LVOV MATHEMATICAL SCHOOL
IN THE PERIOD 1915–45 AS SEEN TODAY
BANACH CENTER PUBLICATIONS, VOLUME 87
INSTITUTE OF MATHEMATICS
POLISH ACADEMY OF SCIENCES
WARSZAWA 2009

REMARKS ON THE HISTORY OF MATHEMATICS IN LVIV UP TO THE MIDDLE OF THE XXTH CENTURY

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1. The history of Lviv University. The history of Lviv University starts with the foundation of the Jesuit collegium in 1608 [1]. On the 20th of January 1661 the Polish king Jan Kazimierz signed the diploma assigning the "significance of Academy and the title of University" to this collegium with the permission to teach all scientific university subjects of those times and to award scientific degrees of Licentiate, Bachelor, Master and Doctor. During its history, the University changed its name and status several times [2, 3]:

- 1608–1661 – Jesuit Collegium;
- 1661–1773 – Academy, University;
- 1773–1784 – Lyceum;
- 1784–1805 – Josef II University;
- 1805–1817 – Lyceum;
- 1817–1918 – Universitas Franciscae;
- 1919–1939 – Jan Kazimierz University;
- 1940– up to now – Ivan Franko Lviv University.

The dissolution of the Jesuit order in 1773 led to the transformation of the University into Lyceum. In addition to some Jesuit professors, which were still there, some others were sent from Vienna. The Lyceum had no permission to award scientific degrees in spite of the fact that some theses were defended there.

According to the decree of Josef II of 1784 the University was reopened and consisted of four faculties: theology, law, medicine, and philosophy (there were only theological and

2000 *Mathematics Subject Classification*: Primary 01A72; Secondary 01A73.

The author would like to thank Prof. Dr. Taras Banakh and Prof. Dr. Roman Duda for cooperation and help in preparation of this article.

The paper is in final form and no version of it will be published elsewhere.

DOI: 10.4064/bc87-0-1

philosophical faculties before). Yet, the University was transferred to Kraków in 1805 according to the corresponding order of Franz I. The remaining part became a Lyceum again. The basic difference between University and Lyceum was in reducing the number of chairs (the Chair of Mathematics survived), smaller duration of study, and limitation in awarding scientific degrees (in particular, the degree of Doctor). The University was again resumed in 1817, and further named after Jan Kazimierz according to the order of the Ministry of Education of Poland after the collapse of the Austrian-Hungarian Empire in 1918.

After the Soviet occupation in 1939 the University was reorganized: the theological faculty was closed. In January of 1940 the University was named after Ivan Franko (1856–1916), the famous Ukrainian writer, scientist, political and public figure, who was studying at the University during the years 1875–1880.

2. Mathematics at the University till the end of XIXth century. Initially, the teachers of mathematics in the collegium and the university were former pupils of Jesuit colleges. There was a tradition that lecturers in logic, physics, and mathematics had to change their place of pedagogical activity at least once during four years. Thus, more than 60 lecturers teaching mathematics during the period 1608–1744 are known. Then some special training courses for teachers of mathematics in Jesuitic collegia were founded in 1743 and existed up to 1773 [1]. This led to the foundation of the Chair of Mathematics in 1744 headed by Faustyn Grodzicki (1709–1787). Here is the list of mathematicians working at the University till the end of XIX-th century:

- 1744–1749 – Faustyn Grodzicki (1709–1787);
- 1749–1763 – Michał Redziminowski (1709–after 1773);
- 1753–1769 – Tomasz Siekierzyński (1720–1774);
- 1769–1773 – Ludwik Hoszowski (1732–1802);
- 1774–1785 – Ignacy Rein (1761–after 1807);
- 1794–1801 – Piotr Lody (1764–1829);
- 1787–1805 – Franciszek Kodesch (1761–1831);
- 1805–1813 – Jan Holfeld (1747–1814);
- 1834–1838 – L. Schulz von Straschnizki (1803–1852);
- 1840–1870 – Ignacy Lemoch (1802–1875);
- 1871–1889 – Wawrzyniec Żmurko (1824–1889);
- 1873–1899 – Oskar Fabian (1846–1899).

