

THE DEVELOPMENT OF THE ESTONIAN NATIONAL SCHOOL MATHEMATICS CURRICULUM IN 1990–2005

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Introduction

Before World War II curricula, strongly influenced by Western Europe, were used in Estonia. For example, in mathematics those curricula emphasised the importance of the functional dependence and urged the junction of different fields of mathematics (arithmetic, algebra, geometry). The Estonian Mathematics Teaching Commission then guided the evolution of the Estonian school mathematics.

A centralised Soviet-Union-wide curriculum was enforced in 1949. According to it mathematics was taught in relatively great quantities (altogether 60 lessons *per week* in all the classes). School mathematics was divided into different courses (algebra, geometry and trigonometry). The textbooks taken into use were translated from Russian. As the Soviet regime was somewhat liberated in the 1960s, Estonian school mathematicians managed to achieve the re-introduction of new textbooks of Estonian origin since 1964. Mathematics as an integrated school course as in pre-WWII times was re-established as well. This course did not utterly copy the all-Union curriculum. For example, unlike in the Soviet Union in general, the concept of integral was introduced in Estonian schools from 1965.

Project of the mathematics syllabus from 1989

The winds of change appeared with the first episodes of serious criticism against the Soviet school mathematics only after the accomplishment of *the Estonian Education Platform* in 1989 [1]. Corresponding materials tell the following about the school mathematics of that era: *the extreme volume of the study material in the programs of mathematics neither enables sufficient exploration of any segment of the studies nor allows it to develop necessary skill in any topic. Mathematics as a subject that is meant for teaching profoundness, consistency, deep exploration and deep thinking in reality satisfies only the needs of the usage of incomplete knowledge and quasi-education.*

One of the most important innovative ideas that can be noticed from that period is the aspiration for the readjustment to the general pedagogical goals, which take into account and determine the development of personal-

ity. **Differentiation** of the teaching of mathematics was seen as one of the possible ways to accomplishing it. For that distinction between the essential core education and the supplementary courses in the modular system was suggested.

The project “**Mathematics. The root education curriculum for forms V to XII**” was published in 1989 [2]. The significant change that was planned for the general educational system was the implementation of the 9+3 education model (9-year compulsory school and 3-year secondary school). All the national curricula planned and used in Estonia since then are based on that education model.

In connection with the project in question it must be emphasised that already then the mathematical education in school was planned on different levels for separate educational branches, the humanities branch and the science and mathematics branch. Mathematics for the humanities branch was then called the mathematics belonging to **the root education**. For the first time the secondary school mathematical syllabus in the science and mathematics branch was composed **in course system**.

As for the mathematics belonging to the compulsory school and secondary school root education, a considerably smaller total number of lessons *per week* (Table 1) was taken into account (**48** lessons) than the Soviet, 1988 syllabus allowed (**55** lessons).

Quite sure, such a cut brought along great cutbacks in the volume of the material taught. Thus the topics *vector, linear inequalities, systems of linear inequalities, powers with rational number exponent, radical expressions conversion, radical equations* vanished from the compulsory school syllabus. Lots of topics in the syllabus were marked with an asterisk (*), as those which were meant to be optional topics for the most capable pupils. In the compulsory school that kind of topics were for example *frequency table, square deviation, triangular right prism, regular prism and pyramid, right parallelepiped, parametric equations, grouping method in factorisation and biquadratic equation*.

Great cutbacks occurred on the secondary (high) school level, too. For example in the secondary school mathematics syllabus we do not find *powers with rational number exponent, n th root ($\sqrt[n]{a}$), simplification of irrational and trigonometric expressions, irrational and containing the modules equations, trigonometric equations*. The secondary school syllabus lacked the concept of vector as well. So the treatment of the interposition of lines and planes was clenched to a descriptive overview taking up only 12 lessons in total. However, the questions of synthetic solid geometry had a relatively sound attention as wholly 30 lessons are devoted to those. This is quite natural, as the latter was virtually cast out from compulsory school.

