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# THE EMERGENCE OF NATIONAL MATHEMATICAL RESEARCH COMMUNITIES IN CENTRAL-EASTERN EUROPE

# TWORZENIE SIĘ KRAJOWYCH ŚRODOWISK MATEMATYCZNYCH W KRAJACH EUROPY ŚRODKOWO-WSCHODNIEJ

A b s t r a c t

Since medieval times mathematics was being developed mainly in Central and Western Europe but in the 19th century it greatly expanded both to the United States and to some countries of Central-Eastern Europe. This expansion, accompanied by the rapid growth of mathematics as a whole, has recently become an object of interest and investigation. The interest, however, reflects the Western viewpoint, cf. [17], with the bibliography covering Germany, Spain, Italy, France, Moscow. The aim of this paper is to outline the history of emerging national mathematical research communities in Russia, Poland, Bohemia, Lithuania and some other countries of Central-Eastern Europe.

*Keywords*: *history of mathematics in countries of Central-Eastern Europe in the 19th c.*

S t r e s z c z e n i e

Od czasów średniowiecza matematyka była rozwijana głównie w Europie Środkowej i Zachodniej, ale już w XIX wieku jej badanie zostało znacznie rozszerzone w Stanach Zjednoczonych i niektórych krajach Europy Środkowo-Wschodniej. Ekspansja ta, wraz z szybkim rozwojem matematyki jako całości, stała się ostatnio obiektem zainteresowania i analizy. Zainteresowanie jednak odzwierciedla punkt widzenia Zachodu (por. [17]) obejmujący Niemcy, Hiszpanię, Włochy, Francję, Moskwę. Celem niniejszej pracy jest przedstawienie historii wschodzących krajowych matematycznych środowisk naukowych w Rosji, Polsce, Czechach, na Litwie i innych krajach Europy Środkowo-Wschodniej.

*Słowa kluczowe*: *historia matematyki w krajach Europy Środkowo-Wschodniej w XIX w.*

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1. A mathematician cannot work alone. Necessary to him are people to communicate with, people able to understand his work, to criticize its weak points, to appreciate and take into account its achievements. Without such people his pains are pointless and his efforts are useless.

   People able to communicate with the working mathematician form a mathematical **community**. In the antiquity and medieval times the mathematical community was very sparse and letters in Greek or Latin were a prevailing mean of communication. At the beginning of modern times, however, mathematics was gaining momentum and national languages have grown in maturity and importance. These two factors, expanding mathematics and growing importance of national languages, contributed to the emergence of **national** research communities. As the long isolation of British mathematics after Newton-Leibniz controversy over priority or the French--German enmity after the war 1870 show, the phenomenon could split one common world-wide community into separate parts. The danger was real, but **globalization** took an upper hand over the risk of separation. Eventually national communities do communicate with one another and presently form a common world-wide mathematical community.

   The aim of the present paper is to describe the emergence of some national research communities in Central-Eastern Europe and their later growth, both in size and importance, with the idea of uncovering contributing factors and finding common patterns in their rise and development.

2. Depending on the national venue, there were different causes favoring the emergence of a local mathematical community. Nevertheless, there were also some common features. Among the latter particularly important were **educational reforms** on a state scale. After the activity of Commission of National Education in Poland and changes introduced by the Revolution in France (both in the 18$^{th}$ century), there came reforms in Prussia, which begun after her loss in the Napoleonic wars and became widely influential in Central and Central-Eastern Europe. There were two main Prussian reformers, Wilhelm von Humboldt (1767–1835) and Friedrich Schleiermacher (1768–1834). Both deserve the credit for the establishing clear distinction between the levels of secondary schools and of higher education and the interplay between them, and for the founding Berlin university in 1810 which soon became the highly influential model of a modern university.

   In their vision the main task of secondary schools was general education based upon common curriculum imposed by the state and controlled by it. In contrast, in universities the emphasis was placed upon research, accompanied and complemented by academic freedom, in German *Lehr- und Lernfreiheit*, that is, the freedom to teach and to do research without any interference. Its implementation in the Berlin university has turned that university into a model one. The main type of a secondary school was *gymnasium* (usually consisting of eight grades); its final exam called *matura* conditioned the university immatriculation. In turn, only university graduates could apply for a teacher's position in gymnasium. In that way a positive feedback between secondary and higher education appeared. As a result, universities were getting well prepared students eager to develop their intellectual interests.

