Mathematics curriculum development in Finland – unexpected effects

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Curricula changes in the Finnish school system have taken place in 8-10 year intervals. They have been recorded in the official curricula for schools by the Finnish Ministry of Education. However, these texts do not provide a complete picture since they are rather short of details. Schools can freely choose their textbooks and there is neither an official inspection nor an official approval for the textbooks. The system is based on the free market principle. Because of this textbooks, and the practice of teaching, should also be studied in order to understand the Finnish mathematics curriculum. A similar situation prevails in many other countries.

The leading ideas, from the point of view of people working in pedagogy, from 1960 on were ”New Math” (1960-1970), ”Back to Basics” (1968-80) and “Problem Solving”(1978-), see [M1] and [PAL]. These trends have appeared in many other countries as well. However, these key words do not give a proper picture what really happened in the mathematics curriculum and education.

In Finland these trends had the following effects on the mathematics curriculum.

- Mathematics at school became descriptive - exact definitions and proofs were largely omitted.
- Geometry and trigonometry were neglected.
- Computations were performed by calculators and numbers and not on a more advanced level.

“Problem Solving” and putting emphasis on calculators have taken time from explaining the basic principles and ideas in mathematics. It should be also remembered that with the invention of calculators and computers the pressure to traditional mathematics teaching increased enormously since a general believe in 1960-70 was that all the mathematical problems can be solved by computers and hence the traditional school mathematics is useless. This criticism did not come from ordinary laymen only but from well known scientists as well and this attitude was very much adopted by people working in education and didactics. These ideas had a profound effect on the changes in the Finnish school curriculum.

A typical effect has been that although sums and other operations with numbers are taught to the students to be performed in their head in the lower stage of comprehensive school such calculations are not practised any more later on. Calculators are used instead. This prevents the students to learn the effects of computations and the feeling of the magnitude of numbers also disappears. It also prevents the students to practice calculations in everyday life because many of them

soon forget how to do such calculations. This very much applies to students who are not among the best in mathematics.

L. Näveri [N] has studied the effects of the curriculum changes in Finland. Two similar tests were performed in mathematics in 1981/87 and in 2003. Participants belonged to the age group 15-16 year old (9. grade); this corresponds to the age group in the PISA survey since the school starts at the age of seven in Finland. The number of participants in both surveys was more than 350. The problems were identical and no calculators were allowed. Samples of the questions in the study are presented below.

The first samples of questions and the percentages of the correct answers dealt with multiplication. Here the question was: Correct or incorrect?

Multiplication	1981	2003
$5 \cdot 5 \cdot 5 \cdot 5 = 5^4$	95,2 %	90,1 %
$(-3)^2 = 9$	67,8 %	47,5 %
$18 \cdot 4 \cdot 32 \cdot 15 = 15 \cdot 32 \cdot 4 \cdot 18$	93,2 %	85,9 %
$0{,}015 \cdot 248 = 0{,}15 \cdot 24{,}8$	66,8 %	62,3 %
$0 \cdot 8436 = 0 \cdot 0{,}536$	79,0 %	65,6 %

In the questions concerning rational numbers the performance drop from 1981 to 2003 was the highest, 20 %.

Rational numbers	1981	2003
26 + 17 =	98,5 %	89,8 %
$(1/2) \cdot (2/3) =$	56,4 %	36,9 %
$(4/5) \cdot 5 =$	66,3 %	44,4 %
$(1/6) \cdot (1/2) =$	56,5 %	28,3 %
(1/5) : 3 =	49,2 %	27,5 %
1278 / 2 =	55,1 %	36,8 %

Also in the algebra section of the study the results did not give a promising picture of the effects of the curriculum changes.

Algebra	1981	2003
$10^3 \cdot 10^2 =$	72,5 %	43,3 %
$x^4\ x^5 =$	71,7 %	47,3 %
$(59^2)^3 = (59^3)^2$	61,1 %	31,7 %

If calculators were allowed in the test, the results would have most likely shown different figures. However, these figures show, beyond any doubt, that students'

ability to perform simple calculations in their head or with a pencil and paper has dropped significantly in the time period 1981-2003. It is difficult to imagine other reasons for this than the changes in the mathematics curriculum and the extensive use of calculators.

The final effectiveness of the Finnish school system can be observed in the matriculation examination. Almost everybody finishing the high school (gymnasium) participates in the matriculation examination at the age of 18. There are about 35.000 students each year participating in the examination. Mathematics test is not obligatory. The matriculation test is 150 years old and its mathematics part has essentially remained the same for the last hundred years. In mathematics a student may choose a basic or an advanced test. The advanced test is chosen by 12.000 students and the basic test by 14.000 students. Both tests consist of 15 problems written on an A4 sheet. A student can choose at most 10 problems out of 15. In practice, solving two problems, or slightly less, he or she is able to pass the test. Eight problems for the highest grade is the standard requirement but this varies annually. The students are graded using seven grades whose distribution is the same each time. Maybe it is not a surprise that the share of those candidates who do not pass the mathematics test is higher than in other tests. Because the distribution of the grades is essentially the same each time, it is a mistake to use the grades as an indication of the mathematics level. The problems have changed considerably during the last decades; the problems are based on the aforementioned, rather loosely stated official curriculum although the text books used at school also play an important role in the tests. The level of problems in the basic test has dropped during the last two decades.

The Finnish matriculation test in mathematics is described in [L] in more detail.

Students, who have passed the matriculation test, do not only go to universities to study. Many of them go to professional schools (for example, training schools for nurses, various engineering colleges) – usually, but not necessarily, these are students who have got low grades in the matriculation test.

During the last ten years teachers in professional schools, and not only mathematics teachers, have complained increasingly of the mathematical skills of the students. These complaints have not been so widespread in the universities and technical high schools. One reason is that the professional schools now use more mathematics than before and assume that their students have learned mathematics at school. Several tests have been performed to find out the mathematical skills of the students starting their studies in professional schools.

The following has been taken from the report [T]. “Basic” and “Advanced” refers to those students who have passed the basic and the advanced matriculation test, respectively. The percentage shows the portion of correct answers. The questions were not written as below - standard expressions were used instead.

	Basic	Advanced

Sqrt(3**2 + 4**2) =	55 %	78 %
(1/3 – 1/7)/4 =	25 %	54 %
a**2 – (a + 1)**2 + 2a =	17 %	50 %
Find R from the formula U = E - IR	26 %	68 %
ln (x**2) – 2 ln x =	7 %	34 %

Since calculators were not allowed in the test, the results clearly indicate that the students who had taken “basic mathematics” have not learned, or at least forgotten, even basic concepts.

The above studies show that the changes in the mathematics curriculum in Finland have had marked effects on learning of mathematics at school. This seems mainly to concern people who are not interested in mathematics at school but who later need some mathematical skills.

In conclusion

- Calculators in teaching mathematics are not properly used at school. Some of the effects have been disastrous.
- The architecture of the mathematics curriculum, as it now stands in Finland, does not produce skills which are later needed.
- “Problem solving” has been overstressed since it has not been able to respond to the needs of the modern society.

References

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