Este programa internacional está dirigido por un equipo franco-brasileño de investigadores en Ciencias Humanas, Ciencias Sociales, Artes y Literatura. Su objetivo es la realización de una plataforma virtual de historia cultural transatlántica, editada en cuatro idiomas, y que analice las dinámicas del espacio atlántico para comprender su rol en el proceso de mundialización contemporánea. A través de una serie de ensayos sobre las relaciones culturales entre Europa, África y las Américas; el programa enfatiza la historia conectada del espacio atlántico desde el siglo XVIII.

Mathematics education in the nineteenth century: Europe, North Africa and the Americas

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América del Norte - América del Sur - Europa - África

Un Atlántico de vapor - Revoluciones atlánticas y colonialismo

An overview of the scholarly circulations of mathematics education between Europe (mainly France) and non-European territories (the Americas and North Africa) in the nineteenth century.

In this article, mathematics education refers to the content produced for intellectual or professional training, primarily within institutional frameworks of higher learning (colleges, engineering schools, universities), in arithmetic, algebra, geometry, calculus, trigonometry, analytical geometry, descriptive geometry and analytical mechanics. This categorization of the different fields of mathematical study is borrowed from a Nîmes professor, Joseph-Diaz Gergonne (1771-1859), which he formulated in the prospectus of his journal *Les Annales de mathématiques pures et appliquées*.

For most of the nineteenth century, international mathematics education transfers generally moved in one direction. The point of emission was Europe, specifically France, and the place of reception mainly the Americas and North Africa. England, Scotland and the German-speaking lands also exported mathematics education, the former mostly to the United States, especially before 1820, the latter to the Americas, primarily in the last quarter of the century, after German university reforms and works on analysis, but their contribution remained marginal during the period studied. In non-European territories, often far removed from the results and mathematical practices accumulated in Europe before 1800, the transformations of the discipline and its actors—individual, collective and institutional—led, by the end of the century, to the emergence of an education system unevenly structured depending on each country, but adapted to the needs of scientists, engineers and administrative executives. Throughout this century of change, the domestic processes of the production of frameworks and materials for mathematics education also depended on the circulation of knowledge, the scale of which went beyond individual countries.

Taking into account mathematical exchanges with France, the great scholarly power of the European continent at the beginning of the century, is a legitimate starting point. In the nineteenth century, France created a highly organized, hierarchical and selective system of instruction, supported by educational publishing under the direction of the post-revolutionary period's leading academics. The École polytechnique de Paris was founded in 1794, first to train army and civilian engineers within a single institution and, later, specialized engineers through related applied education institutions: École des mines (mining), École des ponts et chaussées (roads and bridges), etc. The school embodied the influence of academic power over the education of the elite. In the early nineteenth century, the École polytechnique tightened its control on French education, in particular because of the preparation for the entrance exam which was held in high schools (*lycées*). Created in 1802, they took over a secondary education system that had been stripped of its institutional structures since the closure of the revolutionary central schools and, before them, the *collèges* of the Ancien Régime. The system of competitive entrance examinations, which soon spread to other engineering and military schools that were unrelated to the École Polytechnique, required applicants to have a superior level of excellence in the core subject, mathematics, perceived as a universal language applicable to other areas of scientific knowledge. With the help of calculus, they led to the production of simple, general methods to support fields of inquiry in other sciences (astronomy, mechanics, fortifications, etc.) and train officials working in technical departments.