3. Prussian reforms produced a strong stimulus towards **professionalization**: mathematics became an attractive profession offering a high social status, either in the form of a well-paid job in the expanding secondary school system or an academic career within similarily expanding higher education system. There appeared well-trained professional mathematicians whose main job was to develop mathematics and/or to teach it.

   The German system has also brought with it a new vision of the role of a university professor. It consisted since then both in teaching and in doing research and was highly esteemed. In the specific case of mathematics, the new research ethic ultimately brought with it a greater **specialization** in the field, as mathematicians and mathematicians-to-be tended to focus their studies more narrowly in an effort to make their own personal contributions. Developing along these lines, the system contributed to the exponentially rapid growth of the volume of mathematics and to specialization within the field. These aspects of the development of mathematics in Germany could be clearly seen at the University of Berlin under Dirichlet, Kummer, Weierstrass, and Kronecker and at the (formerly Hannoverian) university in Göttingen [17].
4. One of the main tasks of a university professor was to prepare future researchers. The principal vehicle for the active training of young researchers became a **seminar** which offered a collaborative study of recent research papers under the leadership of a senior researcher and a joint criticism of research attempts of young attendants. Seminars proved to be highly effective and remain to this day an irreplaceable and indispensable tool in producing new researchers.

   In support of the rising mathematical community came **journals** and **associations**. The oldest scientific journals, comprising mathematics, were academy proceedings which appeared in the 17th century and were followed later by special mathematical journals publishing articles and reviews, the first of which appeared at the beginning of 19th century. One of the first was (still existing) *Journal für die reine und angewandte Mathematik*, founded 1826 and called "Crelles journal" after its long-time editor. The number of such journals, together with the number of published articles, rose so fast that in 1871 there appeared *Jahrbuch über die Fortschritte der Mathematik*, the first review journal. It ceased to exist but there are some followers.

   The growth of community has been accompanied and supported by professional associations. Among the first were *Moscow Mathematical Society* (founded 1864) and *London Mathematical Society* (founded 1865), followed soon by national ones: *Société Mathématique de France* (since 1872), *Deutsche Mathematiker-Vereinigung* (founded 1890), *Societa Italiana de Matematica* (founded 1908) and others. Poland joined the general development in 19th century but founding of the *Polish Mathematical Society* was delayed until 1919, when political changes allowed it.

   "These institutions – the graduate seminar, the specialized journal, the specialized society – together with the twin values of research and teaching largely defined the profession and, in subtler ways, the discipline of mathematics as it had developed in Germany by the end of the nineteenth century. These same institutions and values informed the emergence of mathematical research communities in a number of other

countries as well and thereby served to build a common foundation for the subsequent internationalization of the field" [17, p. 1583].

In fact, the triple pattern – seminar, journal, society – could be observed in a number of countries in Central-Eastern Europe, sometimes with slight changes. For example, in partitioned Poland (period 1795–1918) national organizations of any sort were forbidden and a greater role was played by leaders enjoying authority, analogous to that of a president of a society. Professional mathematical associations in Poland and in some other countries of Central-Eastern Europe appeared only after World War I.

5. Educational reforms implemented in Germany were soon imitated, with some rather inessential changes, in the empires of Austria and Russia. They brought new life into old universities and produced some new ones. The basic principle of *Lehr- und Lernfreiheit* was preserved, thus accelerating the process of professionalization and strengthening the awareness of the significance of mathematics and of mathematicians, but also raising national ambitions.
6. Modern mathematics in Russia began with the founding of the Academy of Sciences in Petersburg by Peter the Great in 1724. The first mathematician in the Academy was Leonhard Euler (1707–1783), who worked there for most of his adult life (1727–1741 and 1766–1783). Yet there was no Russian mathematical community around. Euler worked alone, writing and communicating in Latin, French or German, and he had no students of his own. Nevertheless, his value for the Russian science was enormous. He showed that it was possible to do mathematics in a remote country and how to do it.

