Writing the History of Mathematics: Its Historical Development

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15.3 Mexico

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15.3.1 The Creation and Development of the Royal University

Mexico, as it is usually described in modern history or geography textbooks and general encyclopedias, is a product of the 19th century.[3] As its geographical boundaries were negotiated with its neighbors, its first political constitution was also drawn up, establishing Mexico as an independent republic in 1821. Native regions of the Olmec, Mayan, and Aztec cultures, among others, which had flourished before the local populations were conquered by the Spanish, fell within its boundaries. The Spanish then ruled "Mexico" for 300 hundred years, from 1521 until 1821.

Within 30 years of the Spanish conquest, following the structure and image of the Spanish University of Salamanca, the *Universidad Real y Pontificia de México* (Royal and Pontifical (1595) University of Mexico) was established in 1551, the first to be founded on the American continent.[4]

Two years later, when the university officially opened its doors, the following professorships had already been assigned: Theology, Sacred Scriptures, Canon Law, Law, Arts, Grammar, and Civil Law. Other "chairs" (e.g. Medicine and Moral Theology, among others) were subsequently added. It was another hundred years, however, until a Chair for "Astrology and Mathematics" was established.[5] A "Mathematics Chair" proper was officially recognized only in the second half of the 18th century. This was largely the result of a debate provoked by the physician José Ignacio Bartolache (1739–1790). Although some intellectuals in New Spain were interested in following the recent "scientific" and mathematical

[2]Given the fact that the professionalization of the history of mathematics in Mexico is comparatively recent, it has been impossible to support every argument with specific references; some of the most recent history covered here is necessarily of a subjective and personal character, although historical references have been provided whenever possible.

[3]A few isolated references containing "historical" accounts of the evolution of "Mexican" science (including mathematics) — written between the 17th and 19th centuries — have survived [Trabulse 1984, 9–10, notes 1 and 2]. The analysis here, of historians of mathematics active in Mexico, and of mathematicians who incorporated significant amounts of historical material in their writings, will concentrate primarily on the first half of the 19th century and on the personality of Sotero Prieto (1884–1935), tutor and mentor of the first generation of professional mathematicians.

[4]The founding of the Royal University stimulated the development of other schools of advanced studies, among them the *Colegio Mayor de Santa María de Todos los Santos* (1573), the *Colegio de San Pablo* (1575), where it was possible to study the trivium, quadrivium, and theology, and the *Colegio de San Gregorio* (1575).

[5]Friar Diego Rodríguez (ca. 1596–1668) was the first to hold this chair; he taught mathematics to students of the faculty of medicine where it was a compulsory subject, along with astrology [Fernández del Castillo 1953, 39].

developments on the European continent, their efforts were largely thwarted by the Sacred Inquisition.[6]

Following its "duty" to prevent the corruption of readers, the Inquisition elaborated a long list of forbidden books, including, among others, scientific works by GIORDANO BRUNO (1548–1600), GALILEO GALILEI (1564–1642), ISAAC NEWTON (1642–1727), and CHRISTIAN WOLFF (1679–1754).[7] To add a book to the list, only an anonymous accusation was necessary, arguing that the book in question contained some statement against Catholic principles. In New Spain (i.e. Mexico), the index of prohibited works was taken very seriously. It is difficult to assess, for example, the possible influence in Mexico of the *Histoire des Mathématiques* (History of mathematics) [MONTUCLA 1799/1802] by MONTUCLA (1725–1799, **B**) — since it was black-listed in 1808, only four years after its arrival in the new world.[8]

15.3.2 After Independence

Throughout much of the 19th century, the university suffered several decades of turmoil due (in great part) to the persistent rivalry between liberal and conservative parties in their efforts to control the country, once the rebel Mexican army officially signed a treaty recognizing independence from Spain in 1821. Although the conservative party was able briefly to impose another foreign government, the Republic was reestablished when emperor FERDINAND MAXIMILIAN JOSEPH (1832–1867) of Austria was executed on June 19, 1867. Hoping to control the country politically, the new liberal leaders sought to establish the basis for a durable and peaceful social order. One of their main doctrines, in opposition to the ideology of the Inquisition and the Catholic clergy, was freedom of conscience, which was firmly rooted in three different forms of emancipation — scientific, religious, and political. GABINO BARREDA (1818–1881), spokesman for a new educational policy, adapted the positivist thought of AUGUSTE COMTE (1789–1857) in support of his ideas.[9] The original positivist motto, "love, order, and progress," was later replaced by "freedom, order, and progress." (Some years later, the motto was abbreviated simply to "order and progress," as if "love" and "freedom" no longer mattered.)

