The Hungarian Phenomenon (*)

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I. Hungarian Phenomenon

The 1900s saw the emergence of many bright scientists and mathematicians in Budapest. The famous mathematician Stanislaw Ulam writes, "Budapest, in the period of the two decades around the First World War, proved to be an exceptionally fertile breeding ground for scientific talent …… (their names abound in the annals of mathematics and physics of the present time)." [1] The following list illustrates some of the brilliant and creative people who were born and/or educated in Budapest from their childhoods to their teens.

Name	Year of Birth	Main Achievement
L. Fejér	1880	One of the pioneers of theory of divergent series and singular integrals
F. Riesz	1880	One of the fathers of functional analysis
T. von Kármán	1881	Father of modern aerodynamics and supersonic flight
A. Haar	1885	Haar measure is one of the cornerstones in topological groups
G. de Hevesy	1885	Nobel Prize in chemistry, discovery of hafnium
G. Pólya	1887	Father of heuristics and problem solving in mathematical education. Pólya counting theorem
A. Szent-Györgyi	1893	Nobel Prize in medicine
L. Szilard	1898	"Father" of linear accelerator (patent in 1928), electron microscope (patent in 1931) and nuclear chain reaction (patent in 1934).

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Name	Year of Birth	Main Achievement
G. von Békésy	1899	Nobel Prize in medicine
D. Gábor	1900	Father of holography, Nobel Prize in Physics
E. P. Wigner	1902	Nobel Prize in physics
J. von Neumann	1903	Father of computers and game theory. His work ranges from set theory to the design of atomic bomb
E. Teller	1908	Father of hydrogen bomb
P. Erdös	1913	Wolf Prize, with over 1500 publishing and thousands of collaborators
J. C. Harsányi	1920	Nobel Prize in economics with Nash
J.G. Kemeny	1926	Father of BASIC (a programming language)
P.D. Lax	1926	Wolf Prize
G. A. Oláh	1927	Nobel Prize in chemistry

This list includes many Nobel or Wolf Prize Winners. The concentration of these great minds is labelled as "Hungarian Phenomenon" in this paper. Peter Lax once said, "you don't have to be Hungarian to be a mathematician, but it helps". Furthermore, many of them are originator of many important ideas, and called as "Fathers" of something. For example, von Neumann is the Father of computers and game theory, von Kármán is the Father of modern aerodynamics and supersonic flight, Gábor is the Father of holography, Teller is the Father of hydrogen bomb and Szilard is the "Father" of linear accelerator, electron microscope and chain reaction. This shows that the minds are not only great but also extremely creative.

II. What lead to this phenomenon?

Stanislaw Ulam once asked John von Neumann about this Phenomenon. Ulam recorded, "When asked about his [von Neumann's] own opinion on what contributed to this statistically unlikely phenomenon, he would say that it was a coincidence of some cultural factors which he could not make precise". [1] Although it is difficult to pin down all the causes of this phenomenon, it is general believed that the Eötvös Mathematics Competition (it is now renamed

as Kürschák competition) and the Journal (KöMal) have played major roles in the development of gifted children in Hungary [3,4,5]. In addition, good teachers and the atmosphere of high value on intellectual achievement are also related with the emergence of this phenomenon. The details are discussed in the following sections.

A. *Eötvös Contests:*

The competitive idea seems to be a powerful mean for the stimulation of mathematics on a large scale and hence could be used to motivate mathematical culture in a society. Furthermore it can also provide a channel to search for talent youths. The mathematical contests, which have been open to Hungarian high school students in their last year since 1894, played a remarkable role in the development of mathematics.

The Mathematical and Physical Society held the contest in October every year in honour of its founder and president, the famous physicist Loránd Eötvös, who became minister of education that year. The contestants work in classrooms under supervision. Any amount of aid in the form of books or notes is permitted. The Society selects the two best papers and awards a first and second Eötvös Prize. The names of the winners include many famous people such as L. Fejér (1897), T. von Kármán (1898), D. König (1902), A. Haar (1903), T. Radó (1913), M. Riesz (1904), G. Szegö (1912), and E. Teller (1925).

