THE IMPACT OF MATHEMATICS COMPETITIONS ON EDUCATION IN FINLAND

Matti Lehtinen, National Defence College, Helsinki, Finland

Introduction

Mathematical creativity is not quite the same as mathematical giftedness, but no doubt the latter is a prerequisite of the former. Of the means used to promote mathematically gifted young people, mathematical competitions are by far the ones most commonly used. So in a conference of mathematical creativity, it seems appropriate to deal with some aspects of competitions.

I shall address myself mainly to the impact competitions are hoped to have and the impact which can be observed in a small country, which for obvious reasons is my home country. This contribution can be viewed as a case study (which I have noticed to be popular format in educational research), or, since a lot of the things I mention have some contact with my own activities over the years, also as a piece of self-assessment (also a fashionable topic). I have to dwell at some length with the circumstances, i.e. the educational setting and the history of mathematical competitions in Finland.

1 Educational system in Finland and mathematics in it

In Finland, compulsory education starts at the age of seven and continues through the age of 16. For all these nine years, the education is comprehensive. In the first six grades, the children are in care of a general teacher (usually quite modestly qualified in mathematics), while from the seventh grade on, teachers specialize in their subjects. This system was introduced in the 1970's. In the system which was in use before that, only the first four grades were comprehensive, and exam taken at the age of 11 determined, whether the child could continue in a track eventually leading to higher education, or if she or he was destined to a at most blue-collar future. The objective of the reform in the 70's was to postpone this kind of dramatic decision to a later point in life and to give all children equal opportunities by giving them an identical education. Modernized teaching methods were supposed to guarantee a high level of education to everybody. The slogan "everybody can learn everything" was not quite openly proclaimed, but it can be said to characterize the spirit of the reform.

A remarkably high proportion – more than 50 % – of the young people who finish the nine year compulsory education continue in high school. For some years now, the high school has been conducted in a course oriented fashion, and it is up to the student to decide whether he or she uses anything between two and a half to four and a half years to complete the courses. Mathematics is taught in two versions. The shorter one splits the subject in six and the longer one in ten courses, each of 30 hours duration. The scope of topics covered is large and the text books are loaded with a large number of easy problems.

The high school studies end with the national matriculation examination, in which the student has to pass at least four exams, one in the native language, Finnish or Swedish,

one in the other national language, one in a foreign language, usually English, and either an examination in mathematics or a composite examination in which all the other relevant school topics are covered, all the way from religion, philosophy and psychology through history, biology to physics and chemistry. The student can pick his or her choice from a big number of questions. The mathematics examination – which can be avoided altogether – comes in two alternative versions, from which the student can choose independently of his or her choice of the length of studies at high school. The problems in the "short" are supposed to be more practice oriented and mathematically less sophisticated, while the "long" version covers more theoretical mathematics. The mathematics examinations are rather easy to pass – by rule, 95 per cent of the candidates should pass, so the threshold is very low.

In surveys among students, mathematics is ranked among the less popular subjects. This is not so with the youngest students, but quite marked from around the 6th grade. Low performance in mathematics has been kind of a concern in Finland. A society relying heavily on modern technologies needs a cadre of scientists and engineers, and industry, in general, has been demanding measures which would substantially increase the number of good performers in mathematics and science. The concern was felt even at government level, and in the last five years a project has been carried out in which some extra resources have been allocated to furthering mathematics teaching. In government reports released in connection with this project, the at best mediocre success of Finland in international mathematical competitions was given as one reason for starting the project in the first place.

Of all the influences guiding the work in high schools, the influence of the matriculation examination is the strongest. Naturally, good marks in the examination are decisive in obtaining desired further education, but the examination itself with all the customs involved is an important national institution. Parents expect that the high schools prepare their offspring properly for the examination, and teachers behave accordingly.

The general education in Finland is very democratic. So, one can ask, what happens to specially talented students. The answer depends a lot on what you are talented in. There are schools for those who have special abilities in say, sports or music. With dwindling student populations, due to diminishing birth rate, schools in urban areas compete for students (or the attention of parents). So we have high schools profiling themselves in foreign languages, science and in one case even mathematics. The degree of differentiation and the amount of extra effort in the special topic of the school is, after all, quite modest, as the school work is generally guided by the matriculation examination.

Teachers of mathematics usually also teach physics and/or chemistry as well as informatics. Their professional organization, the *MAOL*, comprises the teachers of all these subjects. It is a strong organization.

Summing up, mathematics, especially on a more demanding level, has not been and is not a priority in the education in Finland. This situation might call for measures to take care of both the society's need for mathematically qualified people as well as for the needs of individuals whose gifts are on the mathematical side.

2 The possible influence of competitions

In general, the following two reasons are given to justify mathematical competitions at schools. They are supposed to increase the interest in and awareness of mathematics shown by the students and the society. They are supposed to bring forth mathematical talent which would otherwise remain hidden. Both these aspects would benefit the society and economy.