Table 1

Mathematics lessons per week in the Estonian compulsory and the secondary school in the period of 1988–2005 (H – humanities; SM - science and mathematics; G - general branch; IMP - the intensive classes for mathematics and physics)

School stage	I			II			III			Secondary school				
	1	2	3	4	5	6	7	8	9	10	11	12	Total	
2005 Tallinn project	3	4	4	4	4	5	5	5	5	Compul-sory	3	3	3	48
										Ad-vanced	5	5	5	54
2005 Tartu project	10			13			13				6			42
2002	10			13			13				9			45
1996	9 - 13			12 - 15			12 - 15				9			42 - 52
1991	3	4	5	5	5	5	5/4	4/5	5	H	3	2	2	48
										SM	4	4	4	53
										G	3	3	3	50
										IMP	5	5	5	56
1989 project	3	4	5	5	5	5	4	5	5	Core	3	2	2	48
1988	4	5	6	6	6	6	6	6	4	Compul-sory	3	3	-	55

The mathematics syllabuses recommended by the Ministry of Education in the 1990s

A program committee worked on with the regarded 1989 syllabus project. As a result of that work, the mathematics syllabus was officially ratified by the Estonian Ministry of Education in **1991** [3]. The document clearly determined the course structure, the multi-sectional teaching (humanities (H), science and mathematics (SM), the general (G) branch and the intensive classes for mathematics and physics (IMP). For the first time nine basic courses were represented and for the first time the document represented the syllabuses of the **optional courses**.

Speaking of the contents and the quantity of the subject, we see that the substantial volume of the subject had grown. In spite of the fact that the number of compulsory school lessons remained the same as in the 1989 syllabus, several topics were reintroduced to that school level. Often those topics were made obligatory for all the pupils. Amongst this material there

were, for example, *triangular right prism, right parallelepiped, regular prism and pyramid, set, element of set and subset*. Comparing the 1991 syllabus for the **humanities branch** with the 1989 **root education** syllabus, a certain increase in the quantity of the subject is noticeable.

First Official Completely Curriculum-Style Syllabus (1996-2002)

The next “**National Curriculum for Estonian Compulsory and Secondary Education**” [4], was established by a governmental decree on 1996. For each school stage a **possible range of lessons per week** (Table 1) was set for each of the subjects, including mathematics. The smallest number in that range meant the minimal amount of the obligatory lessons per week. The biggest number indicated the maximal number of the lessons.

For mathematics it can be said that most of the document was an amended and edited version of the 1995 syllabus project. Yet some significant changes have been introduced. Here let us emphasise only the changes, which affect the possibilities for the differentiation of teaching.

If in the 1995 project a possibility for multilevel teaching was opened to mathematics and physics besides foreign language courses, then the final version, signed by the government, permits it **only in foreign language teaching** (the so-called A, B and C language).

Thus the standpoint of the Ministry of Education was that the national curriculum, as a framework plan for the general compulsory minimum, **cannot contain a syllabus for the advanced level of mathematics** for the study branch of science and mathematics. According to the document, the advanced course of mathematics must be treated as one of the possible optional courses and thus the description of its contents has to be presented outside the syllabus, in the so-called book of optional courses.

Such an approach to the teaching of mathematics in secondary school evoked pretty fierce reactions in the Estonian Mathematics Society in 1996.

Unfortunately this **protest was left without necessary attention and results** both in the Ministry of Education and the Estonian society as a whole. To sum up, it can be said that in the spring of 1996 one important phase of creating the mathematics syllabus comes to an end. That phase can be figuratively called a play of fast and loose between the Ministry of Education and the mathematicians. Until then the mathematicians could not believe that only one national standard, the narrow mathematics course, would remain in use for the mathematics studies. Likewise until then the Ministry of Education did not express its opinion explicitly.

