Oral Presentation

MATHEMATICS IN T.G. MASARYK'S JOURNAL *ATHENEUM*

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Tomáš Garrigue Masaryk was the first president of Czechoslovakia. He was a professor at Charles University in Prague, his branch was sociology. This paper tries to find his relations to the mathematics. He regarded mathematics as an important part of education and he has good knowledge of it. He liked especially probability, this branch he used in his philosophical papers. As a publisher of Athenaeum revue, he contributed to publishing mathematical articles in a journal with a wide range of academic readership.

INTRODUCTION

T.G. Masaryk (1850-1937) is best known as the first president of Czechoslovakia. Before embarking upon a career of a politician, however, he pursued academic career in Vienna and in Prague. He was the founder of the journal *Atheneum*, whose authors (and readers) were active in various branches of research. We will show how the interdisciplinary character of this journal and Masaryk's personality had influence on the well-known episode in the Czech national revival of the 19th century, the so-called "manuscripts dispute".

The "manuscripts dispute" can briefly be described as follows: within the efforts to re-establish Czech as a language, two old manuscripts suddenly emerged, Manuscript from Dvůr Králové and Manuscript from Zelená Hora. Their discovery would have helped in establishing the Czech language as a comparatively old one. A significant part of the Czech academic public, however, did not believe that the manuscripts were as old as it was suggested, and tried to disprove their originality. The echoes of the debate can be seen also on the pages of *Atheneum*. Since Masaryk did not believe that the manuscripts were original, many articles claiming that the manuscripts were fakes were published in the journal. The dispute took a decisive turn when statistics was used to decide the dispute that was primarily based in linguistics and literary studies.

This article brings together the manuscripts dispute and Masaryk's involvement therein as the Editor-in-Chief of the journal in a novel way. It touches upon Masaryk's knowledge of mathematics and puts in due context the contributions of two Czech mathematicians, August Seydler and Matyáš Lerch, to *Atheneum*.

CZECH NATIONAL REVIVAL

The Kingdom of Bohemia had won a significant position within the Holy Roman Empire of the German Nation. The King of Bohemia was one of the seven Prince-

Electors and some of the kings played an important role also in the history of the Empire. Let us mention King Charles IV, who made the Lands of the Bohemian Crown the basis of his power. Bohemia also played an important role in the establishment of the central European composite monarchy in the 16th century, especially during the reign of Rudolf II, who made Prague his seat and thus also the capita of the whole state. Tycho Brahe and Johannes Kepler were invited to work in Prague in this period.

After the defeat of the Bohemian Revolt in 1620 and the forced re-Catholicization, the Lands of the Bohemian Crown became a mere province and their influence diminished. This was also a result of emigration of the non-Catholic elite (e. g. Comenius). At the end of 18th and beginning of 19th century, Czechs strived to improve the position of their country during the so-called national revival. Some of the people active in promoting the use of Czech language, especially those around Václav Hanka, thought that they would help the nation by creating manuscripts proving the high standards of the Czech language already in the Middle Ages. Their effort was made significantly easier by the fact that the publication of old texts did not require censorship, and thus the Czech readers could read for themselves how brave their ancestors had been and how they dealt with any enemy from the Saxons to the Polans. It is thus not surprising that any doubt about the manuscripts resulted in uncritical resistance. Masaryk, however, spent his youth abroad and in addition, his wife was an American (Charlotte Garrigue), and therefor he was able to set himself free from the small problems and advocate the use of critical methods, as was then the habit to the west of our border.

In mid-19th century, Czech mathematics also began to flourish. Periodicals in Czech began to be published, as well as textbooks for elementary schools and high schools. The Union of Czech Mathematicians, founded in 1862, guaranteed the quality of the mathematics textbooks and periodicals and also, through one of the journals, organized a corresponding competition for high school students, which I have elsewhere called “k. und k. mathematical olympiad”. During this time, with the help of the personality of Masaryk, a curious connection between mathematics and the humanities occurred. The present article explores this story.