Transfer of structures for mathematics education

It did not take long for the French engineering school "system" to come to the notice of officials in the Americas and North Africa, where it became clear that infrastructure and the technicians required to build and maintain it were sorely needed. In the United States, the Army's stinging setbacks in the first months of the War of 1812 (1812-1815) demonstrated the inadequacy of officer training at West Point. In its earliest years (1802-1817), the academy also proved incapable of educating the civil engineers so badly needed as the country expanded westward. In the Republic of New Granada (present-day Colombia), the Colegio Militar in Bogota was founded at the express command of the general staff (1847), but the school also trained engineers to plan the young republic's major public works projects. Concerned with the need to educate both military and civilian engineers, non-European countries became aware of the technical and scientific superiority of France in particular, and the European powers in general. In the Mediterranean, Napoleon's Egyptian campaign accompanied by French scientists (1798-1801), the capture of Alexandria by England (1807) and of Algiers by France (1830), along with Russian and Austrian pressure on Istanbul, prompted Egyptians, Turks, Tunisians and Moroccans, whose scientific knowledge still dated back to the medieval Arabic texts, to take an interest in modern mathematics.

During the nineteenth century in the Americas and the Mediterranean, rising awareness of the need to train army officers and engineers and the State's technical cadres in mathematics led to the almost systematic foundation or reform of polytechnic or military schools patterned after French institutions. Many Latin American polytechnic schools in the French mold were founded in the nineteenth century. In 1810, the Real Academia de Guardas-Marinha and the Academia Real Militar da Corte, two military academies where mathematics had pride of place, opened in Rio de Janeiro. The Academia Real Militar soon became the cornerstone of an organized network of schools that trained army engineers patterned after France's higher education system. Also inspired by the École polytechnique in Paris, the academic program of the Colegio Militar y Escuela Politécnica in Bogota, the successor of the Colegio Militar, offered a higher level of mathematics and relied on French textbooks almost exclusively. In 1815, James Madison (1751-1836), the fourth president of the United States, sent US army officers Sylvanus Thayer (1785-1872) and William McRee (1787-1833) on a tour of military and engineering schools in Paris to gather information on their teaching methods, especially in the field of mathematics. They studied the academic programs, textbooks and cadets' routines at the École polytechnique, École des mines, École des ponts et chaussées and École d'application du corps des ingénieurs-géographes (the land surveyors and mapmaking school). Upon Thayer's return to the United States in 1817, Madison's successor, President James Monroe, put him in charge of reforming West Point. In the areas of governance, the organization of studies and the testing and evaluation of cadets, the military academy's transformation owed much to the École polytechnique in Paris, a debt acknowledged by a monument to the French engineering school that still stands on the campus.

The École polytechnique monument on the campus of West Point

The reform considerably increased the weight of mathematics (algebra, geometry and calculus) in the first two years and introduced a descriptive geometry course, as these disciplines were now indispensable for the study of mechanics, hydraulics, architecture and stereotomy. A journey to Europe by Franklin B. Greene (1817- 1895) also led to the reform of the Rensselaer Polytechnic Institute. Founded in Troy, New York, in 1824 to promote and disseminate science to future farmers and workers, the institute gradually became involved in engineering education and was the first American school to grant a civil engineering degree (1835). In 1848, Greene reformed the structure and content based on the École centrale des arts et manufactures de Paris and its specific training for industrial engineers. While North Americans crossed the Atlantic, a French expert was brought to Egypt to reform the Muhandiskhana, the school that trained the country's engineers at Būlāq, near Cairo. A follower of Saint-Simon and a graduate of the École Polytechnique, Charles Lambert (1804-1864) headed the institution from 1837 to 1850. His main goal was to provide the Egyptian government with civil engineers, especially to carry out the hydraulic and irrigation works on the plains of the Nile. Lambert's Saint-Simonian background led him to pattern the courses after those of the École centrale de Paris, which stressed practical knowledge useful to engineers. The courses were sent from Paris, but Lambert, as Greene did in Troy, increased the mathematics content.

