Mathematics in Poland: Potential and Crisis

Young Polish mathematicians are winning prestigious European prizes, publishing in leading journals, and working with top international research groups. Yet according to **Prof. Tomasz Łuczak** of the Faculty of Mathematics and Computer Science at Adam Mickiewicz University in Poznań, the broader situation surrounding the mathematical sciences in Poland is becoming increasingly worrying.

Mathematics does not have a Nobel Prize, but it does have the Fields Medal and the Abel Prize. Are they comparable?

TOMASZ ŁUCZAK: Traditionally, the Fields Medal has been regarded as the highest distinction in mathematics. At the same time, however, it is burdened by a certain fundamental unfairness. There is an age limit of forty, and the medal is awarded only once every four years. Someone who is forty-one when the congress takes place is automatically ineligible, while someone who is forty can still receive it.

For that reason, I sometimes think the Abel Prize is the fairer distinction. It carries no age restriction and is often awarded to people whose influence on mathematics, and sometimes on science more broadly, can only be properly assessed after many years.

In science, the true significance of an idea often becomes apparent only a decade or two after it is first proposed. A good example is the concept of the quantum computer, introduced by Richard Feynman in the 1970s and only fully developed in the twenty-first century. The impact of the work recognised by the Abel Prize is often easiest to appreciate with the benefit of hindsight, once we can see how profoundly it has shaped the development of mathematics. That is why I tend to regard the Abel Prize as the more meaningful measure of scientific achievement.

No Polish mathematician has ever won either the Fields Medal or the Abel Prize. Does that mean we are on the margins of the field?

Not at all, especially when it comes to the younger generation. At the most recent Congress of the European Mathematical Society in Seville, Polish mathematicians were among the ten young researchers who received EMS Prizes. That is an exceptionally prestigious distinction. For many years, every European Fields Medalist first received an EMS Prize.

Young Polish mathematicians are highly active internationally. They publish in leading journals, receive invitations to major conferences, and collaborate with some of the best mathematicians in the world. Many of them hold positions in the United States, the United Kingdom, or Switzerland, but that is true of the most talented mathematicians across Europe, not just those from Poland.

That does not mean there is no room for improvement. The number of major European grants won by researchers working in Poland remains relatively small compared with countries such as France or the United

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Kingdom. The reasons are complex, but one factor is familiar: investment. Mathematics does not require the enormous budgets associated with some experimental sciences, yet even relatively modest increases in funding can significantly strengthen a country's research potential.

Austria offers a good example. In recent years it invested heavily in mathematics and theoretical computer science and, within a relatively short period, built research groups that are now highly visible both in Europe and internationally. My greatest concern, however, is not research. It is mathematics education.

Why?

Research shows that many students begin their education enthusiastic about mathematics but, somewhere around the middle of their school years, come to the conclusion that mathematics, physics, and chemistry are subjects that cannot really be understood by most people. They begin to believe these disciplines are reserved for a small group of individuals blessed with some special talent. The widespread acceptance of that idea is disastrous.

We need to do a much better job of teaching not only mathematics but all the mathematical and natural sciences. Yet for many years now, more and more people have come to believe that scientific literacy is not particularly important and that lacking even basic knowledge of mathematics, physics, or chemistry is nothing to be embarrassed about.

This is not uniquely a Polish phenomenon. Similar trends can be observed across much of Europe. The countries of East Asia represent a striking contrast. There, there is still a strong conviction that widespread competence in mathematics, physics, and chemistry is one of the foundations of a modern state. If we want to remain competitive, we need to start thinking in similar terms. That brings us to a problem that receives far too little attention.

The way these subjects are taught?

Poland has effectively stopped treating the teaching of mathematics and the sciences as a legitimate academic discipline in its own right. In most European countries, mathematics education, physics education, and chemistry education are recognised fields of research. Scholars can earn doctoral degrees, habilitations, and professorships in those disciplines. In Poland, however, it is no longer possible to complete a PhD specifically in mathematics education because the discipline does not officially exist within the ministry's classification system.

> Mathematics matters not because it helps people win Nobel Prizes or other prestigious awards. It matters because it teaches logical thinking. When we solve a mathematical problem, we learn how to reason correctly. More importantly, we learn how to evaluate whether a line of reasoning is valid or flawed. That is a fundamental civilisational skill.

The situation is becoming genuinely alarming. We have fewer and fewer specialists in mathematics and science education who hold senior academic qualifications. Young and often very talented researchers who would like to build careers in this area face enormous obstacles even at the doctoral level, let alone later stages of academic advancement.