BIOGRAPHY OF MASARYK

Masaryk was born on 7th March 1850 in Hodonín, a small town in Southern Moravia. His father worked as a coach driver, his mother as a cook. Masaryk attended basic school in Čejkovice and *Realschule* (middle school) in Hustopeče. For a short time he was employed as an auxiliary teacher, he also trained to be a locksmith and blacksmith. These activities did not satisfy him and he wanted to continue his studies. He started to study at German classical gymnasium in Brno. His parents were not rich, so they could not support TGM during his studies. Therefore Masaryk gave remedial lessons to children of rich people. The first Masaryk´s supporter was the police chief Anton le Monier, with whom he left for Vienna in 1869. After Monier´s death, the

banker Rudolf Schlessinger supported him in studies. Masaryk passed final exam at a classical *Gymnasium* in Vienna in 1879 and started to study at the university. In 1876 he passed doctoral exam, in 1879 he became *Privat Dozent*. During his stay in Leipzig he met the American young lady Charlotte Garrigue, whom he married in 1878. From this time on, he added the surname of his wife to his own.

Fig. 1 TGM at the age of 27

Shortly after Masaryk became Privat Dozent in Vienna, the university in Prague (then called Charles-Ferdinand University) was divided (1882) into two independent parts, namely the Czech and the German part. Every professor had to decide in which school he would teach. Thanks to this fact some professorships were vacant and there was the possibility for TGM to be appointed professor. Masaryk used this opportunity: in 1882, he was appointed extraordinary professor and in 1897 ordinary professor. Masaryk was not satisfied with the provincial atmosphere in Bohemia and tried to change this situation. One of his important acts in this respect was the founding of the journal *Athenaeum*.

Masaryk was also engaged in politics. Together with Karel Kramář and Josef Kaizl he formulated new political trend called realism. He was elected to the Imperial Council and to the Provincial Council in 1891. Two years later he resigned from both positions, partly for family reasons. In 1900 he founded Realistic Party and as a representative of this party, he was elected again to the Imperial Council in 1907 and was its member from 1907 to 1914. At the end of 1914 he left the country and started fighting Austro-Hungarian Empire from abroad. The activity was successful, and on

28th October 1918 Czechoslovakia was established. Masaryk was elected the first president of Czechoslovakia and he held this position till 1935, when he abdicated because of his poor health. Masaryk died on 14th of September 1937.

TGM was also involved in the development of Czech university education system. He accentuated the necessity of competition in the scientific work. In this connection, he pointed out the need for competition for the only Czech university, which was Charles University in Prague. The question was in which town the new university should be established. Masaryk, after corresponding with a majority of the scientific public, suggested the capital of Moravia, the city of Brno, as the seat of the new university and in 1912, he proposed founding this university in the Imperial Council. Although he attached a petition with more than 7 000 signatures from Czech, Moravian, and Slovak municipalities, his activity was not successful. The second university was only founded on 28th of January 1919 and named after him [1].

ATHENAEUM

The first issue of Athenaeum was published on 15th October 1883. In the editorial, we can read: "There is an urgent need for a critical scientific journal. A journal in which we could write about scientific work in this country as well as abroad is missing, which is the reason behind the intention to start publishing the journal *Athenaeum*. Consideration, news and critical articles will be published in the journal. *Athenaeum* will pay attention to all branches of research from theology, law, medicine to technical sciences." The publishers made efforts to fulfil their intents and they were successful. It is true that, especially in volumes 3 and 4, the journal paid attention mostly to the so-called *manuscripts dispute*, but apart from this matter, we can also find papers from other parts of science there.

TGM was firmly convinced that the Manuscripts were counterfeited. It is thus not surprising that *Athenaeum* served as a platform for those opposing the originality of the manuscripts, who published their opinions on the falsity of the manuscripts on the pages of this journal. This fact, however, had unfavourable consequences for *Athenaeum*. The publisher, J. Otta, refused to publish the journal from then on, and thus from volume 6, TGM became the publisher of the journal *Athenaeum.* The journal was printed by Masaryk's brother Ludvk in his printing house in Hustopeče. Also the editor in chief changed: the journal was taken over by Masaryk's colleague J. Keizl.

Despite these difficulties, *Athenaeum* was published for several years after this debate, although its jubilee tenth volume was also its last one. *Athenaeum* influenced the development of critical thinking and brought a number of articles from different branches of science, economy, and politics. As mathematical articles were published in every volume (either the articles mentioned below or especially reviews of our and international publications), we can say that TGM indirectly positively influenced Czech mathematics.