The problems in the contest come from diversity of in-depth mathematical fields in elementary level. There are only few prerequisites: quadratic equations, plane geometry, and some trigonometry. No calculus is included. The basic principle for the choice of problems is as follows:

“A problem should put to the test most of all the depth and not quantity of the competitor’s knowledge. Either the content of the problem, or its solution, or the way leading to the solution should be interesting. A problem should have a solution that can be found within the allocated time.” [5]. The solutions usually require a pioneer spirit, a certain degree of insight and problem-solving

skills. The contest challenges the creativity of the students rather than their knowledge. Peter Lax once remarked, “The importance of [this] mathematics competitions is shown by the fact that in the 1950’s, George Pólya and Gabor Szegö introduced similar competitions in California.” [2]

B. *Secondary School Mathematical Journal (KöMal---Középiskolai Matematikai Lapok):*

The journal, founded by D. Arany, can be traced back to 1894, the year of which the Eötvös contest began. It is the second oldest mathematical monthly for school children in the world (the first was published in France in 1875). It aims at posing problems and providing additional teaching materials for secondary schools. The most fertile part was the problem section, which proposes six to eight problems each month. The problems are differentiated according to age groups. Everyone can join the competition. The solution usually comes from the pen of the student who gets the best version. Such a competition is different to the Eötvös competition in which problems are expected to be solved in a relatively short time. In KöMal, the rapidity does not play a major role. This leads to the possibility of posing profound problems that may take longer time to solve. KöMal has cultivated some talent Hungarian mathematicians and scientists like L. Fejér, A. Haar, T. von Kármán, D. König, G. Pólya, T. Radó, Riesz brothers, G. Szegö, and P. Erdös, whose career paths can be traced back to their activities in the problem section. A Hungarian mathematician, G. Szegö, recalled, “I remember vividly the time when I participated in this phase of the Journal (in the years between 1908 and 1912); I would wait eagerly for the arrival of the monthly issue and my first concern was to look at the problem section, almost breathlessly, and to start grasping with the problems without delay.” [3]

When Paul Erdös was asked if his mathematical development was affected by KöMal, he said, “Yes, of course. You actually learn to solve problems there. And many of the good mathematicians realise very early that they have ability.” [6]

C. *Good teachers*

Good teachers also play a decisive role in this phenomenon. As E. P. Wigner recalled, “My own history begins in the high school in Hungry where my mathematics teacher, [László] Rátz, gave me books to read and evoked in me a sense of the beauty of his subject.” [6] It was told that once when Wigner was asked in the late 1970’s, which was 60 years after leaving his high school, “Do you remember Rátz?” Wigner answered, “There he is!” and pointed to a photograph of Rátz on his office wall. Wigner commented, “This school was, at that time, perhaps the best high school of Hungary and probably also one of the best of the world.” The Father of holography, D. Gábor also commented, “My memories of the secondary school are the best ever.”

J.G. Kemeny was born in Budapest in 1926 and then immigrated to the USA at the age of fourteen. When he was asked about why there were so many great mathematicians in Hungary. He said that good teaching is one of the reasons. He recalled, “I went through seven and a half grades of school in Hungary. I had a mathematics teacher who would have been well qualified to teach at a good college. He did an enormous amount to strengthen my interest in mathematics …… being interested and knowing something is very different. This teacher was better than any teacher I had in high school in the United State, really significantly better.” [6]

Let’s see two famous teachers in Hungarian mathematics in this period:

László Rátz was von Neumann and Wigner’s mathematics teacher at the Lutheran High School in Budapest. He was an able teacher who could recognise his better students and to inspire them. He recognised von Neumann’s talents and took von Neumann under his wing. He arranged free private lessons to him and introduced him to the University. Rátz once commented that it would be a sin not to take special care of von Neumann’s mathematical education.

Wigner deeply adored Rátz whose photograph was kept in Wigner’s office.

Wigner recalled, “he had every quality of a miraculous teacher: He loved teaching. He knew the subject and how to kindle interest in it. He imparted the very deepest understanding...no one could evoke the beauty of the subject like Rátz …… He edited a mathematical journal [KöMal] …… He ran the journal for 20 years, often distributing it with his own money.”

Lipót Fejér himself was a great mathematician. Fejér was also the spiritual father of many Hungarian mathematicians since he was an inspiring teacher who had a great influence on Hungarian mathematicians of the time. He used to sit in cafes chatting with his students about mathematical problems and telling them tales of famous mathematicians. Many young talented people were attracted into his circle through his appealing personality. They include A. Haar, T. von Kármán, D. König, G. Szegö, G. Pólya and P. Erdös.