Europeans also played a key role in creating and developing Tunisia's polytechnic school. In 1838, Ahmed I (1806-1855), the bey of Tunis, asked Luigi Calligaris (1808-1870), an Italian army colonel who had been living in Tunisia since 1831, to head the École militaire du Bardo to train army officers and administrative officials. By combining their teaching with military engineering courses, Calligaris made mathematics compulsory in the training of Tunisian engineers, as had been the case in European polytechnic schools since the early nineteenth century. In 1856, the school became the École de guerre du Bardo, now administered by French officers. Under the direction of Ernest de Taverne (1819-1861), the mathematics curriculum borrowed from French military schools and the courses were taught in French. The École d'ingénieurs in Fez, which opened in 1846 to train Morocco's civilian and military engineers, was based on French engineering schools. Pure mathematics—arithmetic and geometry—astronomy and ballistics dominated the curriculum. More broadly, during the period 1830-1870 the sciences in Morocco were modernized under the sultanates of Mawlây 'Abd al-rahmân (1778-1859) and his son Sîdî Muhammad (1830-1873), both flanked by the maverick Frenchman Joseph Desaulty (1808-1879), a former army officer who had converted to Islam and was very well versed in mathematics.

French engineering schools were an uncontestable source of inspiration and information for the curricula, overall organization and student evaluation and testing procedures at institutions of higher education providing engineering education in the Americas and North Africa. Above all, the reformers transferred the increasing importance of mathematics in curricula, revolving around two disciplines structuring the French programs: calculus and descriptive geometry. Differential and integral calculus and descriptive geometry allowed general methods to be produced and applied to research in other branches of science (astronomy, mechanics, fortifications, engineering) useful to engineers and officers. Differential and integral calculus as well as descriptive geometry were introduced to West Point in the early 1820s and the Colegio Militar in Bogota at the turn of the 1850s. With descriptive geometry, three-dimensional objects can be represented in two dimensions according to very specific rules, allowing engineers to measure, on paper, the constituent dimensions of a structure (a bridge, a building, a ship, etc.) inaccessible in reality. The "engineer's science," in the words of Gaspard Monge (1746-1818), gradually became part of the curricula of engineering schools outside France. In the United States, the discipline, known to fewer than a dozen men before the 1810s, was introduced by Claude Crozet (1789-1864), then an engineering professor at West Point. The teaching of descriptive geometry, integrated into military engineering courses, was almost immediately taken up by the regional military academies founded after the reform of West Point: the American Literary, Scientific and Military Academy (Norwich, Vermont, 1819), Virginia Military Institute (Lexington, Virginia, 1839), Military College of South Carolina (Charleston, South Carolina, 1842) and Delaware Military Academy (Wilmington, Delaware, 1859). There is also evidence that the subject was taught at the Academia Militar in Rio in 1812. But it was perhaps at the Muhandiskhana of Būlāq that descriptive geometry most ostensibly cemented the engineer\'s training. In 1837, it was taught to first-year students (as was already the case at the École polytechnique de Paris) before being applied to stone cutting, stereotomy and drawing gears.

However, the mathematization of curricula proved difficult in the areas concerned, since the average level of education was generally much lower than in France. Thus, in their attempts to transfer French structures and practices, local actors came up against, among other things, the central importance of mathematics, which future engineers in France already knew before entering technical institutionq. Standardized in France, the highly variable level of mathematics demonstrated by young Americans, Brazilians or Egyptians wishing to study engineering required, in most cases, a strengthening of theoretical courses (mainly mathematics) and a reorganization of practical ones. Thayer did not introduce a selective entrance exam at West Point, as was the case at the École Polytechnique in Paris. Consequently, most cadets could not immediately take advanced courses, especially in mathematics. The reform considerably increased the weight of mathematics during the first two years with basic courses in algebra and geometry, which were absent in Paris. At the Rensselaer Institute in Troy, Greene strengthened the teaching of mathematics because the heterogeneous levels of the incoming students. In 1864, Thomas Egleston (1832-1900), a graduate of both Yale and the École des mines in Paris, founded the School of Mines at Columbia College in 1864, the first school in the United States specifically devoted to mining and metallurgy. His intention was to import what he had learned in France. Many of the professors he hired had also studied at the École des mines. In the area of mathematics education, the transfer of this type of structure to the United States ran into the same problems as it did at West Point. The School of Mines admitted students who already had degrees from a university, military academy or technical institute. Admission was subject only to an interview in which applicants had to demonstrate their knowledge of algebra, geometry and plane trigonometry, a level far below that required from candidates to the École des Mines in France, who were graduates of the École Polytechnique. Thus, Egleston's curriculum for the training of future American mining engineers added a heavy dose of mathematics. In Egypt, the École centrale model was also largely adapted to specific local conditions. Students admitted to the Muhandiskhana had such a low level in mathematics that Lambert added remedial courses. The curricula of non-European engineering schools gradually expanded and, by the end of the century, rivaled those upon which they had been based.