MATYÁŠ LERCH

Fig. 2 Matyáš Lerch

Matyáš Lerch (1860–1922) was a significant Czech mathematician, professor at University in Freiburg in Switzerland (1896–1905), Czech Technical University in Brno (1906–1920), and the founder of the Mathematical Institute at the newly established Masaryk University in Brno. After finishing his university studies he was awarded scholarship by the state and spent one year studying in Berlin, where he met leading German mathematicians. After returning from his stay in Germany, Lerch decided to make Czech scientific society familiar with the contemporary knowledge concerning number sets. He published an article (Lerch, 1886) in *Athenaeum* [2]. In this article Lerch explained pure arithmetic theory of establishing various types number set based on natural numbers. Lerch followed the works of Bolzano, Abel, Cauchy, Weierstrass, Cantor, Dedekind, and also Kronecker, whose influence on Lerch was really strong.

Lerch based his theory on the set of natural numbers N (including zero). He defined equivalency of two arranged couples of number $(a,b)\sim(c,d)$ if $a+d=b+c$. He called the set of all equivalent couples *differenta*. He then gives the definitions of basic arithmetic operation (addition, subtraction, multiplication and division). The sum of two differentas $D_1=(a,b)$ and $D_2=(c,d)$ is also a differenta $(a+c,b+d)$. The subtraction of two differentas is based on the theorem, that for every two differentas D_1 and D_2, there exists just one different D which fulfils the equation $D_2=D_1+D$. Product of two differentas D_1 and D_2 is defined as the differenta $(ac+bd,bc+ad)$. Division of two different is based on finding the different D which fulfils the equation $D_2=D_1\cdot D$. Unlike in the case of subtraction, the differenta D does not exist for every differenta D_1, D_2, which means that division is not closed. In the end, Lerch identified term differenta with the term integer.

In a similar way he established rational number [3], i. e. he gave the definition of the equivalency of two fractions, namely that $\frac{a}{b} \sim \frac{c}{d}$ if $ad = bc$. He of course eliminated fractions of the sort $\frac{a}{0}$ and $\frac{0}{0}$ [4]. For introducing irrational numbers, Lerch decided to use Cantor's way through limits of the infinite series of rational numbers. Lerch probably chose this method in order to maintain logical unity of the article. As well as in the previous cases he divided the set of the infinite series into equivalent groups; a particular group is called konvergenta. There are two kinds of konvergenta. The first includes constant series numbers a, which represents rational number a. The second kind, which does not contain constant series, represents the irrational numbers. We can learn from other Lerch's papers that he also knew Dedekind cut theory well.

Lerch's article is important, because it is the first mathematical article written in Czech in which number sets are constructed on the basis of natural numbers. Lerch used rather complicated symbolism: he used German letters to denote the differentas, but the article is nevertheless understandable. There is a question why Lerch published the article in *Athenaeum*. One reason could be that Lerch and Masaryk taught at the same university and it is more than probable that they knew each other, although there is no evidence about the depth of their relationship. The second reason could be the fact they both attended foreign universities.

As a sideways remark, let us mention that Lerch also published the theorem about which Runge told him during his stay in Berlin. If the *konvergent* a includes serie $\sum_{\nu=1}^{\infty} \frac{A_\nu}{B\nu}$ where $A_\nu, B_\nu inZ$ and fulfil $a - a_\nu = \delta_\nu \leq \frac{1}{B_\nu^n + \varepsilon}$, where $\varepsilon > 0$, then a is not a root of an algebraic equation of degree n.

MANUSCRIPTS

On 16th September 1817, a manuscript was found in Dvůr Králové, allegedly dated as a 13th century manuscript (shortly RK, Rukopis královédvorský, i. e. the Manuscript from Dvůr Králové). In November 1818, another manuscript was sent to the National museum, dated as a 9th century manuscript (shortly RZ, Rukopis zelenohorský, i. e. the manuscript from Zelená Hora). Except for those two manuscripts another alleged old literary memorabilia were found in those times. Majority of these discoveries were connected with the persona of Václav Hanka [5].