[6] FRIAR DIEGO RODRÍGUEZ included readings of COPERNICUS, TARTAGLIA, CARDANO, BOMBELLI, BRAHE, and KEPLER, among others, in his courses on mathematics and astrology.

[7] However, a positive consequence of this prohibition is that we now possess listings of some of the books that arrived from Europe during the Colonial period. In trying to fulfill their commitments, the inquisitors drew up detailed descriptions of some private libraries. Thus it is not only possible to list some of the authors (EUCLID, PTOLEMY, KEPLER, and NEWTON, among others), but to date precisely when they first arrived in Mexico. See, for example, [FERNÁNDEZ DEL CASTILLO 1982], [MORENO CORRAL 1992], and [O'GORMAN 1939].

[8] Unfortunately, when lists of forbidden books were published, the Inquisition did not provide reasons or explanations. The list simply gave the complete references for such books. On the other hand, the private record shows that the Inquisition had received an "oral report" that MONTUCLA's book contained "heretic propositions" [*Catálogo* 1992, slip 1147, page 228].

[9] The most complete and serious attempt to explain the origins, development, and decline of positivist doctrines in Mexico is [ZEA 1968].

The positivist ideal envisioned a complete reform of the Mexican educational system, and one of its main goals was the popularization of the exact and natural sciences. This reform, on the other hand, explicitly excluded studies promoting religious debates; some of the latter were actually replaced by the study of experimental sciences. Nevertheless, some reforms were more easily described on paper than put into practice. In fact, by the turn of the century (after nearly 35 years of a new dictatorship), the study and development of technology and the sciences (both natural and exact) had fallen well behind prevailing European standards.

15.3.3 The Emergence of Modern Mathematics in Mexico in the Twentieth Century: The Autonomous National University

The University of Mexico attracted the most cultured, educated, and, at times, outspoken members of the community. Consequently, on various occasions the university was closed, due in large measure to the political instability of the country.

In 1910, still under the dictatorship of PORFIRIO DÍAZ (1830–1915), a newly transformed National University reopened its doors. JUSTO SIERRA (1848–1912), one of the main advocates of the "scientific party" — so called because its members justified a reelection of DÍAZ using "scientific" arguments — regarded the university as the most important cultural institution of the nation. This presumed a new role for the teaching and development of the sciences. The *Escuela Nacional Preparatoria* (National High School) — where students were prepared to enter the university — and the newly-created *Escuela de Altos Estudios* (School of Advanced Studies) began to offer specialized courses in biology, physics, chemistry, and mathematics. These schools promoted a favorable academic climate in which those interested in the teaching and study of higher mathematics could discuss their findings. A non-exhaustive list of those who did includes ÁNGEL DE LA PEÑA (1837–1906), SOTERO PRIETO (1884–1935), ALFONSO NÁPOLES (1897–1992), and FRANCISCO CÁRDENAS (1898–1969). Among the most distinguished of these was PRIETO, Mexico's first serious historian of mathematics. Trained by his father, an elementary mathematics teacher, PRIETO was a natural leader and a highly admired professor according to reminiscences of some of his students. He taught various branches of higher mathematics and is credited with the introduction (in Mexico) of the theory of relativity (see, for example, [PRIETO 1921/23]).

15.3.4 The Faculty of Sciences

Between 1920 and 1940, political and academic conditions changed dramatically regarding the role and value of the mathematical sciences. By then, political spokesmen envisioned the transformation of Mexico, anticipating its modernization through industrialization and application of new technologies. The study of branches of engineering was to be supported (see [VASCONCELOS 1926]). Mathematics, as a foundation for engineering, was thus viewed much more favorably than it had been in the past. PRIETO happened to be at the right place at the right time.