   In the 19th century Russia underwent elaborate educational reforms, originally patterned after those of the Polish Commission of National Education and soon thereafter following the German model. Several state universities were revived or newly founded (originally there were six – Vilnius, Dorpat, Petersburg, Moscow, Kazan, Tomsk – but later their number slowly rose). In the lack of native mathematicians a governmental policy was to send talented youngsters abroad with the objective to learn mathematics there and to come back with that knowledge. In that way first Russian mathematicians of world renown emerged: Victor Jakovlevič Bunjakowski (1804–1889) and Michail Vasil'evič Ostrogradskij (1801–1862), both had the merit of the initiation of the early mathematical community in Petersburg.
7. Mathematical communities appeared also in Dorpat, Kazan and Moscow. The last one grew to a larger significance with the figures of Nikolai Vasil'evič Bugaev (1837–1903), who had studied both in Berlin and in Paris for two-and-a half years beginning in 1863 and then returned to Moscow to influence colleagues and students through extensive teaching and vigorous support of the *Moscow Mathematical Society* (founded 1864) and of its journal *Matematičeskij Sbornik* (founded 1866). Bugaev taught a wide range of courses in, for example, number theory, the theory of elliptic functions, the calculus of variations, the theory of analytic functions etc. Moreover and most importantly, he wished to train students capable of contributing to further development of these subjects at a research level. "He also fostered and contributed to a philosophical atmosphere in which mathematics was interpreted essentially as a theory of functions and where the theory of discontinuous functions played a key role. This conception not only proved conducive to the acceptance of Georg Cantor's novel set-theoretic ideas but also

served as the foundation of the Moscow school of function theory, spearheaded in the early decades of the 20th century by Bugaev's student, D.F. Egorov, and perpetuated by Egorov's disciple, N.N. Luzin" ([17, p. 1587]; see also [20]).

The case of Moscow University "drives home the obvious point that the success of the mathematical endeavor in a given national context depends crucially on the process of training talented students in areas rich in interesting, open questions. At its core, mathematics undeniably involves proving theorems, and these students not only learned how to carry out that creative process successfully but also embraced the belief that they should pass on their insights to a subsequent generation. As they had been trained, so should they train – this philosophy came to characterize the mathematical mission internationally in the latter quarter of the 19th century. Moreover, in concert with the other factors examined above, it encouraged the formation of self-sustaining mathematical communities, that is, interacting groups of people linked by common interests" [17, p. 1587].

8. The case of Poland was different. There were old universities in Cracow (founded 1364), Vilnius (founded 1578) and Lvov (founded 1661), there were reforms introduced and executed by the Commission of National Education, which existed 1773–1794 in then still-independent country, with the noticeable progress and good prospects for further development [11]. However, in 1795 the state was partitioned among the three neighbors (Russia, Prussia, and Austria) and a century of national oppression began. The universities in Cracow and Lvov (which turned to be in the Austrian empire) fell into decline, while the old university in Vilnius, and the newly founded (in 1816) university in Warsaw (both in the Russian empire) were closed in 1832 after the unsuccessful November uprising against Russia.

   The revival came only half a century later with the autonomy granted in the 1870s to the province of Galicia (embracing Cracow and Lvov) which led to a subsequent re-polonization of universities in Cracow and Lvov, followed by their rapid growth and supported by some organizational and editorial initiatives in Warsaw.

   In Cracow Franciszek Mertens (1840–1927) became a professor in 1865–1884; an excellent mathematician himself, he had no disciples of his own. However, two other mathematicians came to Cracow: in 1895 Kazimierz Żorawski (1866–1953) and in 1900 Stanisław Zaremba (1863–1942), and their influence was much wider.

