

1. Kennedy [1980] 2006 apparently did not research Peano's middle-school studies.
 - a. Both Peano and Pieri attended middle school in cities with universities, moderately distant from where their families lived. Peano lived with an uncle in Turin; Pieri, with his elder brother in Bologna.
 - b. Here is Pieri's curriculum, at a technical institute:

Italian..... 4 years
French, German..... 3 years each
Social studies (geography, history,
 economics, ethics)..... two courses each year for 4 years
Mathematics and design courses,
 sometimes two or more at once..... 4 years
Physics..... 2 years
Chemistry and natural history..... 1 year each

The science courses were all in the last two years.
 - c. Peano's curriculum, at a liceo, would have been similar, probably with less science and mathematics, but with Latin and/or Greek every year.
 - d. Each would have had to compete for financial support; both succeeded.
2. We're about to follow Peano's entry as a student into the University of Turin. To set the scene, I'd like to summarize the organization of the academic world that he was entering. During the early and mid-1800s, some Italian universities, particularly Turin, were imitating the developments in France and Germany. It's best, then, to consider those first. This was a period of tremendous growth in mathematical knowledge and study on the Continent. The same is true of other disciplines, I suppose, but I'm not expert enough to comment on them.
3. *French and German universities*
 - a. You've witnessed the founding of the French academy of sciences and the flourishing of French mathematics in that atmosphere. You've seen how the Prussians slavishly imitated the French, establishing the Prussian academy, where Euler and Lagrange would work.
 - b. Struik, in sections 8.1–8.3, will note that the industrial revolution brought widespread social changes on the Continent. The effect of those changes on mathematical development is apparent.
 - c. Struik also pointed out that England was industrializing during the 18th century, before the French revolution, but was in the mathematical doldrums. Therefore industrialization by itself does not account for the enormous growth of mathematical activity on the Continent in the 19th century. There have been some historical studies of the reasons for this growth—in particular by Marxist historians in Eastern Europe—but I haven't studied this in detail. I don't think such studies are well known.
 - d. L'École Polytechnique and l'École Normale Supérieure were founded about 1794 in Paris during the French Revolution, to train soldiers and military and

- civil engineers, and to train teachers, respectively. As emperor, Napoleon (1769–1821) greatly extended their influence.
- e. Early faculty members of these French universities achieved major advances in mathematics: for example, Fourier, Lagrange, Laplace, Legendre, and Monge. Some of their early students became professors there and continued and amplified their work: for example, Cauchy and Poncelet. The Paris universities became the center of mathematical development in France, supplanting the academy. Starting around this time mathematicians started to specialize.
 - f. By the early 1800s, the Prussian Alexander von Humboldt (1769–1859) was making grand explorations of the Americas and studying their natural phenomena in great detail. On his return to Europe, he settled in *France* for many years because its environment best supported his work. There he received great accolades and prestige. For a biographical sketch published by Humboldt State University in Arcata, with portrait, [click here](#). For glimpses of one of his books, [click here](#). (That page was a bookseller's: they priced the book at about \$25,000.)
 - g. Napoleon conquered or reduced to satellite status most of Germany and Italy. Although his reign was short (1799–1815), his influence, inside and outside France, was enormous. In particular, the Scuola Reale Normale Superiore, founded in 1810 in Pisa, was founded as a branch of L'École Normale Supérieure. [Click here](#) for a photograph of the Scuola. Other governmental institutions in northern Italy, ruled to a large extent by France during those years, were reformed according to the French model.
 - h. After Napoleon, Alexander's brother Wilhelm (1767–1835) became Prussian minister of education, and played a major role in Prussia's effort to attain cultural and industrial equity with France. For a biographical sketch, with portrait, courtesy of Wikipedia, [click here](#). When Prussia had progressed well along that path, Alexander returned, and published his last works there.
 - i. Associated with Wilhelm von Humboldt was August Crelle (1780–1855), originally trained as a civil engineer, who pursued mathematics almost as an amateur. He worked for the Prussian government, first in the interior ministry, then in the education ministry. He spearheaded a major government effort to enhance the Prussian universities, and foster scientific research. [Click here](#) for a portrait of Crelle. German mathematics research took off after the 1820s, first in Berlin, then at other universities.
 - j. Throughout Europe, development of mathematics shifted from research academies to universities. But even though industrialization characterized this period, mathematics did *not* take on a more utilitarian aspect. If anything, the prestige of pure mathematics heightened. Applications broadened, no longer exclusively emphasizing mechanics and astronomy.
 - k. Because the universities in France, Germany, and Italy, were completely controlled by the national governments, government educational policies were

