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A Survey on the Background of the Study of the History of Modern Mathematics in Mexico

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§1. Introduction

1.1 The foundation and development of the Royal University. Mexico, as described in most modern history or geography textbooks or general encyclopedias, is a product of the XIX century. At this time, it had generally settled its territorial disputes with its neighbors, and its borders were permanent. Its first political constitution was drafted, establishing Mexico as an independent republic. Within its territory were the native lands of the indigenous cultures which were present before the conquest by the Spaniards (*e.g.*, the Olmec, Mayan and Aztec cultures, among others). The Spaniards themselves had ruled for 300 hundred years, from 1521 to 1821.

In 1551, the *Royal University of México (renamed the Royal and Pontifical University of Mexico in 1591)*, the second university on the American continent,[2] was founded. Two years later (1553), it officially opened its doors. The university campus, administration and programs were similar to those of the Spanish University of Salamanca. At the time it opened, the following professorships had already been established: theology, sacred scriptures, canon law, law, arts, grammar and decree law. Other 'chairs' (*e.g.*, medicine and moral theology, among others) were added over time.
Almost a hundred years later, the chair of 'astrology and mathematics' was established.[3] After yet another hundred years, in the second half of the XVIII century, the 'mathematics chair' was officially recognized in its own right. This event occurred during the debate provoked when the physician José Ignacio Bartolache (1739-1790) was tentatively appointed to the chair of 'astrology and mathematics'. Although some intellectuals in the New Spain, as Mexico was then known, were influenced by the recent developments in science and

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1. I have attempted to provide proper historical documentation for this paper. Unfortunately, the study of the history of mathematics has occurred so recently, and has directly involved myself and my colleagues, that it is impossible to back up all my assertions and to totally eliminate subjective and personal influences.
2. The founding of the Royal University stimulated the development of other schools of advanced studies (including, among others, 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).
3. Friar Diego Rodríguez (ca. 1596-1668) first held this chair, and taught mathematics to students of the faculty of medicine, where it was compulsory [Francisco Fernández. *La Facultad de Medicina*. México: UNAM. 1953. p 39].

mathematics in Europe,[1] their efforts to teach these new ideas were often impeded by the sacred inquisition. The inquisitors believed that it was their duty to suppress ideas that were contrary to their understanding of the Catholic faith. They banned an increasingly lengthy list of books, including works by Giordano Bruno, Galileo Galilei, Christian Wolf and Isaac Newton, among others.[2] A book could be added to the blacklist, if the inquisitors received an anonymous accusation implying that the book contained a statement that violated Catholic principles. In New Spain the ban was vigorously enforced. It would be difficult to assess, for example, the influence of Montucla's *History of Mathematics* on Mexican intellectual history; it was black listed in 1808, only four years after its arrived in the New World.

1.2 After Mexican independence. In the first two-thirds of the XIX century, the university suffered through several decades of turmoil. This was due, in large part, to the long lasting rivalry among liberal and conservative parties which tried to gain political control of the country, after the treaty of independence from Spain. At one point, the conservatives were able to impose rule by another foreign government; however Mexico regained its independence after the execution, on June 19, 1867, of the Austrian emperor Ferdinand Maximilian Joseph (1832-1867). To maintain political control of the country, the new liberal leaders sought to establish a durable and peaceful social order. Unlike the ideology of the sacred inquisition and Catholic clergy, the new leaders promoted a doctrine of freedom of conscience. This freedom of conscience included scientific, religious and political emancipation. Gabino Barreda (1818-1881), the spokesman of the new educational policy, had adapted the positivist thought of Auguste Comte (1789-1857) to support this doctrine.[3] The original positivist motto ('Love, Order and Progress') was later changed to 'Freedom, Order and Progress' (some years later, only 'Order and Progress' would be emphasized). The positivists planned to reform the whole Mexican educational system, emphasizing the exact and natural sciences. Disciplines associated with religion or theology were not given priority; some of these subjects were replaced by the study of experimental sciences. Nevertheless, it was easier to plan these idealistic reforms than to implement them. By the turn of the century, after approximately thirty-five years of dictatorship, progress in teaching and studying the natural sciences and technology (with a few exceptions, such as astronomy and mineralogy) had fallen well behind the standards of the developed countries.

