The De Morgan Journal 2 no. 2 (2012), 47–52. ISSN 2049-6559

HUNGARY: SEARCH FOR MATHEMATICAL TALENT

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In Hungary we have an established old system for finding mathematical talents. I thinks it has been working and works well enough. Of course it is not perfect. In this paper, I have collected some observations (focusing mostly on the *Szent István Gimnázium*† and *Fazekas Mihály Iskola és Gimnázium*‡ in Budapest) but I have not tried to prioritise them.

Organization

In Hungary, specialist mathematics classes start at 7th grade. It means that the students are 12–13 years old. It is very difficult to say whether it is early or late. It is early because some 12-year-old students seem to be very gifted in that age, but later they lose interest in mathematics. On the other hand it is late, because the most talented children stand out earlier. I think the Hungarian way is a good compromise.

Budapest has 2 million citizens and 4 schools running special maths classes (from 7th grade to 12th). This is more than sufficient provision. Two special high schools with special maths classes would be enough. (30–35 pupils attend the same class. $6 \times (30$ to $35)$ students in a high school.)

Most of the special maths classes have 2 streams and 2 maths teachers. They teach different areas of mathematics.

Mathematics classes are only part of Fazekas (and in other schools with specialist classes). In every single case that is the situation in Hungary. Other classes are mostly specialising in such subjects as foreign

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2000 *Mathematics Subject Classification* 97B99 (primary), 97D10 (secondary).

† http://szigbp.hu/england.

‡ http://www.fazekas.hu/.

languages, science (physics, biology, chemistry), literature and history, music, but there are so called normal classes.

Young mathematicians are not engaged in other extracurricular activities. In Fazekas and other school like it, various specialist classes live very well together, and the social network in schools is healthy.

Focus on problem solving

School lessons in Hungary are 45 minutes long. In a specialist mathematics class, the weekly number of mathematics lessons varies between 6 and 10. (Nowadays, I think, we rarely have 10 lessons a week, but when I was 17, I had 10 lessons a week, 2 lessons every day.) In my opinion 6 classes a week is a minimum. There are no university-style lectures; instead, "discovery teaching" is used in almost every special class. Students are given a plenty of problems, and a lot of time to solve them.

Here is an example of a non-standard problem.

> *Questions game.* There is a well known standard problem: how many questions (answered *Yes* and *No*) do you need if you have to find a given number from the first n integer. But here is its non-standard version: what is the best strategy if you have 10 dollars, and you have to pay for each answer: *Yes* costs you 1 dollar, *No* costs 2. ☺

Or this one:

> We are given the 64 center points of the squares of a chessboard. How many straight lines do we need to separate these points from each other?

We offer our students a wide range of geometrical problems including problems of geometric constructions. We think these problems are very good for talented students, especially in the early years (7th-9th grade). This involves, for example, Mohr-Mascheroni theorem (which states that any geometric construction that can be performed by a compass and straightedge can be performed by a compass alone), difficult Euclidean constructions: regular polygons, triangles from 3 given parameters etc. What can we do if we have only a ruler? What happens if a square is given too? Or if a circle is given, but not its center point? Or the circle with its center marked?

As an example of our approach to teaching, I include as an appendix the text of a handout with geometric construction problems. It focuses on conic sections, but you can imagine similar handouts about other parts of geometry.

Perhaps I have to mention that in the US the geometrical construction problems are not part of the curriculum. I do not know what is the situation in England.

Curriculum

Curriculum is a very difficult issue. For example, we do not teach calculus, but we teach normal mathematical analysis to 11th, 12th grade students. It needs to be explained that in Hungary we do not teach calculus at university until the last 2 or 3 years. Every university and high school teach normal mathematical analysis with definitions, theorems, lemmas, proofs etc.

But calculus is very different. Calculus contains a lot of methods for calculating specific values, and at a certain point students do not understand the correct meaning of these values. For example, at a calculus class students are frequently asked to calculate integrals before they learn the definition of the Riemann integral.

In my opinion, it is very useful and develops the creativity in students if the teacher does not teach a well-specified topic. At the university level, the narrow specialisation of courses obstructs development of mathematicians-to-be. University students know that they have learned 2 or 3 theorems at the last lecture and, given a problem for solving, they expect that they can use these specific theorems and methods in solution. But this approach narrows students' creativity. I teach in a high school, and I try to mix areas of mathematics to improve the students' understanding and creativity.

Physics and informatics are taught separately from mathematics. But we teach algorithms and basic computer science in specialist mathematics classes as part of mathematics curriculum.

Escape routes

It is very important to give students a chance to leave the specialist class after 8th grade. First 2 years provide time to make the decision whether the pupil fits into a specialist class or not. If someone finds a specialist mathematics class too difficult, there should be an opportunity to give it up and continue his/her studies without any problem.