Less openly discussed, but certainly existing ambitions among the organizers of extra-curricular activities like competitions are hopes that seeing material more ambitious or at least different from the one printed in the text-books would influence the teachers' attitudes. Whether it is true or not, at least many of us who pretend to know a bit more think that the ordinary teacher's view of mathematics is, in the average, rather narrow, and exposure to competition problems even through their students, is hoped to widen the teachers' horizons. Another hidden purpose of the competitions is an influence on the curriculum. There is an opinion that regrets the curriculum change which has almost completely erased classical geometry from the classroom, and thereby also the concept of a deductive structure and proof. The usual choice of competition problems, which often contain quite a dose of Euclidean geometry, can be seen as a silent opinion on curricular matters towards the restoration of proof-oriented mathematics.

These matters are not the ones which would encourage a potential participant to participate. What he or she would expect is probably the excitement present in any competition, the intellectual reward of being better than somebody else, and the material rewards associated with competitions.

Mathematics is not a popular pastime for young people, and in general especially not popular among girls, competitions could be hoped to be a psychological boost to shy, lonely and socially isolated but talented young persons. As a marked giftedness in any speciality is by definition a rare phenomenon, it is not likely that such a student would have friends among his or her schoolmates sharing the interest. Participation in a competition might thus be socially rewarding for the participants, showing them that they too can find an appreciating peer group. Success in competitions by girls is hoped to provide a positive role model for girls, showing that it indeed is possible to combine the female sex with being good or outstanding in mathematics.

3 Mathematics competitions in Finland

3.1 How they got started

First attempts of a mathematical competition for high school students in Finland are from 1955. The organizing body was the MAOL, and, incidentally, the initiator was the first Finnish female Ph.D. in mathematics, Inkeri Simola. The problems were published in the journal of the MAOL, and teachers were asked to bring them to the attention of possible participants. The problems were quite respectable, what comes to difficulty, and the participants were supposed to work with them at home, utilizing whatever lit-

erature they might find, but they were supposed not to seek any advice from teachers or other people. There were modest monetary prizes, donated by individuals.

The first competition attracted only five participants, but nonetheless the winner was a person (*Pekka Tarjanne*) who later distinguished himself as one of the youngest ever professors in the University of Helsinki (in theoretical physics) and with a career in the International Telecommunications Union. After a couple of years the high school competition waned off, and the MAOL, having found a sponsor in a banking organization, started in 1960 a new competition for ninth graders. This time the problems were a lot easier, with a strong emphasis of problems having an monetary setting. There were both local and national prices, and all participants were rewarded by a pin depicting the letter π. The number of participants was in the thousands. The competition is alive and well even today. It lost its sponsor in 1972, then got another bank to back it, then lost this one, too, as the bank decided to back a computer competition instead, but still runs with some government support.

3.2 The IMO as the reason for mathematics competition

Another impetus to start a more ambitious competition come in a way from above. In 1965 the 7th International Mathematical Olympiad was due to in the German Democratic Republic. Mainly because of personal connections between some leaders of MAOL and officials in Berlin, Finland was invited, as the first non-socialist country, to participate in the IMO. As there was no high school competition running, the team was selected from among students supposed to have the necessary qualifications. In this respect, the team was a disappointment. But the prospect of a continued participation caused MAOL to revive the high school competition in the form described above. The competition never became popular, and there was no new IMO invitation either until 1973. However, after that year Finland has been a permanent participant in the IMO's as well as in the more regional Nordic and Baltic Way competitions. During a period in the 80's and 90's, the American multiple choice competition AHSME was also given in Finland, to a limited number of participants.

The high school competition since then has gone through two substantial changes. The first took place in 1976, when the competition was changed to an examination run concurrently in the participating schools, with two levels of difficulty and the next one in 1997, when a final round to be held in one place for the top 20 of the school round was established. There are monetary prizes, but by far the most coveted price seems to be exemption from entering examinations promised by technical universities and faculties of science for the top 10 of the final round. This might be surprising because the students performing well in the competition are those to which the entering examinations should not be a resistance.

3.3 Activities around competitions

After the first failure in the IMO, the need of special training for IMO participants was recognized. Starting from 1973, a loose voluntary training organization has existed. Its members are mathematicians, past members of the IMO teams, none of them working at

a school. The first training was a couple of days meeting before the IMO. A correspondence course has been running from the late 70's, and since 1995, rather regular weekend meetings about every two months, open for all interested, but mainly targeted to potential IMO participants have existed.

MAOL, the teachers organization, has a standing committee on "matters relating to students". The only task of this committee is to administer the competitions in mathematics and science, in a way by an authority relegated to it by the Central Board of Schools and the Ministry of Education.

4 The actual influence of competitions in Finland

Of the hopes one may have of mathematics competitions, some are fulfilled in Finland, at least partly, and some are not.