He taught mathematics at the *Escuela Nacional de Ingenieros* (National School of Engineers), where he was able to unite a small but highly motivated group of students wishing to pursue the study of mathematics. In a relatively brief period of time, the status of this group was formalized and established as a "section" (or department) in the Faculty of Philosophy. Between 1931 and 1933, PRIETO lectured on the history of mathematics [PRIETO 1991]. His original manuscript lecture notes — in a very poor facsimile edition — do not reveal origins, methodology, pedagogic goals, or the significance of mathematics. PRIETO does not mention the sources he read or the influences on his historical views. The notes only seem to reflect specific data needed to lend substance to the lectures, and unfortunately never mention possible hypotheses, theses, major concepts, trends, or traditions. In his notes, PRIETO constantly lists (in modern notation) problems mathematicians were trying to solve, but he does not illustrate reasons why particular questions were important, why there was any interest in attempting to solve them, or what tools were available to attack them. Basically, each lesson was prepared independently of the others following a chronological order.[10] Nevertheless, from the comments of some of PRIETO's students, it seems clear that the lecture notes do not reflect the character of the courses as delivered or the influence they may have had on PRIETO's students.[11] The notes, however, are admittedly dry and unappealing.

The opening phrase of the lecture notes suggests that PRIETO was interested in doing more than presenting a chronological outline of mathematics to his students. He stated: "The history of a science clarifies the origins of its fundamental concepts and exhibits the evolution of its methods." [PRIETO 1991, 1]. That is to say, it was not simply a matter of memorizing hundreds of names, dates, and titles. History as a discipline, for PRIETO, had a much deeper meaning. He had read GIOVANNI BATISTA VICO (1668–1744), for example, and believed that history played a major role in the understanding of culture. This, in turn, meant that it was necessary to know how a given culture evolved. History was about more than collecting data; it also included laws explaining trends and clarifying how history — and the history of mathematics — developed as they did. Although some of his followers (e.g., AGUSTÍN ANFOSI (1889–1966), CARLOS GRAEF (1911–1988), and FRANCISCO ZUBIETA (*1911)) subsequently lectured on historical topics, none seems to have shared PRIETO's identification with VICO or any other school of historical thought.

A few years later, in 1939, the Department of Mathematics was officially established as part of the Faculty of Sciences of the now renamed *Universidad Na-*

[10] Originally, PRIETO planned two yearly academic courses, each divided into two terms. The first course ran from October 1, 1931, to June 7, 1932, and from July 19 to November 1, 1932, and covered (in 71 lectures) the history of mathematics from the Egyptians up to the 16th century, including some comments on Portugal and Spain. The second course covered parts of the 17th and 18th centuries (in only 30 lectures), and was offered from February 14 to June 8, 1933.

[11] In fact, in a personal communication, Dr. ALBERTO BARAJAS, a former student of PRIETO, has questioned the authenticity and authorship of the facsimile notes ascribed to PRIETO.

cional Autónoma de México (UNAM) (National Autonomous University of Mexico).[12] This "autonomous" character meant that, although the university received most of the necessary funds to operate from the federal government, the university had complete freedom to govern itself, both politically and economically.

Academic conditions were substantially improved in both the teaching and transmission of mathematics.[13] Well-established scholars from abroad regularly visited the *UNAM*, and offered substantial support to the efforts of their Mexican colleagues.[14] Students trained abroad started to return to Mexico, bringing with them new ideas and methods. Meanwhile, the *Instituto de Matemáticas* (Institute of Mathematics) and the *Sociedad Matemática Mexicana* (Mexican Mathematical Society) were founded in 1942 and 1943, respectively.[15]

It was not long before the profession began to enjoy a new level of recognition, in part because some mathematicians had developed very close ties to major political figures. Most all of the sciences went through a powerful renaissance at this same time. By 1951, when the university celebrated its four-hundredth birthday, part of the festivities included the organization of the *Congreso Científico Mexicano* (Mexican Scientific Congress). When the proceedings were published, they occupied 15 thick volumes containing more than 500 works, some of which were historical in character [*Memoria* 1953/54]. The first volume contains the mathematical papers. Some of which (see RECILLAS AND NAPOLES, among others) are survey works describing research developed at Mexican institutions.