Mathematical courses were taught at the philosophical faculty which was considered to be a preliminary stage of studying at other faculties. For example, in 1775 when the studies at the philosophical faculty lasted for three years, listeners studied the pure mathematics at the first year, the applied mathematics at the second year and geometry, practical mathematics and field studies at the third year. There was even a Chair of Practical Mathematics (alternative name, Chair of Geometry and Land-surveying) between 1796 and 1805 headed by J. Holfeld, who took part in cartographical surveys of Galicia. I. Rein and J. Liesganig (1719–1799) were engaged in geodesic surveying as well (J. Liesganig taught mechanics and technology).

For every discipline taught in the University there was an obligatory textbook. In particular, in the catalogue from 1801 there is a recommendation to teach mathematics by Ch. F. Wolf, A. G. Kästners, the trigonometry by G. Vega [7], the geometry by J. T. Mayer [8]. These textbooks were overspread in Europe those times. Ch. F. Wolf (1679–1754), a student of Leibniz, graduated from the Jena University and taught in the Universities of Leipzig, Halle, and Magdeburg. He was a member of the Berlin Academy of Science and a supporter of the foundation of St. Petersburg's Academy of Science [5]. A. G. Kästners (1719–1800), a graduate of the Leipzig University, was a professor at the Leipzig and Göttingen Universities, and a member of the Prussian Academy of Sciences in Berlin. He wrote a number of textbooks determining the level of education in universities in the second part of 18th century [6].

The first professor at the Lviv university who was not a graduate of a Jesuit university was F. Kodesch. During 43 years (except for 8 years of professorship in Kraków) he taught pure and practical mathematics in Lviv. Initially he taught using the above mentioned textbooks by Wolf and Kästners. Afterwards he obtained a permission to teach according to his own textbook [9]. Józef Puzyna characterizes Kodesch's textbook as follows [2]: *The first volume of this textbook consisted of arithmetics and elementary algebra at the level of mathematics in Descartes' times... The notion of function found no applications in the book and even was not defined there. The second volume was devoted to geometry... The last two chapters included trigonometry with applications, and analytic geometry of conical sections. The author had not included the analytic geometry of surfaces of the second order and gave no notions and applications of differential calculus.*

The higher mathematics for the first time was taught at the university by Leopold Schulz v. Straschnizki. He was one of the best Austrian mathematicians of those times. In 1835 two of his students defended dissertations in pure mathematics [2]. In 1838 L. Schulz obtained a chair in Vienna Polytechnic, which was a considerable loss for the University.

In 1840 I. Lemoch became a professor of mathematics at the University. Before that he was an official in the Kaiser building office in Vienna – a teacher with no special scientific aspirations. After some time he taught according to his own textbook [10]. He preferred the geometry, though later he taught the higher mathematics as well.

After 1948 there was a reorganization of the philosophical faculty, which started to prepare teachers for schools and gymnasiums (and lost its preparatory status).

Professor W. Żmurko, a graduate of the Lviv University and Vienna University and Polytechnic, wrote more than 25 works published in journals of Vienna, Paris, and Kraków. He was known in Europe as a constructor of mathematical tools for drawing curves. He taught mathematics by his own textbook [11]. It was considered original but somewhat archaic (even for 1864). Following Hamilton, Żmurko introduced "triple values" and did not suspect that this construction led to a counterpart of complex numbers in $\mathbb{R}^3$ [12]. In 1851–72 he headed a chair of mathematics at the Lviv Polytechnic. In 1881 at the University the free reader's positions were occupied by: Professor of Lviv Polytechnic W. Zajączkowski (1837–1898) and Doctor of philosophy W. Kretkowski (1840–1910). Since 1873 selected mathematical courses were taught by Professor of math-

ematical physics Oskar Fabian (algebraic analysis, integrals, series of Fourier, and others). Besides courses in physics he taught analytical mechanics, elasticity theory and hydrodynamics. O. Fabian was the author of a textbook in theoretical mechanics [13].