more effective than what you're used to thinking about in today's United States.

4. *Universities in other countries*

- a. As noted, some Italian universities started in the 1800s in imitation of the French. As German universities achieved parity, the Italians began adopting their practices, too.
- b. English universities were organized very differently.
- c. Universities in the United States were not comparable until the late 1800s. Before his 1869 appointment as president of Harvard, Charles William Eliot (1834–1926) had made a deep study of European higher education, and began implementing that pattern here during his forty years as president. In 1892, the University of Chicago was founded along European lines; its mathematics department was partly staffed by recruits from Germany.

5. *Organization of Italian universities in the late 1800s.*

- a. Almost all universities in Italy were financed and run by the government. The few private ones were tiny, and have not played any role in the events I've been researching for the last few years.
- b. A university must have had a small permanent managerial staff, but the top executive was the *rector*, elected from the faculty for a term of several years. Reelection was possible but rare.
- c. Each university was divided into several *faculties*, such as mathematical-physical sciences, law, medicine, engineering. Each faculty elected one of their members as *president* for a term of a year or two. Re-election was possible but not common.
- d. The faculty funds supported *chairs* in the various disciplines. There would not be a mathematics department, but chairs of infinitesimal analysis, algebraic analysis, projective and descriptive geometry, higher geometry, mathematics for teacher-training, mechanics, experimental physics, geodesy, astronomy, etc.
- e. A professor who held a chair was responsible for getting the job done in that area: teaching certain courses (usually two at a time), supervising the laboratories, administering examinations, supervising research students, doing research, publishing papers and books, handling editorial business for journals, and evaluating candidates for similar positions all over Italy. If he would go on leave for research elsewhere or for illness, he would usually secure his own replacement.
- f. A professor generally had an *assistant* to help with all those professional tasks. Assistants were generally younger researchers entering the arena of competition for the chairs as they became vacant.
- g. There was a mandatory retirement age, somewhere in the 70s, I think. When a professor retired, resigned, or died, the chair became vacant, often for more than a year, while a competition or negotiation with the government was held to determine a successor.

- h. Professors often assumed the duties of a vacant chair in addition to those of their own, to get more pay, or simply assure the quality of instruction in a related area.
 - i. The (usually several) candidates for a permanent chair presented published materials and testimonials to a committee of five professors chosen nationwide by the government. The committee usually met in Rome.
 - j. A similar process was required for advancement from the lower professorial rank, *professore straordinario*, to the higher rank, *professore ordinario*. (The analogous German titles are *Professor extraordinarius* and *ordinarius*.)
 - k. Italian universities differed greatly in desirability, so as soon as they were appointed, professors often began competing for better positions elsewhere.
6. *The student population*. A student asked, were the students in Italian universities in 1880 all upper class?
- a. No: Peano was the son of a farmer who owned and worked his land.
 - b. Pieri's father was a lawyer, much interested in local history. Pieri was one of eight children. Their family had one live-in domestic servant in Lucca. The small amount of family information I have seen refers frequently to lack of finances.
 - c. In researching the many academics whose lives touched Pieri's, I found surprisingly few from noble families. A few more from wealthy merchants. But just as many from impoverished families.
 - d. *Women*. Women began to earn doctorates in Germany around 1890, and in Italy around 1900. Peano and Pieri were among the first Italian professors to supervise women doctoral students.