Circulations of students

While sending students from the United States and North Africa to France for training in mathematics and, more generally science, was a new phenomenon in the nineteenth century, it followed a tradition that had already begun in the previous one in other fields (medicine, the arts, etc.). Most of them crossed the Atlantic and the Mediterranean to study at engineering or military schools. The records of Parisian institutions show that they came from many countries, especially Egypt and Brazil.

Over the period studied, the École Polytechnique was the only institution that did not issue diplomas or certificates to foreign students. Unlike the applied engineering schools, it did not create a specific status for foreign students. They were allowed to attend classes, but could not obtain a degree. Nevertheless, its excellent training and international standing attracted foreigners, most of whom were from Europe. American and Egyptian students were in the minority, but their presence was felt.

Before 1851, students at the École des ponts et chaussées who did not come from the École polytechnique were admitted as free auditors. They could not be granted the title of \"ingénieur des ponts et chaussées.\" By decree on October 13, 1851, foreigners were admitted as full-fledged students and their number increased significantly. The countries of the Americas and Africa sent foreign students to the École Centrale de Paris in even greater proportions.

It was common for foreign students to successively or jointly attend several European schools during their stays abroad. Egleston enrolled at the École des mines and the École polytechnique in the late 1850s. His fellow American Alphonse Feldpauche (1848-1915) graduated from the École professionnelle in Mulhouse before enrolling at the École centrale in 1842. Foreign students also attended provincial schools: a dozen Moroccans went to the Académie militaire in Montpellier between 1885 and 1888. In the 1860s, foreign students at the École des mines, who often spent just one or two years in Paris, completed their training at the Royal School of Mines of Saxony in Freiberg. Germany also absorbed part of the foreign student flow, which grew with the century and the new attractiveness of its universities. North Americans and Moroccans attended the mining school in Freiberg, Göttingen University and the Berlin Military Academy. Young foreigners also attended Parisian high schools. In 1881, eight students from the collège Sadiki in Tunis took mathematics courses at the Lycée Saint Louis. In 1831, the American Samuel Ward (1814-1884) studied science in Paris.

When students went back home, they turned their European education to good account. Some took up careers in industry, the army or teaching. Egleston founded the Columbia School of Mines based on the École des mines in Paris, which he had attended; the Moroccan students of Montpellier joined the army; and many Americans became mining, industrial or government-employed engineers. Numerous young foreigners who studied in French schools returned home to participate in the development of science, transportation and industry at a time when engineering schools and technical institutes were being founded in their countries, participating in the transfer of mathematical knowledge. In Paris, Samuel Ward met Sylvestre François-Lacroix (1765-1843) and Adrien-Marie Legendre (1752-1833), two mathematicians with whom he kept up a scientific correspondence while still a student at Columbia College. The young Ward sent the two Frenchmen a copy of issue 13 of *The Mathematical Diary*, a New York journal in which he published a problem that he wanted to submit to them. He also asked for and received copies of their works.

