Talent Nurturing in Hungary: The Pósa Weekend Camps

Péter Juhász

It is a Friday afternoon in an old mansion house in the Buda Hills. We hear the chatter of high school students and parents arriving in the courtyard. It is obvious that this is not their first time here. The next weekend math camp led by Lajos Pósa is starting soon, and the air is filled with anticipation. Pósa knows the parents quite well—many of them came to the camp when they were little. They might revive old memories in a few words or possibly talk about more recent topics.

A bit later, the parents say goodbye to their children, but this is not a hard goodbye. The kids quickly go find their usual rooms and catch up with their friends, with whom they share their rooms. They know they will see their parents in about two days, and the time in between is going to fly by. The two days will include about fourteen hours of intensive thinking about math problems—which might sound frightening to many—but for them this is something they have been waiting for for the past few months.

In fact, they were not simply waiting for the camp, they were also preparing. The camps usually start with a plenary session, in which the students discuss their progress on the homework problems from the previous time. Some of these problems are easier, and they are intended for the students to practice the new ideas they learned in a different setting, but some problems are very difficult and require substantial effort, even from the most talented students. When a problem turns out to be particularly difficult, it is not uncommon that the problem will be worked on over several camps before the solution is discussed. The students are not expected to solve all the problems, but instead to think about them persistently.

After the homework discussions are finished, about five or six new problems are assigned. The students start working on these problems, but not all by themselves. They work in teams of two, three, or sometimes four, which they form themselves. Each team occupies a different room of the mansion so they do not disturb one another.

This peaceful, stress-free, and collaborative environment is one of the most important traits of the camps. In the rooms the teams and the mathematical puzzles are locked in together; they do not know what the other teams are doing; they work at their own pace. If they want, the students can work at desks, but many prefer to think in their beds, while walking around, or simply just sitting on the ground. Some groups talk quite often and some—especially in the camps for older students—communicate only in a few words. This freedom and calmness makes the camps quite special.

The teamwork itself is also far from ordinary. One would expect that, in a team, if someone solves one of the problems, they would immediately share it with the others. In the Pósa camps this is different. The central concept of these camps is the joy of thinking, so everyone should have a chance to tackle and solve the problems themselves. If this is the case, one may ask, why are there teams in the first place? In these camps, initially everyone thinks about the problems individually and in any order they want. If they solve a problem, they are supposed to keep the solution secret; only those who have thought about it but do not know the solution yet are allowed to continue discussing that problem. If anyone solves the problem during the discussion, they also stop conversing. Solving problems is a little bit like finding a way out of a dark forest. It is exciting and we all want to participate. While the way is uncertain, it is better to have company, but once we are out and have

Péter Juhász is a research fellow at Rényi Institute of Mathematics, Hungarian Academy of Sciences; a math teacher at Szent István High School, Budapest; and an instructor at Budapest Semesters in Mathematics Education. His email address is juhasz.peter@renyi.mta.hu.

This article was translated by Gergely Ódor.

Communicated by Notices *Associate Editor William McCallum.*

DOI: https://dx.doi.org/10.1090/noti1887

experienced the joy of finding the solution, it is better to let the others find the right path themselves. Initially, this version of teamwork might be strange for the students, and in seventh or eighth grade they often break the rules. But by tenth grade no one allows the others to reveal the solutions; they have already experienced how the joy comes from finding the path themselves and not simply knowing the answer. The journey is more important than the destination.

The camps are structured by alternating plenary and teamwork sessions. The plenary sessions usually include solution discussions but sometimes also tales about the history of mathematics, quizzes, and sessions where the students are supposed to ask follow-up questions. Learning to ask good questions is a central objective of the camps. The authors of good questions receive chocolate rewards, and if a question becomes part of the camp curriculum, the authors will be mentioned in the preceding story each time the problem is assigned, and thus become part of camp history. This way students learn that raising good questions is an important part of science, often more important than finding smart answers.

Every Saturday afternoon is spent in team competition. The teams have three hours to solve five problems related to the camp curriculum. Here is an example problem that often appears in eighth-grade camps:

> *A precious piece of treasure is locked up in a safe. The door of the safe is circular and there are four indentations on it. The indentations are positioned on the vertices of a square centered at the midpoint of the circular door. Each indentation hides a binary switch, which cannot be seen from the outside but its position can be identified if we put our hands in. We are standing in front of the door and we can each put our hands into one of the indentations, and we can change their setting. However, once we pull our hands out, the door senses that it has been tampered with, and it starts rotating extremely fast*

Lajos Pósa (1947–) stood out as a child with his special mathematical abilities. At the age of fifteen, he wrote a joint article with Pál Erdős. The Pósa condition, which guarantees the existence of a Hamiltonian cycle in a graph, is taught in many schools around the world even today. In high school he went to the same class as László Lovász and Miklós Laczkovich. His career in mathematics started wonderfully, but after acquiring his PhD degree he gradually renounced research for mathematics education.