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1. Friar Rodríguez had incorporated the work of Tartaglia, Cardano, Bombeli, Brahe, Copernicus and Kepler, among others, into his course(s) in mathematics and astrology.
2. The Inquisition had a positive, if unintended, consequence for modern historians. We now possess lists of some of the books that arrived from Europe during the colonial period. In their efforts to fulfill their duties, the inquisitors made detailed descriptions of the contents of books in some private libraries. Therefore, we not only know the authors of works available in Mexico at the time, but also the precise date that they arrived. See, for example: Fernández-del Castillo 1982, Moreno-Corral 1992 and O'Gorman 1939.
3. Zea's treatise [1968] is the most detailed and scholarly explanation of the origins, development and decline of the positivist doctrine in Mexico.

Paradoxically, some intellectuals had made use of 'scientific' arguments to provide theoretical and political justification for the reelection of Porfirio Díaz (1830-1915) to a fourth term in office. These thinkers, who had originally expressed their views in a newspaper entitled *Freedom* [*La Libertad*], became known as the 'scientific party'.

§2. The emergence of Modern Mathematics in Mexico (1910-1939)

2.1 The Establishment of the Modern National University. As might be expected, the university had, from the beginning, attracted people who were cultured, educated, and, sometimes, critical of government policy. On different occasions, the university was closed down because of political instability in Mexico. In 1910, when the country was still under the dictatorship of Díaz, a newly transformed National University reopened its doors.[1] Justo Sierra (1848-1912), one of the main advocates of the 'scientific party', had visualized the university as the most important cultural resource of the nation. New emphasis was given to the teaching and development of the sciences. *The National Preparatory School* [La Escuela Nacional Preparatoria], where students received instruction to qualify them for university, and the newly created *School of Advanced Studies* [Escuela de Altos Estudios] now offered specialized courses in biology, physics, chemistry and mathematics. In these schools, at least, academic conditions were favorable enough to promote the study and teaching of higher mathematics by interested faculty and students, and to allow for effective intellectual discourse. A partial list of staff includes Francisco Cárdenas, Ángel de la Peña, Juan Mansilla and Alfonso Nápoles. Perhaps, the most distinguished of them all was Sotero Prieto (1884-1935), who had been trained by his own father, an elementary school mathematics teacher. Some of Prieto's students recalled that he became a natural leader of the mathematics faculty and a well admired professor. He taught and delivered lectures on several branches of higher mathematics, and is credited with introducing cinematic geometry and the theory of relativity to Mexico [see, for example, Prieto 1921-1923].

2.2 The Foundation of the Faculty of Sciences. Between 1920 and 1940, changes in political and academic conditions resulted in dramatic changes in the perceived role and value of the mathematical sciences. By now, political spokesmen anticipated the modernization of Mexico through industrialization and the incorporation and application of new technologies. Emphasis was given to the study of engineering [see: Vasconcelos 1926]; mathematics was looked upon much more favorably than in the past because of its critical role in the engineering sciences.

Prieto was there, at the right place and the right time. He taught mathematics at the *National School of Engineers* [Escuela Nacional de Ingenieros], where he was able to unite a small but highly interested group of students who wished to pursue mathematical studies. In a relatively brief period of time, the status of this group was formally established and grew into a section of the faculty of philosophy. At that time, between 1931 and 1933,

1. *Cf.* Garciadiego 1991.

Prieto lectured on the history of mathematics [Prieto 1991]. Prieto's original lecture notes contained only the specific factual information that he needed for the lecture. No references or background information was given, nor was anything written about the origin, methodology, pedagogic goals and significance of the factual lecture material. In his notes, he constantly describes (in modern notation) problems that mathematicians were trying to solve, but he does not explain why those questions were important, why mathematicians were attempting to solve them, nor the methods available to attack them. Apparently, the lessons were prepared independently of each other, in the order that the lectures were presented.[1] These dry and unappealing notes are not consistent with reports of his students that suggest he delivered exciting, stimulating lectures.[2]