[12]Unfortunately, PRIETO was no longer alive to appreciate this moment. Four years earlier, he had committed suicide by shooting himself in the head.

[13]This transformation was not limited to mathematics. Other disciplines, like physics, chemistry, and astronomy to mention just a few, enjoyed similar metamorphoses. Such transfiguration also took place within the humanities.

[14]DIRK STRUIK, for example, visited Mexico for six weeks in 1934. Thereafter, he visited Mexico repeatedly; on the occasion of his most recent visit (1976), he delivered a set of six lectures on the history of mathematics. As a direct consequence of this visit, ALEJANDRO GARCIADIEGO enrolled at the University of Toronto (Toronto, Ontario, Canada) to become the first trained professional historian of mathematics in Mexico. He received his masters and doctoral degrees between 1979 and 1983. Visits of GEORGE DAVID BIRKHOFF, GARRET BIRKHOFF, SOLOMON LEFSCHETZ, and NORBERT WIENER, among others, proved to be of immense value for the development of mathematics in Mexico in the present century.

[15]The Federal Government also supported the foundation of other major institutions of research and training. President LAZARO CÁRDENAS (1895-1970), in his wish to support higher education, created the *Instituto Politécnico Nacional (IPN)* (National Polytechnical School) in 1939. This institution offered a bachelor's degree in physics-mathematics and, later, provided an alternative for the doctoral degree in mathematics. In 1943, some of the most prestigious intellectuals in Mexico founded *El Colegio Nacional* (The National School). Members of the Spanish academic elite, refugees from the atrocities of the Civil War, established *El Colegio de México* (The Mexican College), the most influential research and teaching school for historical and social studies. Unlike *El Colegio de México*, the *Colegio Nacional* does not prepare students. Its members offer conferences and lectures for the interested public and publish, generally, their collected works. Somewhat earlier, the foundation of the *Sociedad Mexicana de Historia Natural* (Mexican Society of Natural History) (1936) heavily promoted historical studies on scientific themes through its official journal.

When a newly built University City opened in 1954, the "Tower of Sciences" housed most of the scientific institutes. This building provided the opportunity for colleagues from different scientific disciplines to gather on a daily basis. Some shared philosophical interests and an inquisitive attitude towards nature and the importance of science in general. On February 21, 1955, SAMUEL RAMOS (philosophy), GUILLERMO HARO (astronomy), and ELI DE GORTARI, a logician, founded an interdisciplinary *Seminario de Problemas Científicos y Filosóficos* (Seminar on Scientific and Philosophical Problems). In a relatively short period of time, this seminar attracted a large number (225) of professors and researchers, some of whom lived abroad. Every month, anyone who wished to do so was free to participate in the seminar, and in the course of its first few years, DE GORTARI oversaw publication of more than 74 pamphlets and 33 books.[16]

15.3.5 The Nightmare: The 1968 Student Movement

In mid-1968, an apparently insignificant street fight between two schools (administered by *UNAM* and *IPN*), was suppressed by city police and subsequently escalated into one of the most important social and political events in Mexico in the second half of the 20th century — surpassed in its extent and consequences only by the Mexican Revolution (ca. 1911–1920). University and polytechnic students, emotionally and ideologically motivated by similar political student movements elsewhere — especially those in France that erupted in Paris during May of that same year — along with support from the intellectual community in general, carried out public rallies on the main streets of Mexico City. The government (1964–1970) of GUSTAVO DÍAZ chose not to negotiate or compromise with the students. Instead, to end the conflict, DÍAZ decided to use brute force to repress a mass meeting held in Tlaltelolco — the cradle of Mexican culture in Mexico City — on October 2, 1968. When the Mexican army invaded the university (violating its "autonomous" character) as well as the *IPN*, the university was forced to close its doors. Meanwhile, many students and professors, among them DE GORTARI, were illegally detained by the police and the army. With them went the full support of the *Seminario de Problemas Científicos y Filosóficos*.