3. Mathematics at the University at the end of XIX and beginning of XX century. After coming to the University of Józef Puzyna various special courses in mathematics were initiated. In that period also practical lessons and scientific seminars of mathematical chairs were organized. The following mathematicians worked at the University:

- 1885–1919 Józef Puzyna (1856–1919)
- 1900–1906 Jan Rajewski (1857–1906)
- 1908–1918 Wacław Sierpiński (1882–1969)
- 1913–1918 Zygmunt Janiszewski (1888–1920)

J. Puzyna taught more than 30 various courses. Besides a basic course in analysis he taught: the theory of elliptic functions, the theory of abelian functions, number theory, non-Euclidean geometry, invariants, differential Lie equations, and others. It is interesting that in 1898/9 in the programme a course "Topological Studies" was announced. It seems that the contents of this course was related to the first part of his book "Teoria funkcyj analitycznych" [14]. It contains the first exposition of set theory and some topological notions in Polish. At that time his book was a real encyclopedia of Analysis. Since 1893/4 J. Puzyna supervised two mathematical seminars: higher and lower. The latter seminar was arranged jointly with J. Rajewski and W. Sierpiński. In 1911/12 the higher seminar was supervised by W. Sierpiński. In the programme of the seminar [17] one can find, in particular, presentations by S. Ruziewicz "On everywhere divergent trigonometric series", W. Lichtenberg "On the Richard paradox, on transfinite induction and transfinite iteration, on Peano curve". Active students were awarded stipends. Among them one can find O. Nikodym and S. Ruziewicz. The seminars were active during all war years. There is a list of all participants of the higher seminar [4], which includes the names of W. Lewicki, A. Łomnicki, O. Nikodym, S. Ruziewicz that afterwards became professors of mathematics.

Among works made under supervision of J. Puzyna there was a paper of W. Lewicki [15], published also in Ukrainian in [16]. It was the first scientific publication in mathematics written in Ukrainian. Lewicki created Ukrainian terminology for mathematics, physics and chemistry. He was the "Ukrainian counterpart" of S. Dickstein (1851–1939) (who created the Polish mathematical terminology).

Due to efforts of J. Puzyna in 1900 the second (superordinary) chair of mathematics was created. It was headed by J. Rajewski and then by W. Sierpiński (during 1914–1918 he was interned and stayed in Viatka and Moscow). The decision to nominate W. Sierpiński professor (from 12 December of 1912) was not approved in Vienna. He taught a series of modern courses in mathematics: set theory, Lebesgue integral, the notion of measure of point-sets, application of the set theory to analysis, the latest achievements in the theory of real functions, analytic number theory, critical survey of principal concepts of mathematics, and others. In 1913 the Ph.D. degree was awarded to S. Mazurkiewicz

(1888–1945). On his application for Ph.D. degree [18] there is a notification about his promotion on 22.02.1913 with Prof. J. Puzyna as the supervisor.

After obtaining Ph.D. degree in Sorbonne, Z. Janiszewski returned to Lviv. In 1913/14 he taught courses in analytic functions and functional calculus. The collaboration of these three famous mathematicians resulted in founding in Warsaw the journal "Fundamenta Mathematicae" (1920), the first specialized mathematical journal in the world. It was the realization of Janiszewski's idea of needs and directions of the development of Polish mathematics.

The First World War interrupted the activity of Lviv mathematicians and after the war the Lviv mathematics entered into its new epoch. In 1917, being in Kraków, Puzyna invited H. Steinhaus to Lviv. On 13 March of 1919, after moving to the Warsaw University, W. Sierpiński in his letter [19] to the philosophical faculty asked S. Ruziewicz to teach lectures and supervise the pre-seminarium. Lecturing in mathematics was entrusted to A. Łomnicki but at the same time he was invited at the second mathematical chair in the Lviv Polytechnic.