I suggested above that Prieto did not believe only in teaching historical facts[3] or that his students should merely memorize hundreds of names, dates and titles. As a discipline, history had a much deeper meaning for Prieto. He had read Giovanni Batista Vico (1668-1744) and believed that history played a major role in understanding culture. Real understanding involved comprehension of the way in which culture evolved. History not only consisted of factual data, but also of principles that could explain historical trends and human behavior. Although, some of Prieto's followers (*e.g.*, Agustín Anfosi, Carlos Graef and Francisco Zubieta) would eventually give lectures on topics in mathematical history, none of them seemed to have share either Prieto's interest in Vico's theories or in any other school of historical thought.

A few years later, in 1939, the Department of Mathematics was established in the faculty of sciences of the university, now called *National Autonomous University of Mexico* [Universidad Nacional Autónoma de México]. Unfortunately, Prieto had committed suicide by shooting himself in the head in 1935. But academic conditions in the country had improved immensely with respect to teaching and research in mathematics.[4] By this time, some well established professional mathematicians had visited Mexico and collaborated with their Mexican colleagues,[5] and more followed shortly thereafter.[6] Students who had studied abroad began to return, bringing new ideas and methods back with them. At about

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1. He originally planned to teach two year long courses, both lasting for two terms. In fact, the first course consisted of 71 lectures, that ran initially from October 1, 1931 to June 7, 1932 and then from July 19, 1932 to November 1, 1932. It covered mathematical history form the time of the Egyptians until the XVI century, including some material on mathematics in New Spain. The second history course consisted of 30 classes that ran through one term from February 14, 1933 to June 8, 1933 and covered parts of the XVII and XVIII centuries.
2. In fact, in a personal communication, Alberto Barajas, a former student of Prieto, has questioned the authenticity and authorship of the notes ascribed to Prieto.
3. "The history of a science clarifies the origins of its fundamental concepts and exhibits the evolution of its methods" [Prieto 1991, 1].
4. These changes were happening not only in mathematics, but in sciences such as physics, chemistry, and astronomy, and also in the humanities.
5. Dirk Struik, for example, visited Mexico for ten months in 1934, and a number of times thereafter. In 1976, apparently on his last visit, he delivered a set of six lectures on the history of mathematics.
6. The visits of George David Birkhoff, Garret Birkhoff, Solomon Lefschetz and Robert Wiener, among others, proved to be on immense value for the development of mathematics in Mexico in the present century.

the same time, the Institute of Mathematics (1942), and the *Mexican Mathematical Society* [Sociedad Matemática Mexicana] (1943) were founded.[1] There were other signs that the study of mathematics was developing in Mexico: a preliminary attempt to print a complete and logically sound edition of Euclid's *Elements* was made.[2] Soon, some mathematicians gained influence with major political figures, providing the profession with increased recognition. The other sciences were also becoming much more prominent at this time. By 1951, when the university celebrated its four hundredth birthday, the festivities included the organization of the *Mexican Scientific Congress* [Congreso Científico Mexicano]. The conference proceedings were eventually published in fifteen thick volumes containing more than five hundred articles. Some of the presentations focused on the history of mathematics and science.

The 'tower of sciences', located in the newly built university city (1954), housed most of the scientific institutes. This arrangement provided the opportunity for colleagues from different scientific disciplines to interact in a daily basis. Some of them were interested in issues which were common to all scientific disciplines. On February 21, 1955, Samuel Ramos (philosophy), Guillermo Haro (astronomy) and Eli de Gortari (logic) began a seminar entitled *Seminar on Scientific and Philosophical Problems* [Seminario de Problemas Científicos y Filosóficos]. Over a relatively short period of time, the seminar attracted 225 professors and researchers, some from abroad. Although not all of then were present at the same time, any of them were free to participate in the monthly meetings as he or she was able. Over the next few years, de Gortari was responsible for editing more than seventy four articles[3] and thirty three books.[4]