In Hungarian tradition, strong subject training is required in teacher training. Pedagogy is seen as an academic rather than a professional issue. Student teachers are expected to justify a sequence of lessons, not from the perspective of the learner, but from the point of view of mathematical coherence, elegance and rigor. [7] Eötvös proclaimed, “If we succeed in realizing the goal that everyone who teaches physics and mathematics in the country is a real physicist and mathematician, then we do a great service not only to the school, but to Hungarian science as well. We need teachers who are scientists.” [2]

It is also interesting to note that one cannot find a von Neumann street or Wigner street in Budapest. But there is a Rátz László street. This can be easily understood because a good mathematician is only a necessary condition, but not a sufficient condition of a good mathematics teacher.

D. High value on intellectual achievement

Solving scientific or mathematical problems is by no means easy. It may need a hard work of weeks or months. Why was the youth in Hungary willing to take up such work?

Honour might be a driving force. The Eötvös prize was considered as a success in Hungary at that time. Every bright student was anxious to win it. The prize was a great honour, not just for oneself, but also for the teachers and school.

The problem section in KöMal also played a similar role. The best solution was printed with the name and school of the author so that every one could see it. Therefore, it would be really an honour to have your name appeared in the Journal. In addition, the success in problem-solving nourished young men a wonderful taste of joy from creative intellectual adventure, which charted for live.

The good mathematics teachers, who spared no effort in arousing students' interest in mathematics as well as transmitting the beauty of the subject, also play a role. As a result, intellectual achievement was highly rated. Such spirit in schools and society might encourage young minds to join the intellectual adventure of science and mathematics.

III. Discussions and Conclusion

It is very difficult, if not impossible to pin down the causes of the Hungarian Phenomenon. After all, who can ensure that it is not a statistical fluctuation? Moreover, like many historical events, it is hard to test the validity of the explanation since history is not reproducible. However, a study like this might be meaningful since it would shed light on the mathematical education.

Let's compare the IMO with Eötvös contest and see what we can learn from the comparison. The effect of the IMO in Hong Kong is different from the Eötvös contest in Hungary. The latter did cultivate a mathematics culture whereas IMO did not. Dr. M.K. Siu, a co-ordinator of the 35^{th} IMO commented, "I am disappointed at not finding how the IMO breathes life into a general mathematics culture in the local scene. On the contrary, many people may be misled into believing that those difficult "Olympiad Math" problems

represent the highpoint in mathematics, and that mathematics is too difficult to lie within reach of an average person." [8] What makes the difference? In my humble opinion, we are in lack of a journal like KöMal, which plays a vital role in preparation of students' participation in the Eötvös contest. The journal, which contains 6 – 8 problems each month, is very popular in high schools at that time. Its popularity is shown by the average number of 3 – 4 subscribers per class. As a result, the mathematics culture has been nourishing throughout a whole year. The journal provides masses of interested students while the Eötvös contest is only the "tip of the iceberg". Furthermore, competition as a mean of mathematics education has a long tradition in Hungary. The Eötvös contest is much older than the IMO. It is, from the beginning, a public event of interest every year in Hungary.

Many educators worry about that over training for mathematics contest would hamper one's independence and imagination. The preparation of contests, especially for international ones requires a wide range of knowledge and drilling. The accumulation of huge quantity of knowledge in children's memory would lead to a harmful outcome. As Pólya pointed out, "If he [the teacher] fills his allotted time with drilling his students in routine operations, he kills their interest, hampers their intellectual development, and misuses his opportunities. But if he challenges the curiosity of his students by setting them problems proportionate to their knowledge, and help them solve their problems with stimulating questions, he may give them a taste for, and some means of, independent thinking." [9] This is exactly the spirit of the Eötvös contest. There are only few prerequisites in the Eötvös contest: quadratic equations, plane geometry, and some trigonometry. No calculus is included. During the contest, any amount of aid in the form of books or notes is permitted. Either the content of the problem, or its solution, or the ways leading to the solution are interesting. Moreover, correct answers are not good enough. Best solutions with creative spirit and a certain degree of insight are preferred. Problem-solving skills as well as insight are required. In other words, the contest is not intended for students who know a lot of mathematics. It aims at

digging out future mathematicians of insight as well as creative scientists. This sheds light on explaining why the Hungarian scientists and mathematicians are exceptional good at opening new horizons.

To sum up, the Eötvös contest, the KöMal, good teachers and the atmosphere of high value on intellectual achievement are believed to be major factors that lead to the outburst of brilliant mathematicians and scientists around the 1900's in Hungary. It is unlikely that the whole experience in Hungary would work in Hong Kong. Although we cannot and should not copy everything from this phenomenon, it is a useful reference for a reflection of our education.

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