The relocalization of mathematics textbook publishing

Textbooks accompanied the transfer of new structures for mathematics education from France to the Americas and North Africa. Many foreign institutions needed course materials so desperately that French textbooks were initially imported and used in their original language by professors and students. In the United States, *Le Traité de mécanique céleste* by Pierre Simon de Laplace (1749-1827) was used at Columbia, for example. Thayer introduced *L'Essai de Géométrie analytique appliquée aux courbes et aux surfaces du second ordre* by Jean-Baptiste Biot (1774-1862) in mathematics courses at West Point, while Sylvestre-François Lacroix's *Traité élémentaire de calcul différentiel et intégral* is mentioned as a textbook for cadets. In Tunisia, the use of French textbooks is mostly explained by the control of French officers over the École de guerre du Bardo, where French was the official language for instruction in the sciences and students used, among other mathematical textbooks, Hudelot's *Traité de géométrie descriptive à l'usage des sous-officiers de toutes armes*. The power of the French administration over the school—and the country, which became a French protectorate in 1881—also explains the lack of translations into Arabic, except for *Cours de géométrie élémentaire* by Charles Marie Adrien Guilmin (1812-1884), published in 1880. After West Point and the Bardo were reformed, French became the second subject in the general curriculum to support the teaching of mathematics. The number of French books that the libraries of these two military academies had was remarkable for the time: nearly a thousand, including about a hundred works on mathematics at West Point and 200 at the Bardo. French textbooks were used not only by professors, who were often francophone, but also by their students, who were much less proficient in the language despite the intensive courses they took. Many commentators mentioned the urgent need for translations to ensure rigorous teaching and the transmission of knowledge, which led most institutions of higher learning in the Americas and North Africa to resort, directly or *in fine*, to translation.

These translations were perceived abroad as key to understanding the French education system and played a role in its international dissemination in the nineteenth century. A first example, the international editions of Adrien-Marie Legendre's *Éléments de géométrie*, helps to measure the extent of the phenomenon. The first edition came out in Paris in 1794, remained in print almost continuously for a century and left a lasting mark on the teaching of geometry in the United States, Brazil, Egypt and many other countries.

Dates	Contries
1802	Italy
1807	Spain
1809	Brazil
1810-1812	Greece
1819-1828-1829-1844-1849-1867	United States
1819	Russia
1822	England
1822	Germany
1826	Sweden
1829	Netherlands
1830	Switzerland
1836	Ottoman Empire
1839-1858	Egypt
1866	Colombia

Foreign editions of Legendre's *Éléments de géométrie* (different editions and authors in case of multiple dates)

French arithmetic, algebra, geometry, trigonometry, descriptive geometry and differential and integral calculus textbooks were translated in Egypt (1820-1880), the United States (1818-1870), Colombia (1860-1870) and Brazil (1810-1820). In the United States and Egypt, depending on the subject, French had a significant influence on the domestic edition.

In Egypt, the factors that influenced the reform of the Muhandiskhana under Lambert were not unrelated to the provenance of the teaching materials, which were translations of works by professors at the École centrale in Paris: *Le cours de géométrie descriptive* by Théodore Olivier (1793-1853), *Le cours complet de mathématiques* by Jean-Baptiste Bélanger (1790-1874), etc. But Egypt was an exception. Even for the course in descriptive geometry, a subject that began to have a massive presence in the curricula and the publishing market of secondary education in France from the 1820s onwards, translators made little use of the textbooks used in military or engineering schools. Most of the authors chosen wrote books for *lycées* (high schools) and specialized mathematics courses, i.e., the preparatory classes for the École Polytechnique entrance exam: Legendre (geometry), Sylvestre François-Lacroix (algebra, geometry and arithmetic) and Jean-Louis Boucharlat (1775-1848) for differential and integral calculus, polytechnic professors Louis Pierre Marie Bourdon (1779-1854), Charles Félix Augustin Leroy (1786-1854) and Louis Lefébure de Fourcy (1787-1869) for algebra, descriptive geometry and trigonometry, respectively, and Étienne Bézout (1730-1783), whose works, which came out slightly earlier, continued to be published and read. Their books were notable not only for the mathematical results they contain, but above all for their synthesis and exposition of scientific knowledge. They were not just sequences of juxtaposed knowledge: the authors envisioned the presentation, structure and transmission of the content.