Transition syllabus from 2002 (currently effective official syllabus)

For decreasing the problems that occurred in realising the 1996 syllabuses, a corrected and improved version of the curriculum was signed in 2002 [5]. That is also currently the effective national curriculum. That document keeps the general structure of the previous curriculum – syllabuses for all the subjects are presented based on school stages, the study contents and the goals are rather declarative. Therefore the new curriculum did not eliminate the major flaw – that actual schoolwork was still guided not by the syllabuses but by the textbooks, by the contents of the national final exams and by the academic placement tests. In lesson division plans significant changes were made, as fixed quantities or lessons *per week* for each school stage replaced the prior usage of intervals of lessons *per week*.

In the mathematics syllabus the following smaller changes were made. In the first school stage the concept of tetrahedron and making its model were left out. In the third school stage only *the systems of quadratic equations* were cut.

For the secondary school a whole *course of integral*, which had been in syllabuses since 1965, was deleted and its time was used for the repetition of other material. Also, the concepts of mathematical statistics *population and sample* were left out of the syllabus and practical data processing assignments were not mentioned as well.

With a quantitative decrease of mathematics teaching time in background the amount of study material was not reduced in the syllabus, if not to mention some slight cuts. This resulted from the interpretation of the declarative syllabus by the authors of textbooks and the composers of national final exams and placement tests in a Soviet syllabus paradigm. This led to weak results in achievement tests and final exams.

For instance, it was rather common at that time that in the national mathematics achievement tests, conducted in the end of each school stage, 20 or more per cent of pupils received an unsatisfactory mark. One year the results of the compulsory school national final exam in mathematics had to be enhanced after the initial evaluation, as a scandal grew in the press for unsatisfactory results of too many pupils.

Mathematics syllabus project composed by the Curriculum Development Centre of Tartu University (2005)

Difficulties that appeared in introducing the 1996 syllabus, forced the Ministry of Education to establish a permanent development unit in the autumn of 2002 – the Curriculum Development Centre of Tartu University. The work of the Centre was guided and led by a 10-member board to which mostly pedagogy lecturers and professors of Tartu University belonged.

The board decided that it was possible to compose a new Estonian general education curriculum in the so-called science-based form. Several educational study theories were considered as a basis for it. During a couple of years and numerous debates a decision was made to base the curriculum on Lev Vygotsky's educational theory, which was created in the 1930s.

At first a requirement was derived from the theory that the syllabus for each subject had to be composed as a **list of competencies**. Regrettably the people who determined this starting-point did not admit that in the world generally and particularly in Estonia there is no competence for creating a practically applicable curriculum that is based on a single general educational theory. Therefore the actual composition of the mathematics syllabus in the Curriculum Development Centre of Tartu University was based more on experience and intuition.

For the mathematics workgroup the Curriculum Development Centre set three initial terms:

- a) The lesson division plan remains as it was in the 1996 and 2002 syllabuses.
- b) The compulsory school syllabus must be composed in school stages and in secondary school it must be made by courses.
- c) A gap between the decreased number of lessons and mathematical contents in compulsory school must be eliminated.

Analysing these tasks, the workgroup found that the contents of the 1996 and the 2002 Estonian compulsory school mathematics syllabuses were in a rather good accord with those of other developed countries. This is why it is not possible to make the syllabus significantly easier by reducing its content drastically. **The only reasonable way to make the mathematics course easier is to reduce its profoundness, deductive features and the detail of the presentation of the subject.**

The workgroup found that in the current paradigm of the Estonian school mathematics it cannot be expected that the authors of textbooks, the composers of national final exams and placement tests and the teachers react passably for the latter term. For that reason it was decided that the new mathematics syllabus should present quite particular subject lists and the required learning results for each form. In some sense it is a reversion to the way how syllabuses were presented in the beginning of the 1990s. Unlike that time it is not any more binding to follow the syllabus in detail. If a teacher wishes, he/she can apply his/her own syllabus for achieving the general study results as given in the official syllabus.

As a result of the work in 2003–2005, the mathematics workgroup of the Curriculum Development Centre presented a compulsory school mathematics syllabus and explanatory notes, composed in the aforementioned way,

for a public discussion (see <http://www.ut.ee/curriculum>). As the workgroup was called for syllabuses based on school stages, those were derived from the form-by-form syllabuses.