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1. The Federal government also supported the establishment of other major research and training institutions. President Lazaro Cárdenas, in his wish to assure comprehensive opportunities in higher education, created the *National Polytechnical School* [Instituto Politécnico Nacional, IPN]. This institution offered the bachelor degree in Physics and Mathematics which eventually became an alternative for the doctoral degree in mathematics. In 1943, some very prestigious intellectuals founded *El Colegio Nacional*. Members of the Spanish academic elite, while seeking refuge from the Spanish Civil War, created *El Colegio de México*, the most influential school of historical and social studies. In addition, the *Sociedad Mexicana de Historia Natural*, founded in 1936, used its official journal to effectively promote historical studies on scientific themes.
2. Unfortunately, this ahistorical bilingual (Greek-Spanish) edition was never completed. Published in two volumes (1944 and 1956), the editor translated only the first five books, logically reorganizing them according to modern standards. UNAM has recently reprinted the work (Euclid: *Elementos de Geometría*. Juan David García-Bacca, editor. México: UNAM. 2 vols. 1992), but there is nothing to suggest that the translation will ever be completed.
3. Including original contributions by his colleagues, translations of classical authors (Lobachevski, Pavlov and Planck, among others), as well as contemporary thinkers (*e.g.*, Jacques Hadamard, Alexander Alexandrov and Gordon Childe, to mention a few).
4. Some of these books included commentaries on the translated work of original authors, (*e.g.* William Harvey), contributions by colleagues (*e.g.*, García Bacca) and translations of the work of contemporary historians and philosophers of science (*e.g.*, John D. Bernal, Philip Frank, Maurice Frechet and Hans Reichenbach, among others).

2.3 The nightmare. The 1968 student movement. In mid 1968, a street fight between students of UNAM and the IPN, which initially seemed to be of little consequence and was quickly suppressed by the city police, escalated into one of the most important social and political events in the country in the second half of the XX century; it was surpassed only by the Mexican revolution (*ca.*, 1911-1920) in terms of its size and social consequences. The intellectual community, including UNAM and IPN students (who formed an alliance, after initially fighting each other) engaged in public rallies on the streets of Mexico City. They affiliated themselves with the same ideologies that motivated other student movements of the time, especially the one in France, the scene of student protests in May, 1968. The government (1964-1970) of Gustavo Díaz choose not to negotiate with the students. To end the conflict, the government brutally suppressed a mass meeting held in Tlaltelolco, the cradle of Mexican culture, on October 2, 1968. As a result of the altercation, the university (and the IPN) was seized by the Mexican army (violating its 'autonomous' character), forcing it to shut down once again. Many students and professors were illegally detained by the police and the army. De Gortari was one of the many people arrested; unfortunately, he was driving force behind the seminar on scientific and philosophical questions, which did not continue until many years later.

The university reopened its doors about a year later, but many students and professors did not regain their freedom immediately. Most of them were accused of various offenses under common law and lost their political status. Over the years, at irregular intervals, the government offered amnesty to most of them. Nevertheless, the damage had been done. The university had been transformed, socially, politically and ideologically. Many academics had lost their political innocence. To some extent, the university community became politically polarized. In general, those interested in philosophical or historical questions tended to hold left wing ideologies; others, usually well-established faculty members with traditional views regarded such ideology to be detrimental to the development of mathematics and science. At one point, these individuals started to oppose, both secretly and openly, attempts to promote the study of the history and philosophy of mathematics.

Yet another group, consisting mainly of younger members of the community (most of them students), became more critical of the role of science in and its application in society. But some students had different goals in mind; they were interested in the rigorous study of the history of mathematics. Some of them studied the discipline in foreign graduate schools. By chance, one of them studied under Kenneth O. May (1915-1977). Eventually, May would influence the professional development of the study of the history of mathematics in Mexico. May's influence lived on, even after his death, much like that of the Spaniard Cid (Rodrigo Díaz de Vivar, *ca* 1043-1099), who won military battles posthumously. The legacy of May's impressive administrative capacities played a role, in the mid 1980's, in the development of the Mexican academic community. This community founded the first historical and philosophical academic journal (*Mathesis*) and the first learned society [*Asociación para la Historia, Filosofía y Pedagogía de las Ciencias Matemáticas*] devoted to the study of the history, philosophy and pedagogy of mathematics.

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