Fig. 3. Page 6 from Manuscript of Dvůr Králové

All these manuscript proved that Czech language was very rich and that it was possible to write excellent literally works in Czech language. Czech patriots were enthusiastic about these manuscripts and regarded them as a treasure of old Czech literature. Only a small number of scientists doubted the authenticity of the manuscripts, but their number was increasing as time passed. However, in 1886, Jan Gebauer [6] published the article "Requirements of further examinations of RKZ" in *Athenaeum*, which started the dispute in which not only the experts were divided. We can say that half of scientists defended the originality of the manuscripts, while the other half fought against it. Masaryk led the opponents and *Athenaeum* started to publish articles in which scientists of various branches proved the falsity of the manuscripts. Although the controversy had to do with literature, mathematics interfered with this dispute as well.

AUGUST SEYDLER

August Seydler (1849–1891) was a Czech mathematician, physicist and, above all, astronomer. During his studies at Charles University in Prague he met leading Czech scientists and he attended lectures on physics by Ernst Mach. Mach was fond of Seydler and secured him a scholarship of 100 gold coins for two years. After finishing his university studies Seydler started to teach at the University. He was appointed *Privat Dozent* in 1872 and extraordinary professor in 1881. Since 1869 he also worked in the Prague observatory and he is the founder of the Astronomical Institute. His wife was Anna Weyrová, a sister of the well-known Czech mathematicians, the brothers Emil and Eduard Weyr.

Fig. 4 August Seydler

Seydler published paper (Seydler, 1886), in which he tried to prove that the manuscripts are counterfeits. Although *Athenaeum* published many articles proving the contemporary (19th century) origin of manuscripts, they were all written from the point of view of the humanities. Seydler's article looks like from a completely different world, because it refers to mathematics, especially to probability theory. His way of thinking can be explained by the following example. We suppose that in some article we can find some falsehoods, indecent words or some mistakes which were caused by the low acquaintance of the author. While the reader can be confused and unable to decide whether such faults had been caused by chance or whether it was the intention of author, scientists, especially mathematicians proceed in another way. They count such mistakes and try to find the probability whether the author did this or that mistake consciously. When the probability of the casual mistake is p, then the probability that the author made all the n mistakes by chance is $P=(p)^n$. We can bet $1:\frac{1}{P}$ that at least one of the mistakes was caused consciously.

Seydler decided to study the so-called coincidences; that is the fact that some words can only be found in RK and in pieces written by Hanka. He used the well-known Bernoulli formula

$$P=\binom{c}{a}x^a(1-x)^b,$$

where a is the number of incorrect forms of word or phrase and b is the number of correct ones. Then $c=a+b$ and $x=\frac{a}{c}$. For the coincidences he used the formula

$$R=\frac{\binom{p}{m}\binom{c-m}{a-m}\binom{\gamma-m}{\alpha-m}}{\binom{c}{a}\binom{\gamma}{\alpha}}.$$

Here again a or α is the number of incorrect forms, b or β the number of correct forms, and $c = a + b$ or $\gamma = \alpha + \beta$. Words from the manuscripts are denoted with Latin letters, words from Hanka papers are denoted by Greek letters, p is sum of investigated words, and m is number of common strangeness.

Seydler investigated two hypotheses. According to the first one, all the strange phenomena (words and grammar) in manuscripts are accidental and according to the second one, the correspondence between these strange phenomena in the manuscripts and the ones in papers from the beginning of 19th century (before finding manuscripts) are accidental. Result of his work follows:

1) We can bet at least 3 000 millions to one that all the strange phenomena are not accidental.
2) We can bet at least 13 millions to one that the correspondence between the strange phenomena in manuscripts and Hanka's works is not accidental
3) We can bet at least 8 millions to one that the correspondence between the two strange phenomena in RK and Jungmann's [7] poems which were published before finding of the manuscripts, are accidental.
4) We can bet at least 100 trillion (10^{12}) to one that the correspondence between RK and papers published before finding manuscripts are accidental.

Although Seydler did not directly say that the manuscripts were false, every reader of his paper must come to a clear conclusion – the manuscripts are fakes. One weakness of his paper is evident: Seydler relied heavily on Gebauer's view for old Czech language and considered it as absolutely right. Defenders of manuscripts discovered this weakness and started to disprove his results, see for example (Ivanov, 1969). Nowadays linguists regard the majority of coincidences false and Seydler's proof lost a great deal of its persuasiveness. In any case, it is the first attempt to use mathematics in the research of the Czech language. Further it also proves that Masaryk believed in the force of an exact science, which mathematics is, and embraced its help in his fight. In addition probability theory was not widely spread in Czech countries in those times and we can say Czech mathematicians are only starting to get acquainted with it. Approximately at the same time, articles by A. Pánek were published, in which the author introduces probability theory to Czech mathematicians (Pánek, n.d. a; n.d. b).