In 1919 Puzyna died and was buried in the village of Stankiv where he has a patrimony. Afterwards he was reburied at the cemetery of Stryj [20].

4. Period between two World Wars. After J. Puzyna in 1919 the chair was occupied by E. Żyliński. In 1919/20 the lectures were taught by private docents H. Steinhaus and S. Ruziewicz. In 1920 there were already 4 professors: E. Żyliński, H. Steinhaus, S. Ruziewicz, and S. Banach. Among the students of the Philosophical Faculty there were: J. P. Schauder, W. Orlicz, H. Auerbach and then S. Mazur. Since 1930 L. Chwistek started to work at the faculty. At the mathematical chairs there were 3–4 assistant positions often occupied by students. Till 1939 the following mathematicians worked at the university:

- E. Żyliński (1890–1954), since 1919 an extraordinary professor and since 1922 ordinary professor;
- H. Steinhaus (1887–1972), since 1917 free reader (Privatdozent), since 1920 an extraordinary professor and since 1923 ordinary professor;
- S. Ruziewicz (1889–1941), since 1918 free reader, since 1921 an extraordinary professor and since 1927 ordinary professor;
- S. Banach (1892–1945), since 1922 an extraordinary professor and since 1927 ordinary professor;
- L. Chwistek (1884–1944), since 1930 an extraordinary professor and since 1938 ordinary professor;
- W. Orlicz (1903–1990), since 1927-30 an assistant, 1935-37 free reader;
- H. Auerbach (1901–1942), since 1925 an assistant, since 1936 free reader;
- S. Mazur (1905–1981), 1926, 1930-35 an assistant, since 1936 free reader;
- J. P. Schauder (1899–1943), since 1927 an assistant, then free reader;
- W. Nikliborc (1899–1948), 1927–37 free reader;
- S. Kaczmarz (1895–1939), 1929–39 free reader;
- W. Stożek (1883–1941), 1930–34 free reader;
- J. Meder (1905–1975), 1927–29 an assistant;

- M. Stark (1908–1974), 1930–33 an assistant;
- W. Hetper (1909–1940), since 1935 an assistant;
- K. Szałajko (1912–2003), since 1935 an assistant;
- M. Kac (1914–1984), 1935/36 an assistant.

A part of Lviv mathematicians that were active in mathematics were connected with teaching in secondary schools or offered private lessons: M. Eidelheit (1910–1943), J. Hercberg (1908–?), J. Pepis (1910–1941), J. Schreier (1908–1943), L. Sternbach (1905––1942), M. Zarycki (1899–1961).

Each year the number of lectures, practical lessons and seminars in mathematics increased at the university. For the period since 1919 till 1938 their number increased more than three times: from 17 till 52 hours per week. Especially this concerned special courses. For that period more than 50 various special mathematical courses were taught.

Among important events in the Lviv scientific life there were: First Polish Mathematical Congress in 1927, the foundation of the journal "Studia Mathematica" in 1929, publication of S. Banach's monograph "Théorie des opérations linéaires" in 1932 and appearance of the "Scottish book", the legendary book of mathematical problems, started by S. Banach in July of 1935.

Daily meetings in "Scottish café" created the Lviv style of scientific investigations in mathematics. This was a new style of collective work on mathematical problems, often in unusual circumstances.

In the inter-was period the Lviv mathematical school had general international recognition, in particular, for the following achievements:

- creation of the foundations of functional analysis by S. Banach and his students;
- application of topological methods to functional analysis and differential equations by J. P. Schauder;
- interpretation of probability as a measure in works of Steinhaus and Łomnicki, application of probability methods in the theory of orthogonal series;
- investigation of the continuity and differentiability of functions and convergence of orthogonal series.

A characteristic feature of Lviv mathematical school was free use of non-constructive methods relying on the Axiom of Choice, Baire category and Lebesgue measure.