   An important development took place also in Lvov [6]. At the university there was Józef Puzyna (1856–1919) who taught extensively before World War I, giving nearly 30 courses in different branches of mathematics and writing an original monograph on analytic functions. With the view to forming a prospective mathematical community in Lvov, he invited Wacław Sierpiński (1882–1969) in 1908 and Hugo Steinhaus (1887–1972) in 1917. Sierpiński taught there set theory and led a seminar on "applications" of that theory to topology and to the theory of real functions; among the participants were Zygmunt Janiszewski (1888–1920) and Stefan Mazurkiewicz (1888–1945), who formed a core of what later became known as the "Warsaw school of topology". At the end of World War I Janiszewski happened to be in Warsaw and then proposed (in 1918) a program how "to win an independence for Polish mathematics". The essence of the program consisted in joining efforts to work in a chosen one new

field of mathematics (which eventually became "the set theory and its applications"), to work collectively and in a friendly manner (in a seminar), and to found a journal devoted to the chosen field (*Fundamenta Mathematicae*, 1920–) [7, 15]. After his untimely death the program was continued by Sierpiński, who then just came to Warsaw after the internment in Russia, and by Mazurkiewicz who also happened to be in Warsaw in that time, and the two men became leaders of the *Warsaw school of mathematics* [13, 14].

Similar development took then place in Lvov where Steinhaus invited Stefan Banach (1893–1945) to join him. Banach's Ph.D. thesis from 1920 in which he introduced "Banach spaces" became the cornerstone of functional analysis. Both Steinhaus and Banach became leaders of the Lvov school of mathematics, soon supported by the journal *Studia Mathematica* (founded 1929) devoted to the "theory of operators" [10]. The two new Polish journals, *Fundamenta Mathematicae* and *Studia Mathematica*, were the very first specialized mathematical journals in the world. The role of a research seminar in Lvov, however, was taken over by sessions of the Lvov branch of the Polish Mathematical Society and by the famous Scottish Café together with its equally famous *Scottish Book* [16, 18].

The two schools, Warsaw and Lvov alike, became soon known as the *Polish school of mathematics* [12, 13].

9. In Bohemia there was the old university in Prague (founded 1348) with the long mathematical tradition behind it. However, after the Thirty Years War (1618–1648) and under the Habsburg rule the country was being steadily Germanized to the effect that in the first half of 19$^{th}$ century the dominant language of its culture and science was German and up to the end of 1850s the language of instruction in secondary schools and universities, including Prague university, was solely German. But then came the Czech national revival and in 1871 there appeared first Czech mathematical courses at the Prague university; Czech departments were founded, including mathematical ones. A relentless work began on the modernization of Czech mathematical terminology, accompanied by translations into Czech of some old books and writing new original schoolbooks in Czech . The leading role in that movement, aimed at the establishment of Czech national mathematical community, was played by the *Czech Union of Mathematicians* (*Jednota českých mathematiků*), founded in 1869, and its *Journal for Cultivation of Mathematics and Physics* (*Časopis pro pěstování mathematiky a fisiky*), founded in 1872. In that way, already at the turn of 20$^{th}$ century, the Czech mathematical community appeared with a number of mathematicians publishing in Czech and in foreign languages (predominantly German or French) and aiming at attaining the world level.

   The Czech case is an outstanding example of a mathematical community which emerged slowly from the grass-root level and without any single leader, due to a common effort of the whole generation.

10. One of the main aims of teaching mathematics at the Prague university was to prepare teachers for secondary schools. In view of the "overproduction" of mathematical departments many of the would-be Czech teachers were leaving Bohemia going to other parts of the Austrian-Hungarian empire, predominantly to Balkans.

"After their arrival, they learned the respective foreign language and begun to create curricula for the teaching mathematics and descriptive geometry at the secondary schools and at universities. For they colleague-teachers, they wrote the first methodological manuals about the teaching mathematical subjects in their mother tongues. For their pupils they created the first brief teaching manuals and collections of mathematical exercises (…). During the few first years, they translated Czech textbooks of mathematics and of descriptive geometry to other languages (…). They set a form for the first generations of students educated in their mother tongues. In the second phase of their "mission" – usually at the end of the first decade of their stay – still inspired by Czech models, they wrote new textbooks for secondary schools and universities (…). These textbooks were widespread and used until the end of the World War I. Thanks to their quality education, high professional standard and all around activities they contributed to the creation of the mathematical terminology that has been used – except for a few modifications – until today (…). On the basis of their good experience from Bohemia they led local mathematical communities to the unification of professional associations (…) and initiated publishing professional, educational and popularization periodicals (…). In addition, they participated in the international promotion of the results of professional and pedagogical research (…)" [3, p. 43-45].