It was nearly a year before the university reopened, but most students and professors did not obtain their freedom immediately. Most were accused of different offenses under common law and not for their political convictions. From time to time over the next few years, the government offered amnesty to most of those who had participated in the 1968 student movement. Nevertheless, the damage

[16] These included original contributions, as well as translations from both classic sources (LOBACHEVSKII, PAVLOV, and PLANCK, among others), and contemporary thinkers (e.g., JACQUES HADAMARD, KURT GÖDEL, ALEXANDER ALEXANDROV, and GORDON CHILDE, to mention a few). Of the books, there were translations with commentaries of original sources (e.g., WILLIAM HARVEY), new works by colleagues (e.g., GARCÍA BACCA), and translations from contemporary historians and philosophers of science (e.g., JOHN D. BERNAL, PHILIP FRANK, MAURICE FRECHET, and HANS REICHENBACH, among others). It is very significant that none of these texts was directly associated with the history of mathematics.

had been done. Socially, ideologically, and politically, the university was inevitably different.

Above all, members of the university had lost their political innocence. The university community was politically polarized, and those interested in philosophical or historical questions were largely associated with left wing ideologies. In general, the well-established and more traditional members of the staff regarded the development of mathematics and the sciences as free from an ideological agenda. At one point, they opposed — both secretly and openly — several attempts to popularize the study of the history and philosophy of mathematics. Most of these scholars claimed that students only needed to learn technical mathematics. Some courses (including classical mechanics and electricity) were omitted from the standard curricula. On the other hand, mostly younger members of the community (the majority of them students) became increasingly critical of the uses and roles of science in society. Others, with different goals and interested in the proper study of the history of mathematics, decided to travel abroad to pursue their graduate studies. Among the world's leading historians of mathematics, KENNETH O. MAY (1915–1977, **B**) greatly influenced the professionalization of the history of mathematics in Mexico. He did not visit Mexico, but like the Spaniard CID (RODRIGO DÍAZ DE VIVAR (ca. 1043–1099)) who, even after his death, won military battles, MAY inspired the Mexican community through his example to establish its first historical and philosophical journal (*Mathesis*) in 1985. His administrative and organizational skills also inspired others to establish the *Asociación para la Historia, Filosofía y Pedagogía de las Ciencias Matemáticas* (Association for the History, Philosophy, and Pedagogy of the Mathematical Sciences) and marks the final step in the successful professionalization of the discipline in Mexico. Today, historians represent one of the most productive and dynamic groups within the Mexican mathematical community. Although they remain a small group of scholars, they edit a highly respected research journal, and have organized several meetings of an international character. Undergraduate and graduate students take courses and develop dissertations in this area.

15.3.6 Conclusion

The mathematics department of the Faculty of Sciences, the Institute of Mathematics, and the Mexican Mathematical Society — all physically located at the *Universidad Nacional Autónoma de México* (1551) and main components in the process of professionalization of modern mathematics in Mexico — were founded, almost simultaneosly, between 1939 and 1943. Unfortunately, SOTERO PRIETO, who believed the history of mathematics should be a major component of the working knowledge of any mathematician, who guided the first generation of professional mathematicians, and who even lectured on historical topics, died just before this process of professionalization materialized. PRIETO's immediate followers and students did not share some of his basic principles. Consequently, the history of mathematics lost its most important driving force and initial momentum.

Interest in the history of mathematics, as well in philosophical and pedagogical concerns, fell well behind that of other branches of mathematics. In fact, in the mid 1970s, members of the *UNAM* staff proposed to eliminate these subjects from the curricula offered to students.

Nevertheless, by the mid 1980s, the first graduate students, professionally trained as historians of mathematics, returned to Mexico from abroad. As a consequence, over the next few years, and inspired by similar activities promoted by KENNETH O. MAY, these scholars offered undergraduate and graduate courses, launched a new research journal, and established the first society of its kind in Mexico for the history of mathematics.