While these books were translated into English to advance the reform of the institutions at which the translators themselves often taught, they did not remain confined to that purpose. The translation of a half-dozen textbooks by Bézout, Lacroix and Legendre at Harvard by Professor John Farrar (1779-1853) contributed to the modernization of the university's academic program between 1818 and 1824. In the following decade, they joined the curriculum of American colleges and West Point. At the Military Academy, a series of translations (Legendre, Biot, Bourdon) by Charles Davies (1798-1876), a professor of mathematics from 1823 to 1837, continued the Frenchification of the training of army engineers, and was taught in many colleges and high schools throughout the century. More generally, translation played a role in the dissemination of modern mathematics in various regions. Many école polytechnique alumni became professors at colleges or regional military schools, bringing with them the methods they had once been taught.

The case of the Virginia Military Institute attests to this ricochet movement, found above all in the Americas. Nicknamed the West Point of the South, the VMI was headed by Francis H. Smith (1812-1890), a West Point graduate (class of 1833). Smith was convinced that the methods Thayer had implemented on the banks of the Hudson worked. The translations of French authors (Legendre, Biot, Lefébure de Fourcy) that he did between 1840 and 1870 for his courses followed in the footsteps of his former teacher, Charles Davies. For his mathematics courses at the Académia Real Militar in Brazil, Francisco Cordeiro da Silva Torres Alvin (1775-1856) translated three textbooks by Lacroix, *Le Traité élémentaire d'arithmétique*, *Les Éléments d'algèbre* and the two-volume *Traité élémentaire de calcul différentiel et intégral*, in 1810, 1812 and 1812-1814, respectively, as well as *Géométrie descriptive* by Monge (1812). The academy used two other textbooks—*Elementos de geometria* and *Tratado de trigonometria* (1809)—adapted from Legendre by Manuel Ferreira de Araújo Guimarães (1777-1838), a professor of astronomy. These translations, combined with the place of mathematics in Rio's military academies, ensured the spread of the discipline after 1850, especially at the secondary school level. In other countries, French books were used as teaching material on the secondary school level to prepare students for a university education. The institutionalization of primary and secondary school education in the United States, which began in the 1830s with the creation of common schools and high schools, fueled the growth of the textbook market, especially during the second half of the century. French works were relied upon to meet rising demand. The first translations were adapted for young readers. Several French sources were compiled and aggregated in a single work. The practice of mathematics was rare in nineteenth-century Chile, where in 1826 engineer Charles Ambroise Lozier (1784-1864) reformed the Instituto Nacional, which since 1797 had been working to promote science based on the model of the French high school. The curriculum included authoritative works by French mathematicians, translated into Spanish within the institute: Lacroix (algebra), Biot (analytical geometry) and Leroy (descriptive geometry).

Like other teachers in the Americas and North Africa, Lozier encouraged the writing of original textbooks. Translations made up for the lack of domestic teaching materials, but their authors were aware of the need to develop an autonomous local publishing industry. Translations did not arrive in a cultural, linguistic and scientific vacuum. Translators, most of whom were natives, came into contact and had to deal with mathematical and educational traditions that were different in many ways, including the lexicon, mathematical syntax and symbolism, graphics, the use of figures, teaching methods and local readers' level of knowledge. While most of the time in the Islamic countries and the Americas the shift from French to the local language led to a translation that was, if not literal, at least close to the original, in some contexts the transfer of knowledge from one language to another resulted in a hybrid style where the most salient original teaching methods and content were preserved and adapted to domestic uses.

