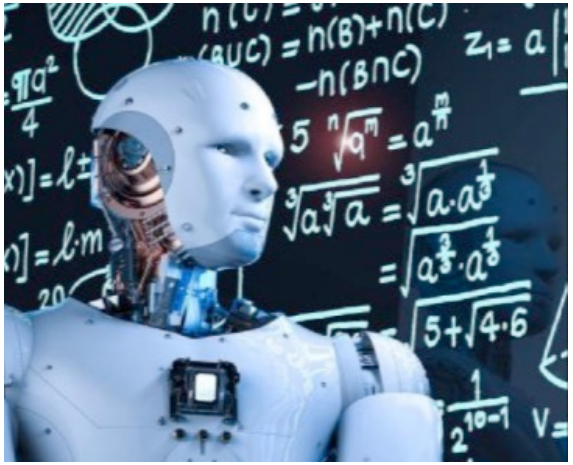
YES!

When you teach mathematics to people, please don't forget about teachers – they are also people.

Maxim Gorky said this about writers and the Russian language, but this is also relevant for us.

CONCLUSION THESES

Education policymakers should be clearly aware of the dangers of simplification of the math teacher training course for countries that are planning to develop their technology and industry.



I keep and nurse a faint hope that artificial intelligence can help us here. Because natural intelligence is probably powerless.

THANK YOU