They have the opportunity to attend an other class in Fazekas (a normal class, a language class, or a science class) or they can leave Fazekas and attend to an other high school. Of course, some of these pupils are disappointed. But this decision is likely very good for whom left the class, and for the others.

Conclusion

In my opinion the most important condition for running a specialist mathematics class is that the teacher has enough time to let the students think. Also, if the teacher has too many classes to teach, he/she does not let the students think; instead, he/she teaches them a lot of techniques and ready-to-use routine methods. Do not do that.

MaMuT

MaMuT (this is a Hungarian abbreviation of "*Matematikai Mulatságok Tábora*", in English: *Camp of Mathematical Amusements*) is a summer camp, where talented students (between ages 10 and 15) are invited to take part in mathematical programs. The invitation is based on the results of the national mathematical competitions.

The main goals of the camp are the following:

– make it possible for these children to meet others with similar abilities and interests (since most of them are studying in regular schools), and
– combine high quality mathematical programs with the entertainment possibilities of a summer camp.

Significant previous experience underlines the fact that this can really help these kids to improve their mathematical skills.

The best teachers in the country run mathematical programs each day. The mathematical programs have one important feature in common: they are about exploring mathematics, not about learning mathematical facts.

The most important teacher of the camp representing this method is Pósa Lajos. Many of the teachers and all the members of the youth staff learned the method and mentality of teaching mathematics from him.

The main principle of this method is that children should be taught how to think, rather than making them learn theorems and formulas by heart, or giving them ready-made methods to solve problems. The children should free their minds and apply their own ideas.

The teachers of the mathematical programs are not lecturers, and they are not trying to teach extra theorems and formulas which are not part of the curriculum. The students should not be treated as passive recipients, on the contrary, we want their active participation (i.e. the teacher should adopt to the abilities of the group), and in some cases we want to let them decide the course of the program (e.g. they can ask questions, and these can be included in the program). Another typical element of this method is letting the children work in groups.

Naturally, this was just a brief description of the method, which itself is much more complicated. Our aim is to acquaint more teachers with this method. This is the main reason why we include the teacher's training in the camp's program.

The camp is not all about mathematics. Every year we make excursions in the mountains of Mátra, teach the children lesser-known board games and other kind of games which can be played in larger groups and also try to come up with interesting programs not related to mathematics.

The invited students do not have to pay for the camp. This way we want to ensure that talented kids, regardless of the financial situation of their parents, can take part in the camp.

Appendix. Sample geometric problems on construction: conic sections

(1) Given the major and minor axes of an ellipse, construct a point on the ellipse, and the tangent line to the ellipse at this point.
(2) Given the focus and the directrix of a parabola, find a method to construct any number of points on the parabola.
(3) We shall say that an ellipse is *constructed*, if we know its major axis and the distance between its foci. Construct the ellipse if you are given the following data:
   (i) a focus, a tangent and the center of the ellipse;
   (ii) its two foci and a tangent;
   (iii) a focus, two tangents and the direction of the major axis;

(iv) a focus and 3 pairwise distinct tangents.

(4) Given the foci and the major axis of an ellipse, construct the two tangents to the ellipse passing through the given point outside of the ellipse.

(5) Given the foci and the major axis of an ellipse, construct the intersection points of the given straight line and the ellipse.

(6) We shall say that a hyperbola is *constructed*, if we know its major axis and the distance between its foci. Construct the hyperbola if you are given
   (i) its two foci and a point on the hyperbola;
   (ii) one of the two foci, two points on the hyperbola and the length of its major axis;
   (iii) the two foci and one of the asymptotes of the hyperbola;
   (iv) one of the two foci, the center and a tangent;
   (v) the length of the major axis and the both asymptotes.

(7) Given the two asymptotes of a hyperbola and a tangent line, construct the point where the tangent line touches the hyperbola.

(8) Given three points on a hyperbola and one of its asymptotes, construct the other asymptote.

(9) Given the focus and the directrix of a parabola, construct the intersection points of the parabola and the given straight line.

About the author

Péter Juhász is a research fellow at the Computer Science Department, Mathematical Institute, Eötvös Loránd University in Budapest.

He was born in 1975, in Gyöngyös, Hungary, and studied in the special maths class of the *Berzsenyi Dániel Gimnázium*[†] in Budapest in 1989. Dr Juhász holds a doctorate in cartography, master's degrees in teaching maths and cartography, and a bachelor's degree in computer science.

Dr Juhász teaches in *Szent István Gimnázium*[‡], Budapest, in a special maths class, and also teaches "discovery learning for gifted students" and discrete mathematics to future maths teachers at Eötvös University. He is colleague of Lajos Pósa and they organise and lead special weekend mathematics camp for the most talented Hungarian students. He also organise and leads a summer mathematics camp *MaMuT*[§].

[†] http://www.berzsenyi.hu/index.php?id_a=25.

[‡] http://szigbp.hu/england.

[§] www.matematikatabor.hu.