Despite their impact on educational reform at West Point, Harvard and many other institutions of higher learning in the United States, many of the translations published in that country came up against the expectations of a readership that had been shaped by over 150 years of British rule. British domination of education and science did not disappear when they left. In the 1810s, the market was monopolized by British textbooks, sometimes reprinted by American publishers. Printer-booksellers would often take a British textbook and republish it for American readers with few, if any, changes. Examples include *A Course of Mathematics* by Charles Hutton (1737-1823), a professor at the Royal Military Academy, Woolwich, published in London in 1798, which Robert Adrain (1775-1843), a professor at Columbia, adapted in an American version in 1812; a series of English works compiled by Harvard professor Samuel Webber (1759-1810) published in 1801; and *Elements of Geometry* by Scotsman John Playfair (1748-1819), republished in Philadelphia in 1806. British publishing totally dominated the American textbook market until the 1820s. In this context, French textbooks did not stand much of a chance of successfully competing with them without making some adjustments first. On the one hand, their theoretical mathematical level was much higher than that of local works. It was therefore necessary to comment on the thorniest passages in the paratext, as Nathaniel Bowditch (1773-1838) did in his translation of Laplace's *Traité de la mécanique celeste*; cut the most challenging proofs in the text (Timothy Walker, 1806-1856); edit out one-fifth of Legendre's *Élements de géométrie* in *Elements of Geometry with Practical Applications, for the Use of Schools* (1829); or add steps to difficult calculations and simplify proofs considered abstruse—in his adaptation of Gaspard Monge's *Géométrie descriptive* published in New York in 1821, Crozet multiplied examples and particular cases to give the reader a general rule. On the other hand, the confrontation on American territory between two pedagogical styles—English and French—led most authors to mix their features. Roughly speaking, deeply rooted national contexts of mathematics resulted in the production of textbooks with very different styles (content, methods, presentation) in France and Great Britain. On the northern side of the Channel, mathematics publishing stood apart in the late eighteenth century. In geometry, translations of Euclid by Scotsmen Robert Simson (1687-1768) and Playfair preceded a century in which the ancient Greek's position remained unchallenged for the teaching of geometry, whereas in France, geometry textbooks offered a more modern version of his work that was open to algebra and calculus (Legendre, Lacroix). Euclid also influenced algebra through English authors such as John Bonnycastle (1751-1821) and William Emerson (1701-1782). Lastly, in calculus, the English long remained faithful to the fluxions of Isaac Newton (1643-1727), while French mathematicians and professors favorably received and disseminated the differentials of Gottfried Wilhelm Leibniz (1646-1716). American translator Charles Davies built his successful author's career by adapting famous French textbooks (Lacroix, Legendre, Biot, etc.) but glossed over their most radically new aspects to make them look like domestic works of British origin. In Davies' wake, other authors in the United States combined English and French methods, including Elias Loomis (1811-1889), a professor at New York University, Edward C. Ross (1800-1851), an assistant professor at West Point, and Charles Hackley (1809-1861), also at New York University.

In some contexts, content and pedagogical methods were adapted, but language could also be significantly changed. In Egypt, that was the main mission of the office of mathematical translations headed by Muhammad Bayyûmî (1810-ca. 1852), who graduated from the École polytechnique in Paris. While specialized translation became a profession with the foundation of the School of Languages, the office took charge of creating a scientific Arabic language adapted to scientific developments, with the development of new notations and a specific lexicon. For the latter, translators used the vernacular language, which has appropriate terms inherited from the mathematical history of Islamic countries, and coined neologisms when necessary, but rarely kept the French terminology. While less translation activity occurred in Morocco, notably because the works remained handwritten—printing did not develop in that country until the second half of the nineteenth century—hybridization processes were also at work there. The unknown translator of Lacroix's *Traité de trigonométrie et d'application de l'algèbre à la géométrie* colored and amended the original by adding praise to God, inserting an explanatory introduction to new terms and putting figures throughout the text instead of grouping them together in plates at the end of the book.

Bolstered by a thriving textbook publishing trade, French mathematical education seems to have been influential during most of the century. However, in the wake of historiography calling the "diffusion model" of the international transmission of knowledge into question, the discovery of complex adaptation processes of French mathematical teaching refutes the existence of an exogenous and homogeneous extra-European catching up. Moreover, return circulations—marginal before 1900—developed in the twentieth century. They attest to the autonomous production of knowledge and original scholarship in the Americas and North Africa, capable in turn of capturing the interest of professors and students in Europe.

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