The early leading person in Croatia was Jan Pexider (1831–1873) but his premature death did not allow him to exert a deeper influence. Karel Zahradnik (1846–1916) turned out to be more influential: he became a professor of a newly founded university in Zagreb in 1875 and for many years was the only professor of mathematics there, teaching algebra, geometry, analysis, number theory, probability. His "mathematical seminar", which he led since 1886, became a breeding ground for the emerging Croatian mathematics.

To Sarajevo in Bosnia and Herzegovina came Alois Studnička (1842–1927), who worked there 1893–1907 in a technical school, significantly influencing the development of the Serbian educational system by, among others, teaching, promoting Serbian terminology, elaborating curricula etc.

An interesting development took place in Bulgaria. After the country get rid of the Turkish hegemony in 1878, it began to build its own educational system. The first "Bulgarian" university professor in mathematics in Sofia was Theodor Monin (1858–1893). He came to Bulgaria from Prague at the age of 23 to teach at a grammar school in Liven in 1881–1886, so when he got in 1887 his university appointment, he was already well versed in Bulgarian and was treated as a Bulgarian. Monin had ambitious plans to write several mathematical textbooks in Bulgarian but in 1891 he fell ill and died soon thereafter. Another Czech, Antonín Václav Šourek (1858–1926) was more lucky and eventually became more influential; he also taught first in Bulgarian schools (since 1880) but later took over the chair from Monin in 1893 and stayed in Sofia until 1914. During the World War I he worked in Bulgarian diplomacy abroad and in 1921 he resumed his university post. He succeeded in covering with his school texts in Bulgarian several branches of mathematics including plane trigonometry, solid geometry, analytic geometry, spherical geometry, and descriptive geometry. He also published several university texts on analysis, analytic geometry,

synthetic geometry, descriptive geometry, and algebra. He also rendered significant services in founding *Physical and Mathematicl Society in Sofia* (1896) and its *Journal of Physical and Mathematical Society* (1904). Being also one of the founders of the Bulgarian mathematical terminology, Šourek is among the most renown Bulgarian mathematicians of the time.

Among Czech mathematicians active in Bulgaria there were also František Vítězslav Splítek (1855–1943) and Vladislav Švak (1860–1941).

11. The independent state of Lithuania was established only after World War I but Vilnius, its ancient capital, became a part of Poland. Vilnius preserved the memory of the old university there (founded 1578 and closed by Russians in 1832) and so, referring to that old tradition, Poland has re-established it in 1919 under the name of Stefan Batory University (the king of the Polish-Lithuanian state who founded the university in 1578).

    Since Vilnius became part of Poland, Lithuanians have founded their own university in Kaunas, the capital of Lithuania at that time, but there was no mathematical tradition behind it. The Faculty of Mathematics and Natural Sciences has decided to appoint staff by competition, addressed to some European universities. Among the applicants there was a German mathematician Otto Volk (1892–1989) and the Faculty decided to nominate him.

    Otto Volk completed his studies and passed teacher's examination in 1917 in Stuttgart. In 1919 he got doctor's degree in engineering (for a mathematical work in potential theory) and moved to Munich, where he received Ph.D. degree in 1920 for a work in pure mathematics (on elliptic functions) and in 1922 he completed his habilitation in mathematics, thus acquiring the rank of Associate Professor. Volk came to Kaunas in 1923 and stayed there until 1930, when he became a professor at Würzburg university (he remained there until his death). However, the years 1923–1930, which he spent in Kaunas, were very productive. Giving many courses, he supervised 31 M.A. degree in mathematics and 3 of his students (Petras Katillius, Paulius Slavenas (1901–1991) and Otanas Stanaitis (1905–1988)) were admitted to doctoral studies at Heidelberg, Yale and Würzburg, respectively. Thus due to his commitment and devotion a Lithuanian mathematical community arose.