The most significant differences in the contents and their presentation between this syllabus and the 1996 and the 2002 syllabi were the following.

1) In the first school stage (forms I-III) in the treatment of *number equalities and equations* based on the relations between the components of operations are not any more primarily used. Instead, analogy and experimenting is used.

2) In the second school stage (forms IV-VI) *solving of linear equations* is started right on the basis of fundamental properties (formerly on the basis of connections between the operation components). For that operations with negative integers are transferred here from the third school stage; *percentage* is now mostly dealt with in the third school stage (7th and 8th grade).

3) In the third school stage (forms VII-IX) the description of *deductive approach to planimetry* that was until then taught in the 8th form is abandoned. Also, the coverage of some theorems which were so far included in the syllabus but usually not managed to cover in reality is given up. Linear equations, function $y = a/x$ and trigonometric relations like $\sin(90^\circ - \alpha) = \cos \alpha$ are not covered as well.

The need for basing the approach and coverage of a subject more on the real context and the need for solving plenty of exercises with practical or near practical content is emphasised.

The **secondary school** syllabus is given as a **two-level course**: a general course (twelve 35-lesson sub-courses) and a narrow course (six sub-courses).

In an explanatory note for the narrow course it is stated that going through this course guarantees a possibility to continue learning only in those study directions where mathematics is not very necessary and where it does not appear as a separate subject in the syllabus.

Work done in the workgroup in Tallinn (since the early spring of 2006)

In the summer of 2005 new workgroups for curriculum development were instituted by the National Examination Centre in Tallinn. Those workgroups received a task to create a new curriculum for general education schools. This new curriculum should be introduced already in the autumn of 2007.

A project for a general part of the curriculum was ready by November 2005 and it seems to be much more pragmatic and caring about the real needs of schools than the general part of the curriculum drafted by the

Tartu Curriculum Development Centre, which originated chiefly for theoretical postulates. For mathematics the general part of the new curriculum holds several important advancements.

- 1) Syllabuses must be presented form-by-form, not by school stages, and have quite detailed lists of the desired study results.
- 2) The number of mathematics lessons in compulsory schools is increased from 36 lessons to 39 lessons (by approximately 8%).
- 3) Profound courses in secondary school are presented as a part of the mathematics syllabus (as yet, hitherto those were completely undetermined in the syllabus and had to be composed by schools and teachers themselves).
- 4) For finishing the secondary school, it was required (on the basis of 9 general courses) to pass a mathematics final exam (along with the native language and the foreign language exam).

As the Tallinn mathematics workgroup was well aware of what was done in Tartu, then in the compulsory school part of the mathematics syllabus presented by them is the same as the Tartu one. Composing of a secondary school syllabus by the Tallinn workgroup is still in progress.

Conclusions

It can be noted that in designing the future school mathematics curriculum, the process of which started in 2002, much more attention than before was paid to the practical needs of the work at school. So in syllabus projects subject and study results lists are presented form-by-form instead of only by schools stages. Also, in the compulsory school syllabuses an effort can be seen to reduce the volume of a learned subject and give instructions for simplifying the presentation of a subject. In one working project there are three mathematics lessons *per* week added (39 instead of 36) to the compulsory school. For the secondary school the separation of a general and a narrow course is planned. The latter is only in the onset.

Regrettably all this work has taken place on a background situation that is as blurred as in the previous periods – there is a lack of an officially signed general part of the curriculum. That is why it has not been possible to place the composition of mathematics syllabuses into the general school context (including the lesson division plan, the ways of the evaluation of study results, connections with school exams and national final exams and with other subjects, etc.) and resulting from that the final completion of the syllabus has been unachievable.

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Summary

The article describes the development of the Estonian school mathematics syllabus 1990–2006 in the context of changes in the national general education curriculum. The major steps of the development, the background and the main problems are observed. The article presents the key changes in the quantity and contents of the subject. It is revealed that the actual time for teaching and studying the subject has diminished significantly but the contents of the subject have maintained their amount.