What accounts for the legendary status of Hungarian schools? Hardworking teachers have always put the latest research in the hands of schoolchildren

George Marx, Hungary

The Hungarian Gymnasium

When Adalbert the Saint was on his way from Prague to Rome at the request of Géza, chief of the Hungarians, he stopped in Hungary and founded the first Benedictine monastery and school in 996—one thousand years ago. (The monastery and school are in an area today called Pannonhalma, and have been declared to be of World Heritage importance.) From this event, the thousand-year long development of Hungarian schools has been uninterrupted. Throughout the troubled centuries of Hungary, the autonomy of schools and the quality of teachers has played a decisive role in preserving the cultural wealth of the nation.

In earlier centuries the churches raised Hungarian schools to a high level. Besides the Benedictines, the Roman Catholic School of the Piarist Order in Budapest deserves mentioning, where Roland Eötvös, founder of the Hungarian Physical Society in 1891, and also Nobel laureate chemists George de Hevesy and George A. Olah, studied. The quality of the Piarist School was down to their legendary teachers. József Öveges, the teacher of George A. Olah, introduced nuclear experimentation with a scintillator detector and Geiger tube for his pupils in the early 1940s. Another school teacher, Mihály Kovács—currently honourary president of the Eötvös Physical Society— built computers with his students in the 1960s, making him one of the first propagators of the computer era in Hungary. (Personal computers were distributed to each Hungarian secondary school free of charge in 1983. Geiger counters for scanning radioactivity in the environment became everyday school equipment in the 1980s.)

Most legendary of all schools is the "Fasori" Lutheran Gymnasium in Budapest, its fame having been propagated by its Nobel laureate alumni, Eugene P. Wigner and John C. Harsanyi, and John von Neumann. (Theodore Herzl, founder of Zionism, also graduated from this school.) Eugene P. Wigner has identified two of the legendary teachers of the Lutheran Gymnasium: László Rátz in mathematics and Sándor Mikola in physics. One cannot find a Neumann Street or Wigner Street in Budapest, but there is a Rátz László Street. Also, the Bolyai Mathematical Society distributes the Rátz Prize for the best mathematics teachers, and the Eötvös Physical Society gives the Mikola Prize for the best physics teachers of the country year by year. The biographer of Neumann, Norman Macrae (a former editor of *The Economist*) said: "The early 20th-century Hungarian education system was the most brilliant the world has seen until its close imitator in post-1945 Japan."

The use of the word "gymnasium" was borrowed by most of German-speaking Europe, and by any country that looked to Germany for educational leadership. France called its version a "lycée", and Britain its version a "grammar school". The modern Japanese—who have adapted an extreme and successful version of the gymnasium system—call their schools "high schools", as if they were like open-to-all American high schools, which they are not.

The advantage of the gymnasium system is that in the best gymnasia students can be pressed toward the limits of their capacities: they are exposed to an intellectual rigor that is not usually reached in high schools in more democratic countries. In particular, the gymnasium system gives dignity to teachers who provide instruction in top secondary schools. A scholar or scientist who knows that his or her talents lie in pedagogy rather than in research does not feel he or she is falling back if he or she spends a whole life teaching in such a school. A fine teacher retiring at the age of sixty from the Minta Gymnasium in Budapest, for example, would find many of the most famous people in Hungary in his or her debt because they had passed through his or her hands.

Enthusiasts say that the two most successful of these gymnasium systems in history hava been the one in post-1945 Japan, and arguably that of Hungary from about 1890 almost to the 1930s. The average Japanese 18 year old is today more advanced in math than all except the top 1% of American 18 year olds. The same would have been true of gymnasium pupils in Budapest in 1914.

At the arrival of the industrial revolution József Eötvös, the minister of culture, introduced compulsory schooling and decided to create secular schools which did not show privilege to any pupil. He asked Mór Kármán to do the job, who created a model school, the Minta Gymnasium in Budapest. This school saw Theodore von Kármán and Edward Teller pass through. The pedagogical achievement of Mór Kármán did not go unnoticed: he was enobled by the emperor-king Franz Josef in 1889. (To excel as school teacher is not today an everyday way of becoming a nobleman.)

There are other secular schools which have excelled through the efforts of their teachers. The Berzsenyi Gymnasium gave the world a long sequence of winners at student olympiads, and also Marcel Grossmann (co-worker of Einstein), John G. Kemeny (inventor of the BASIC language and e-mail), and George Soros (the philanthropist billionaire market trader).

Leo Szilard (inventor of the nuclear chain reaction) and the author Arthur Koestler studied at the Kemeny Zsigmond Gymnasium.

One of the characteristics of these schools and their physics teachers was that they were open to the stormy development of science. Some of the teachers, even some of the pupils (among them John von Neumann), published research papers in avant garde international journals. Ireneus Károly, a teacher at the Premonstratensian Gymnasium in Nagyvárad-Oradea, demonstrated the wireless telegraph over a distance of 10 km in the same year that Marconi invented the radio (1895), and he established an x-ray laboratory within a year of Röntgen's discovery. On 15 February 1896 pupils of the Catholic Gymnasium of Kolozsvár-Cluj-Napoca demonstrated x-rays with their own equipment just three months after the discovery. József Öveges wrote a book for teenagers on ionizing radiation, Miklós Vermes wrote one on relativity, and Mihály Kovács wrote one on computers around 1960. The schoolbooks of Esther Tóth about modern physics were published in China and Japan.

This effort has continued in more recent times. Hungarian gymnasiums measured the Chernobyl fallout in 1986. And incredibly, Hungarian physics teachers visited Three Mile Island and Chernobyl power plants to obtain first hand information following both nuclear accidents.