Mathematicians are often reluctant to supervise or evaluate them because their work does not involve proving theorems. Educational researchers are frequently reluctant for different reasons, because they may not fully understand the specifics of teaching a particular scientific discipline. After all, pedagogy is primarily concerned with education in the broader sense, not with the teaching of mathematics, physics, or chemistry as such.

The problem becomes even more absurd when someone earns a qualification in mathematics education abroad, which is possible in almost every European country, and then struggles to have that qualification recognised in Poland because, officially speaking, the discipline itself does not exist here.

What should be done?

In my view, Poland should create a new academic discipline devoted to science and mathematics education. Given the current shortage of specialists, that discipline should receive special treatment. Mathematics, physics, and chemistry departments with strong research credentials should be allowed to award degrees in science education as well.

That would require legislative changes, but the issue is almost entirely absent from public debate. We spend a great deal of time discussing educational reform while overlooking the fact that physics and chemistry have often been reduced to a minimal presence in secondary-school curricula. Yet a general secondary education should provide students with a solid grounding in mathematics, physics, chemistry, and geography.

To achieve that, we need well-trained teachers and university-based researchers whose professional focus is the teaching of these subjects.

How did we end up in this situation? Is it a matter of prestige, regulations, or funding?

A bit of everything. Funding certainly matters. The social standing of teachers is closely connected to their salaries. But I am a mathematician, not an expert on educational finance, so I would rather focus on what I see as the central issue.

The failure to recognise science education as a fully fledged academic discipline means that many outstanding specialists are effectively prevented from progressing through the academic system. That is an extraordinarily serious problem.

Without good teachers, and without a strong system for educating those teachers, we will not have good students. And without good students, we will not have good scientists.

Talented young mathematicians are still emerging. How do we ensure that they do not abandon their interests or leave the country?

That is a complicated problem, and I would not pretend to have a complete solution. If there is one thing I would emphasise, it is mentoring.

I serve on the board of the Foundation for Polish Science, and in recent years we have been developing a mentoring programme for young researchers. The idea is to connect early-career scientists with experienced scholars, recipients of major international awards, and researchers with extensive international experience.

The goal is not to replace supervisors or doctoral advisers. Instead, mentors provide guidance on career decisions, professional development, and the broader challenges of academic life.

Many exceptionally talented young people make mistakes early in their careers that later prove costly. We hope mentoring can help some of them avoid those pitfalls.

Does the traditional master-student relationship still exist in science?

I think it does. From the outside, science often appears rational, orderly, and detached. In reality, every scientist occasionally needs encouragement, reassurance, or simply someone to talk to. Sometimes what matters is not another logical argument but a human conversation at the right moment.

I remember approaching a distinguished mathematician during my postdoctoral fellowship in the United States. He served as a mentor for our group, and I was worried about something that had been bothering me for quite some time.

I asked him what would happen if, a few years down the road, I stopped having the ideas that were coming to me so naturally at that stage of my career. I asked whether that would mean I should leave academia and find another profession.

He looked at me, smiled, and said: „When I was your age, I had exactly the same fears. Don't worry. Whether it's now or ten years from now, you'll always come up with something." It was not a particularly profound piece of wisdom. Yet simple words delivered at the right moment can sometimes be the most important ones.

Can great discoveries in mathematics be planned, or can we only create conditions in which they might occur?

In fundamental research, it is very difficult to plan discoveries. Of course, we can define ambitious goals. The Millennium Prize Problems are a good example. Seven major mathematical challenges were identified at the beginning of this century, each carrying a reward of one million dollars. Yet so far only one of them, the Poincaré Conjecture, has been solved.

Physics offers similar examples. Controlled nuclear fusion would likely solve many of the world's energy problems. Some of the best scientists on the planet have been working on it for decades, and billions of dollars have been invested. Yet we still have not achieved it.

At the same time, major advances sometimes arrive from completely unexpected directions. Artificial intelligence is a good example. I certainly did not expect it to develop as rapidly as it has.

Artificial intelligence must also complicate the teaching of mathematics. A student can generate a solution in seconds.

Students can produce a perfect solution to a problem while understanding almost nothing about how that solution was obtained. As a result, we are changing the way we work with students. We break problems into stages, ask them to modify solutions, discuss the reasoning process, and test whether they genuinely understand the underlying concepts rather than simply presenting the final answer.

Without strong mathematics, does Poland have any chance of producing future Nobel-level science or competing internationally?

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There is a beautiful essay by William Thurston, one of the greatest mathematicians of the twentieth century, in which he argues that mathematics is ultimately a social science because its true purpose is to understand how another person's mind works.

Mathematics matters not only because of its practical applications or technological value. It matters culturally and civilisationally. If we lose the ability to understand the basic mechanisms that govern the world around us, then even if we continue using powerful technologies developed by others, we will begin to decline intellectually as a society. ■