12. The Ukrainian national revival came late in the 19$^{th}$ century, shaping itself in opposition to both the Russian and the Polish cultural domination. The very first mathematical paper in the Ukrainian language has appeared only in 1894 (translated from the Polish original version) and from that time on the elaboration of the Ukrainian mathematical terminology proceeded; the terminology was introduced subsequently into school textbooks in Ukrainian schools. There was no Ukrainian mathematics at the university level as Poles did not permit the founding of Ukrainian university in Lvov and the Soviets battled against Ukrainian "national deviation" in their geopolitical part. The slow progress came after World War II but the Russian language still dominated and relations with the West were few. The whole situation changed after 1990, when Ukraine became independent.

13. The emergence of national mathematical communities in remote (from a Western viewpoint) Central-Eastern European countries is a fascinating story. In general,

it followed the Western triple pattern but it has also a local flavor. Nevertheless, the phenomenon testified to the vitality of newly risen old nations whose striving for independence also expressed itself in the tendency to attain high level of development in the most noble science of mathematics. Those national ambitions were largely supported by educational reforms which took place in the 19th century in all countries considered and which resulted in creating many posts and allowing many people to make mathematics their life mission.

In Russia the story began with Euler, who set a pattern for doing mathematics but had no immediate followers. The first native Russian mathematicians appeared in the first half of 19th century (Buniakovski, Ostrogradskij) but the more influential community arose in Moscow a few decades later with the leaders who founded a professional association, a specialized journal, and who began to teach modern mathematics and to train future researchers. Great names in that movement were those of Nikolai Vasilievič Bugaev (1837–1903), his disciple Dimitrij Fedorovič Egorov (1869–1931) and his student Nikolai Nikolaevič Lusin (1883–1950), the last one together with his group called Lusitania. Thus there appeared the great Moscow school of mathematics, the leader of Russian and Soviet mathematics [20].

The old universities of Cracow and Vilnius in the Polish-Lithuanian Commonwealth were reformed at the end of 18th century with good prospects for the future, but as a consequence of partitions in the 19th century there came the time of national oppression on the part of Russia, Prussia and Austria, and several national uprisings in turn. In the shadow of the movement towards regaining independence there was, however, a slow progress, augmented by the autonomy granted to Galicia (including Cracow and Lvov) and by some relaxation of the Russian policy in central Poland (with Warsaw), towards establishing a material basis for further development. The basis included re-polonized universities in Cracow and Lvov, a newly founded (in 1872) academy in Cracow, journals founded in Warsaw etc., which after War World I gave support to the Polish school of mathematics with its two branches in Warsaw and Lvov. The school – initiated by Janiszewski in 1918, led by Sierpiński, Mazurkiewicz, Steinhaus, and Banach, and supported by the journals *Fundamenta Mathematicae* and *Studia Mathematica* – soon gained the international recognition [12–14].

For centuries Bohemia was a part of the Habsburg empire but in the middle of 19th century there came a national revival with the tendency to restore the Czech language in culture and science. In the shadow of German political and cultural domination there began a slow but steady grass-root movement which started with the introduction of Czech primary and then secondary schools, textbooks in Czech, first Czech mathematical courses in the Prague university, founding a mathematico--physical association with its specialized journal etc. The movement resulted in the emergence of Czech national community but with no genuine leaders the community did not become then a truly creative mathematical center. First Czech mathematician of international rank came only after World War I.

A great merit of Czech mathematical community consists in influencing the emergence of national mathematical communities in the Balkan states of Slovenia, Bosnia and Herzegovina, and Bulgaria. In that last country Czech mathematicians

deserve particular credit for initiating Bulgarian mathematical terminology, founding its mathematico-physical professional association and its journal.

A still different development took place in Lithuania. There was a national revival in the 19th century but when Lithuania has got its independence in 1918 there was no single Lithuanian mathematician of significance. Lithuanian mathematics began with the German Otto Volk, who taught in Kaunas for 7 years and educated some good students who later became university professors. From those rather modest beginnings a wider Lithuanian mathematical community with its own journal *Litovskij Matematičeskij Sbornik* arose after World War II under the auspices of Soviet mathematics (Lithuania regained its independence only in 1990). The Ukrainian situation is delicate as the country is still strongly influenced by Russian mathematics, although its contacts with the West became more vivid after 1990.

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