MASARYK AND MATHEMATICS

So far, we have not sought Masaryk's direct contribution to the progress in mathematics. Now the time is ripe for it. As we said, Masaryk's research belongs primarily to sociology and philosophy. There is, however, evidence that he had good knowledge of mathematics (and physics), because he emphasized philosophical meaning of mathematics. He also wrote several reviews of books on mathematics and physics for the journal *Atheneum*. From the point of view of his research specialization, theory of probability was the most important part of mathematics for

him. This area of mathematics does not only describe static relationships between quantities, but allows us also to search for the causes of known phenomena, predict possible outcomes, and formulate hypotheses. He studied the theory of probability thoroughly, as the title of his inaugural lecture at the university proves: *Probability and Hume scepticism* (Masaryk, 1883). In that lecture, we can learn about Masaryk's view on mathematics. He writes that scientists are seeking for probability of its finding. Various branches of science have various level of it, and mathematics has the leading role, because no scepticism can disturb that kind of knowledge. On the other hand, the sciences struggle to be as exact as mathematics is.

Masaryk saw the closest relations between mathematics and logic. We must note that logic was then not regarded a part of mathematics, but a part of philosophy, the one which deals with the way of deducing conclusion and which studies objective conditions of thinking. Sceptics deny casual connection between causation and consequence, and according to them, this can only be caused by the opinion, not by the intellect. As Masaryk briefly sums up Hume philosophy, opinion and intellect excludes themselves. Only mathematics is an exception, because only such science can determine causation and consequence through thinking.

Hume considered only three parts of mathematics, namely algebra, arithmetic and geometry. But there is still one branch of mathematics, which explores the connection between causation and consequence – probability. The origin of this field is connected with gambling, but after the determination its basic laws, probability started to be used in the insurance industry, banking and so on. Some mathematicians started to disprove Hume sceptic theses. It is understandable that Masaryk as a philosopher was interested in probability and there is evidence he knew this branch well.

CONCLUSION

I have brought to the readers' attention the first instance of using mathematics to solve a problem in literature in the Czech lands and the involvement of T.G. Masaryk in this important dispute of the national revival. It is probable that the (in general overlooked) fact that Masaryk knew mathematics played a role in this. To start with, Masaryk did not count on mathematics when he became involved in the manuscripts dispute, but Seydler's article was in the range of Masaryk's interpretation of what mathematics is.

Founding of the journal Atheneum was one of the successful outcomes of Masaryk's efforts. Similarly, Lerch had been in Berlin for one year and his aim was similar to Masaryk's, namely to elevate Czech mathematics to a higher level. That could have been the reason why Lerch published his papers in *Atheneum*, and not in the *Journal for the Cultivation of Mathematics and Physics.*

Such use of mathematics in a literary dispute was the first of its kind in the Lands of Bohemian Crown and it remained a singular and an outsanding one. Possibly, it was the first instance of using mathematics for such a problem.

NOTES

1. From 1960 to 1990, for political reason, the universtity in Brno was not called Masaryk University, but bore the name of the excellant Czech scientist Jan Evangelista Purkyně.

2. Foundantions of the pure arithmetic theory of quantities.

3. Lerch uses term signed number, it means $\pm$. Lerch wanted to emphasize that integers are signed, it follows from the fact, that Czech word číslo (number) means only positive number.

4. Lerch uses instead Czech word zlomek (fraction) term divisanta.

5. Václav Hanka (1791–1861), Czech writer, poet, linguist, editor of old Czech literary memorabilities, Privat Dozent at the University and so on. A leading person of Czech national revival. He is suspected from counterfaiting of some memories.

6. Jan Gebauer (1838–1907), significant Czech linguist, regarded to be one of the most important people in this branch.

7. Josef Jungmann (1773–1847), Czech philogist and writer, author of the modern Czech lexicon. Some scientists suspect him of participating in counterfaiting the manuscripts.

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