He taught mathematics in several normal (not special math) high schools. His focus shifted toward talented students in the 1980s. Pósa organized the first weekend camp in 1988. At that time pretty much every circumstance was different. Hungary was still part of the Soviet regime; the parents helped find the location, which was different each time; Pósa usually led the camps without helpers; and there was only a single group of students. Since then the camps have become much more organized. The location—the old mansion house—is fixed. There are two groups of students per grade, which means a total of ten groups run in parallel (from seventh to eleventh grade); each gets to camp about two or three times a year.

Today we are past our 350th camp, and more than a thousand students have had a chance to take part. Some of them are mathematicians or mathematics teachers, but many have become software engineers, economists and financial analysts, and even dramaturges and archaeologists.

Nurturing mathematical talent is a great tradition in Hungary. Experts on education, such as Tamás Varga, György Pólya, or Zoltán Dienes, have left behind long-lasting legacies. We have had countrywide competitions since the beginning of the twentieth century, and since 1894 (except for the years during the World Wars) the *KöMaL* journal has appeared every month. One of the main features of *KöMaL* is a high-quality year-long mail-in competition in mathematics for high school students. Clearly, Hungary was doing quite well in terms of nurturing talent even before Pósa.

However, what Pósa has brought to the table is something completely new and revolutionary. It is still talent nurturing, but the goal is not for students to become efficient problem solvers. It is true that each year almost all the members of the Hungarian IMO team also go to the Pósa camps, but such competition results are merely a byproduct. The goal is for the students to experience the joy of thinking, which is a delicate task, and it only happens in the right kind of environment. It requires both the structure provided by Pósa's carefully constructed curriculum and the freedom given by the supportive and stress-free atmosphere characteristic of the camps. And once the students have experienced this joy, it gives them the confidence to think, to be creative, to dare to fail. All of this is essential for solving hard problems, but more importantly, for asking good questions. Asking questions is deeply embedded in the culture of the camps; in fact, it is quite likely that the most common sentence of these camps is, "What would you ask right now?" Of course the effectiveness of these principles depends highly on how they are put into practice. This is where Pósa's vision and experience matters the most, which is now further strengthened by the alumni who strive to carry on and extend his ideas so that future generations can benefit from the same introduction to the beauty of mathematics and joyful thinking.

until it stops at possibly a different angle than before. Unless of course all four switches are in the same position, in which case the door opens immediately and we win the treasure. Can we always win the treasure in finite time?

The goal of the competition is again not to overstress the students or to establish a ranking among them; it is only an exciting task that helps them stay motivated. This is why at the end, the only information they receive about their results is whether they did very well, in which case the team wins two bars of chocolate, or even better, which is rewarded by three bars of chocolate.

As has already been mentioned several times, a key feature of the camps is the curriculum, which was carefully worked out by Pósa himself. The problems assigned in the camps are all building blocks that depend on one another. If someone cannot come to one of the camps, they must make an effort to make up the work; otherwise they would be left behind and could not take part in the future. Missing one or two building blocks usually does not cause serious problems, but a whole camp's worth of building blocks can be a structural hazard. Since so much happens in one weekend, making up for the material is much more difficult than attending—another reason why students rarely miss the camps.

The building blocks are organized into threads; each problem builds on the previous one. The specific elements needed from each thread might differ between teams: stronger teams go faster, weaker ones need smaller steps. These threads are tied together by the key ideas in their solution (e.g., impossibility proofs, recursive approach, starting from the extreme case, the idea of motion, etc.), instead of the traditional classification (algebra, geometry, combinatorics). Finally, the "building" is stabilized by the frequent intersection of the threads. One or two particularly important problems shed light on the rarely observed phenomenon that sometimes even distant parts of mathematics have a strong connection between them.

During breaks between the mathematical sections of the camp, students play sports or choose one of the many board games available. Bughouse chess is a returning favorite. The evenings are usually spent with camp-wide games, but the students are free to spend this time as they prefer.

The students coming to the camps are the "eccentric children" in most schools, as strong mathematical interest is atypical. In these camps they can meet their intellectual peers, with whom they can build lasting friendships, and everyone feels perfectly normal in their skin. This experience is very inspiring for them, and it affects their life outside of the camp as well.

It is now a Sunday afternoon. Parents are arriving at the old mansion house. The last session is finished, and the children quickly tidy up before going home to rest. They have worked hard for three days, which they have surely enjoyed, but it must also have tired them out considerably. On the way home they sleep in the car or pose some of the problems they solved in the camp to their parents. It is not uncommon that the parents cannot solve these problems.

It will be about three or four months before they come back and the adventure will continue. The adventure introduces them to the beauty of mathematics by letting them discover it themselves.

In case the above paragraphs did not do justice to how special these camps are, we also include a couple of testimonials by former campers who later became mathematicians or mathematics teachers.

- *The long building process, the unexpected connections filled me with such pleasure that made mathematics for me similar to a form of art.*
- *This is where I learned that "real mathematics" is discovery.*
- *In the Pósa camps we learned to walk on the path of thinking. At times we stumbled and fell, but we got up and tried again. Lajos and his well-prepared helpers paved our way with fatherly care, but they never made a step for us. This was the key. They let us discover mathematics ourselves. This way we have not just received solutions to some interesting problems, but something much more important; the hidden power of thinking.*

Photo: Dávid Ferenczy / Abcug.hu

Péter Juhász