The Eötvös Physical Society has always supported teachers. One of the current vice-presidents is a school teacher. Roland Eötvös himself organized the first in-service teacher training seminar in 1895, and physics teachers' meetings have operated for the last one hundred years. The programme of the meetings is decided by teachers themselves by selecting speakers from among the most prominent professors and best school teachers. Rudolf Ortvay organized teacher training on quantum mechanics already in 1930, distributing to them his booklet on the subject.

My exam question at my gymnasium graduation in 1945 was the probability interpretation of electron waves, which had been included in the schoolbook. During afternoon meetings in the early 1940s Mihály Kelemen, our school teacher, introduced us to special relativity and spoke enthusiastically about Dirac's introduction of quantum theory.

Compulsory schooling originally meant four years of primary school (ages 6 to 10). A fraction of students went on to study eight more years in the gymnasium (ages 10 to 18) finishing with a baccalaureate in which Hungarian literature, history, foreign language, mathematics and physics were compulsory subjects for each gymnasium graduate. Afterwards students might have entered university for a further four to six years. (Physics teachers were trained at the university as mathematics and physics, or as physics and chemistry teachers.)

After World War 2 raising the level of education for the whole population was deemed to be important to aid the process of industrialisation, so the government prolonged compulsory education to 8 years. Thus from age 6 to age 14 each child attended a general school. (The gymnasium became shorter: only 4 years from ages 14 to 18.) Instead of gymnasium, students could choose a vocational school or an even more practical workers school after completing 8 years of general school.

In the eighties, with the cooperation of scientists and with the strong encouragement of the Hungarian Academy of Sciences, a new school curriculum was accepted. It was occasionally hard for the organizers of teacher training in universities to keep up with the high tech rush to improve the modern world—even today, the problems given at university entrance examinations are still dominated by 17th and 18th century physics. However, as before, there was some effort to bring the latest research into the classroom.

The arrival of high-tech in Hungary (the transistor radio, the computer, nuclear power plants, space research and satellite television) has always prompted an update of the schooling. And Hungary was among the pioneers in elaborating the school pedagogy of the high-tech chapters of modern life. Hungary hosted international conferences on the teaching of physics in secondary schools. Secondary school teachers wrote PhD theses on bringing modern physics to schools—one had to pay attention not to make quantum physics or nuclear energy dry, remote blackboard topics. Teachers recognised that students pay more attention to physics lessons if instead of discussing springs, pulleys and direct currents, the teachers choose chips, lasers and radioactivity as "hands on" experiments. Schoolbooks written in this spirit were the best selling ones.

Memories of nuclear accidents are heavy burdens on society and the nuclear industry. A journalist from another country reporting nuclear incidents might find the following difficult to understand: that a graphite moderated, water cooled reactor undergoes positive feedback at thermal fluctuation, but a water moderated, water cooled reactor undergoes a negative feedback—it stops working when the water moderator boils off due to overheating. The difference is similar to that between the response of a barrel of gasoline and a barrel of beer, if we throw a flaming match into them. Our pupils can understand it easily.

Teachers have realised that if they discuss global responsibility for the future in physics classes, each student (even would-be poets, businesspeople and politicians) pay attention; this has convinced Hungarian teachers that nuclear disarmament, energy alternatives and global warming are scientific problems which are made even more interesting due to their social relevance. In a highly successful teacher initiative by Esther Tóth, 15 000 Hungarian secondary school students have measured the radon activity over a year in their own bedrooms. The winter of 97/98 was especially frosty and snow-rich in Hungary. And during that winter, the radon surplus dose exceeded the 1986 surplus dose that Hungarians received from Chernobyl. Increased insulation in homes in recent years has raised the indoor radon level by a factor of two or three. This, the students understand.

At the centenary of the birth of Leo Szilard the Leo Szilard Student Competition began, testing students' understanding of nuclear issues. Hundreds of secondary schools students now participate each year. And the winners are welcomed at the Hungarian universities without an entrance exam.

Recently, a good fraction of Hungarian secondary school leavers was asked, how would they respond to the increasing electricity demand of households? The options were coal power, oil and gas, nuclear power, hydropower, biomass, imported energy, or restrictions. The vast majority of the students chose the nuclear option, which is very much different from the public views presented in newspapers and in the parliament in Hungary.

During the communist era a career in the humanities was not attractive for smart youngsters because strict Marxist axioms were presented. The most creative students chose mathematical, scientific, engineering and medical careers.

In 1989 the Iron Curtain was cut down at the western border of Hungary. Educators looked westward for examples to be followed. Many schools decided to follow an Anglo-Saxon pattern. These avant garde schools created independent curricula, in which an early specialisation in the upper secondary school was welcome. But advertisements on streets and on television today lure the youth towards the consumer society, and suggest that financial careers offer a short path to wealth. However, the entrance exam to the School of Economics includes only social studies (history) and mathematics questions, thus would-be businessmen, lawyers and politicians do not take science in their last school years.

Economic leaders have recognised that this trend brings the danger that Hungary may loose competivity in the race of nations. The situation is still in flow. The direction being followed is for education to be made compulsory up to the age of 18, and for science to be compulsory for everyone through 12 school years, with physics as an independent subject. Also, higher education has been offered to around 50% of the population free of charge.

Our students, children and grandchildren will be the decision making citizens of the 21st century. This is where the importance of a direct link between scientist and school teacher, of a shortcut between scientific research and school education comes in. "For a new-born baby every joke is new", as the Hungarian proverb says. Teenagers are not interested in tradition, but they are open towards future. If they see that science is relevant for shaping the future, they may pay attention.

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