4.1 What competitions have achieved

Success in sports brings publicity. Finland's participation in international mathematical events has never been very successful. But because of the generous way prizes are distributed at the IMO's, press releases citing medals have been released and even printed. Also, success by a local student in national competitions often is recognized in local media. So one can say that the aim of increasing public awareness of mathematics has been superficially reached.

A special case with the media are girls. A girl doing well in a mathematics competition will receive much more media attention than a boy. One could think that this is a positive phenomenon: it should tear down the prejudices surrounding girls and mathematics and give a positive role model. On the other hand, these kinds of media publicity also stresses the exceptionality of the event and may in fact turn the "ordinary" girl away.

Negative publicity is not without effect, either. As stated in section 2, the failures in the IMO's have been used to draw attention to the needs of mathematical education.

What about picking up hidden talent? Although a thorough statistical study of what the good competition performers do later in life has never been done in Finland, it is evident that a majority of good competition participants eventually pick up careers in which they can put their mathematical abilities into use. To what extent this is a consequence of there being competitions or just a natural correlation is not easy to decide. Most likely the effect is greatest among those actively involved in the training programmes. When one looks at university students and graduates fulfilling various criteria of excellence like being rewarded prizes for excellent theses one meets a good number of former IMO team members or persons distinguished themselves in the national competitions. In these cases the phenomenon could be described not as "finding hidden talent" but by "talent finding mathematics" by the strong exposure to it. But competitions undoubtedly play a role in creating this union.

A special by-product of competitions is the *Päivölä* mathematical school, started by Mr. *Kullervo Nieminen* in 1994 in a highly improvised manner. Counter to the prevailing concept of uniformity, Mr. Nieminen believed that going through the high school mathematics program, and the whole curriculum, at the officially preset pace was a great waste of time for able students. Against the beliefs of sceptics, to whom this writer also belonged, he was able to realize his vision originally with about a group of approximately dozen students originally only picked into the IMO training programme through the high school competition. The school now has a fairly stable position secured by its cooperation with the Nokia company, although the initiator has left it. Students spend two years in Päivölä to complete the high school as opposed to the three plus years elsewhere. In addition, they work part time with a Nokia research establishment situated nearby. Many but by no means most Päivölä students do well in mathematics competitions. One obvious reason for this is the fact that the ninth grade competition is one way to recruit students there.

The Päivölä experiment has received much more publicity than the mathematics competitions ever. This publicity, however deals mainly with the "incredible" fact that motivated young people can work hard and even like it.

At the personal level of the participants, a lot of the aims of competitions seems to come true. Quite a number of young people have expressed their happiness at getting in touch with mathematics more interesting than the duller version they have been exposed to at school. The more active ones really make friendships with other like-minded people. They form – as is fashionable to say – networks when continuing their studies. As fashions go, the most popular places to go after school for these people seems to be the Helsinki University of Technology and the Mathematics Department of the University of Helsinki. The interest in problem solving in those places has manifested itself in the International University Students Mathematics Olympiad, to which teams consisting of former school competition laureates have been sent from both places.

A rather extensive study of Finnish Olympiad (mathematics, physics and chemistry) participants has been done by *Kirsi Tirri* (e.g. *Actualizing Mathematical Giftedness in Adulthood.* ECHA Conference, Debrecen, August 2000). Her results seem to confirm that in the personal level, being involved with competitions has been a positive event for almost all participants.

4.2 What the competitions have not achieved

Although the competitions are run by the teachers' association, one cannot say that the competitions have much influence on what and how the teachers think or do. A frequent complaint is that a considerable percentage of teachers fails to promote the competition to their own students, so lowering the participation. Among the manifold duties of the present-day teachers (who sometimes have to take care of things more appropriate to kindergarten personnel), activities centering on the good students simply are not of primary importance. The high school competition has been able to attract only very few active high school teachers to get involved in the organization of the competition and

none to the training programmes. Some attempts to incorporate competition-like problem solving into the studies of prospective teachers cannot be described as successes.

One unwanted effect of mathematics competitions in some cases is increasing friction between teachers at schools. There are cases in which a dutiful mathematics teacher administering the competition in his or her school has met with negative attitudes of teachers of other subjects, all competing for the students' time and attention.

The prevailing attitude among mathematicians is that the curriculum in schools is wide but thin. The almost total absence of geometry is seen in the competition performance and it has been pointed out as a reason for poor international performance in various competition reports. Some signs of a return of geometry to school are discernible, and one might just conjecture (without proof) that competitions has played a role in this.

4.3 The balance sheet

Competitions draw some publicity to mathematics, but this publicity is on the superficial level. Competitions have no educating effect on teachers. Competitions increase interest in mathematics among people who are capable of getting interested in mathematics. The influence of competitions on curriculum is negligible.

So the competitions – in Finland – are not what an optimist would like them to be. But they are not without positive effects. It is futile to weigh numerically the input-output ratio of various processes of education. The writer's opinion is that if we wish to foster mathematical creativity, we should have in our arsenal the competition institution, but we should not rely solely on it