5. Mathematics in Lviv Polytechnic. Lviv Polytechnic belongs to the oldest high technical schools of Europe. Its predecessor was a real school founded in 1817 and in 1825 transformed into a preparatory school for studying technical sciences at the university. After its reforming in 1835 it was named Real-commercial Academy. In 1844 the Lviv Technical Academy was founded, which was renamed in 1877 into Polytechnical School and in 1921 into Lviv Polytechnic [21, 22].

Firstly, the mathematics in the academy was taught by A. Reizinger and the practical geometry by I. Lemoch. After transfer of A. Reizinger to the position of Academy director the mathematics was taught by W. Żmurko. The second mathematical chair was opened in 1883. These chairs were headed by:

First chair:	Second chair:
1851–1872 W. Żmurko	1883–1898 P. Dziwiński
1872–1898 W. Zajączkowski (1837–1898)	1899–1908 S. Kępiński (1867–1908)
1898–1925 P. Dziwiński (1851–1936)	1908–1919 Z. Krygowski (1872–1955)
1926–1939 W. Stożek (1883–1941)	1919–1941 A. Łomnicki (1881–1941)

In 1922 a General Department was created. It consisted of three chairs, in particular, the Chair of Mathematics III and Theoretical Physics.

During 1910–1914 S. Banach was a student of the Lviv Polytechnic, first at the Faculty of Machine Building, and then (since 13.10.1911) at the Engineering Faculty. In his examination book [23] there are notifications about: a colloquium in mathematics (15.09.1911) – "very good"; an exam in chemistry (29.02.1911) – "very good", an exam in mathematics I (24.06.1913) – "excellent" and an exam in general mechanics (3.11.1913) – "very good".

The professors of the time of Academy and Polytechnical School wrote a series of valuable textbooks though they were not too famous in the world of mathematics. The period of Lviv Politechnic (after 1921) was fruitful: K. Kuratowski wrote that time his famous monograph in topology. Also there was an important work of A. Łomnicki published in Fundamenta Mathematicae in 1924 on axiomatic foundations of probability theory on the basis of set-theoretic concepts. Now there is an increasing attention to works of L. Böttcher (1872–1937) who was a pioneer of the iteration theory.

The third mathematical chair was headed by:

1922–1927 W. Stożek;

1927–1933 K. Kuratowski (1896–1980).

Students of the mathematical group were specialized in pure mathematics, advanced mathematics, design and projective geometry. One of students and doctoral students of K. Kuratowski at this department was S. Ulam (1909–1984).

In 1933 the General Department and related chairs were abolished.

Till 1939 the mathematics and mechanics was taught also by: P. Dziwiński (assistant since 1874), B. Abakanowicz (reader since 1876), O. Fabian (reader in 1872/3 and 1875–81), W. Kretkowski (assistant since 1899), K. Żórawski (reader since 1892), L. Böttcher (assistant since 1899, adjunct since 1910, reader in 1911–35), Z. Krygowski (reader in 1901–08), M. Ernst (reader since 1906), A. Maksymowicz (reader since 1908), S. Banach (assistant 1920–22), S. Ruziewicz (professor in 1924–30). S. Kaczmarz (since 1923 assistant, adjunct, reader), W. Nikliborc (since 1922 assistant, adjunct, reader, professor), W. Orlicz (1931–37 assistant, adjunct), K. Szałajko (1937–41 assistant), A. Turowicz (1937–39 adjunct).

6. Mathematics at the University in 1939–45. After entering Soviet military troops to Lviv in 1939 all education institutions were reorganized. The Faculty of Physics and Mathematics was opened in the University. In December 1939 S. Banach was appointed to be its dean and M. Zarycki to be its vice-dean. On 7th of December of 1939 chairs were created and their heads were appointed. In particular, the chair of:

- Analysis I, headed by Professor S. Banach, professors: S. Saks (1897–1942), W. Lewicki, L. Chwistek, W. Orlicz, assistants: J. Hercberg, M. Tymoszek, M. Sperling, L. Sternbach, laboratory assistants: A. Plamitzer, S. Leja, A. Alexiewicz (1917–1995);
- Analysis II headed by Professor H. Steinhaus with professor H. Auerbach, reader M. Eidelheit and assistant M. Stark;
- Geometry headed by Professor S. Mazur with professor B. Knaster (1893–1980), docent E. Szpilrajn (1907–1976) and assistant M. Wojdysławski (1918–1942). Since January 1941 he as well as A. Alexiewicz and M. Stark became graduate students;
- Algebra headed by Professor E. Żyliński with reader W. Hetper, assistant O. Andruszkiw. In another rector's decree he was dismissed because did not appear at work all the October;
- Probability Theory headed by Professor M. Zarycki with professor M. Jacob (1900–1944), reader J. Pepis, assistant P. Jurkiewicz. Since February 1940 he moved to the chair of geometry;
- Mechanics headed by Professor J. P. Schauder with professor W. Milijanczuk and assistants A. Raabe, J. Mosler.

Lviv was visited by Soviet mathematicians: P. Aleksandrov (1896–1982), S. Sobolev (1908–1989), L. Lusternik (1899–1981), N. Bogolyubov (1909–1992), A. Bermant (1904–1959), and others. They delivered talks and seminars and contributed to the Scottish book. P. Aleksandrov and S. Sobolev prepared recommendation to awarding Soviet scientific degrees to Lviv mathematicians. S. Banach was invited to Moscow (May 1940), Kyiv (December 1940, June 1941) and Tbilisi (March 1941), since 5th of January till 10th of February 1941 J. P. Schauder was in Moscow University. For the period since September 1939 till May 1941 there appeared only 14 new problems in the Scottish book (till that time the book contained 180 problems).

After the beginning of Soviet-German War the university was closed. Many Jewish mathematicians were killed. Banach survived during the Nazi's occupation working as a donor in anti-typhus Weigel institute. He described this in the cross-examination protocol from 20th of October, 1944 [24]:

... Every day I spent 45 *minutes in the institute. They applied* 15 *boxes with louses that suck my blood through a special net. Each box contained up to* 800 *louses.... I was feeding louses during all* 1943 *year. ... At the end of* 1943 *I was contaminated by louses. ... I was sick for the next half year.*

About the destiny of Lviv mathematicians Banach says in the cross-examination protocols from 20th–23rd of September, 1944 [25]:

... I knew Professor J. P. Schauder in person and met him occasionally till May 1943*. He personally told me that he had been in Boryslav and then came to Lviv. He lived here under different surname "Szandek". In May* 1943 *he suddenly disappeared – people started gossiping about his death ... he was arrested on a street and died. I do not know the details but obviously he was killed by the Nazis.*

In August 1944 Lviv University started to work again. S. Banach left the dean position in November 1944. M. Zarycki became the dean. In 1944/45 there were the chairs of:

- Mathematical Analysis: professor S. Banach (Head), professor W. Lewicki, assistant O. Zyrjanowa and laboratory assistant A. Alexiewicz;
- Function Theory headed by professor W. Orlicz;
- Geometry: professor S. Mazur (Head), professor B. Knaster and assistant S. Jasenieckiĭ;
- Algebra: professor E. Żyliński (Head) and assistant B. Towarnickiĭ;
- Theoretical Mechanics headed by professor W. Nikliborc;
- General Mathematics headed by professor M. Zarycki.

On 31st of August Stefan Banach died and was buried at the Lychakiv cemetery in Lviv. The chair of Mathematical Analysis was headed by W. Lewicki. Many mathematicians emigrated to Poland: W. Orlicz and W. Nikliborc in 1945, then in May 1946 S. Mazur and E. Żyliński. On the other hand, in 1945 some Soviet professors arrived to Lviv: B. Gnedenko (1912–1995), A. S. Kowańko (1893–1975), G. N. Sawin (1907–1975) and later L. Wolkowyski (1913–1992) and Ja. Lopatyński (1906–1981), who laid foundations of post-war scientific schools in mathematics and mechanics.

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