Philosophia Scientiæ

Travaux d'histoire et de philosophie des sciences

24-1 | 2020

Les mathématiques dans les écoles militaires (XVIIIe-XIXe siècles)

Mathematical manoeuvres. The Changing Role of the Dutch Military Academy in Mathematics, 1828-1870

Danny Beckers

Electronic version

URL: <http://journals.openedition.org/philosophiascientiae/2216>

DOI: 10.4000/philosophiascientiae.2216

ISSN: 1775-4283

Publisher

Éditions Kimé

Printed version

Date of publication: 1 March 2020

Number of pages: 159-177

ISSN: 1281-2463

Electronic reference

Danny Beckers, "Mathematical manoeuvres. The Changing Role of the Dutch Military Academy in Mathematics, 1828-1870", *Philosophia Scientiæ* [Online], 24-1 | 2020, Online since 01 January 2021, connection on 31 March 2021. URL: <http://journals.openedition.org/philosophiascientiae/2216> ; DOI: <https://doi.org/10.4000/philosophiascientiae.2216>

Tous droits réservés

Mathematical manoeuvres. The Changing Role of the Dutch Military Academy in Mathematics, 1828-1870

Danny Beckers

Vrije Universiteit Amsterdam (The Netherlands)

Résumé : Le rôle des mathématiques dans la formation des officiers de l'armée néerlandaise, a profondément changé pendant le premier XIX^e siècle avec la fondation de l'Académie militaire en 1828. Les mathématiques étaient au centre de la formation. L'Académie était un des lieux les plus importants de diffusion des connaissances mathématiques aux Pays-Bas pendant la première moitié du XIX^e siècle, mais elle a perdu ce rôle pendant les années 1860-1870. Dans cet article, je me propose d'examiner à la fois les programmes de l'Académie et le rôle central des enseignants de mathématiques de l'Académie dans la Société Mathématique néerlandaise et dans l'Académie royale des Sciences. Par ailleurs, l'évolution des mathématiques, visible dans ces deux institutions dans les années 1850, n'a pas entraîné une adaptation des programmes au sein de l'Académie. Ainsi, à partir de 1870, l'Académie a presque complètement disparu de la vie mathématique des Pays-Bas.

Abstract: The role of mathematics in the education of Dutch army officers changed dramatically in the early 19th century. This shift became visible with the founding of the Dutch Royal Military Academy in 1828, which shows the role of mathematics in military education shifting toward a purely pedagogical function. This change in approach, which primarily occurred in 1860's, affected the standing and perception of an academy once highly respected in the field of mathematics. In the present work, I examine both the curricula at the Academy and the crucial role of the Academy's mathematics instructors in the Dutch Mathematical Society and the Royal Academy of Sciences. Importantly, these two institutions managed to successfully adapt to the changing character of mathematical sciences that occurred around 1850. Mathematicians at the Royal Military Academy, however, appeared to cling to an outdated view of mathematics. Failing to update their approach ultimately caused the Academy to lose its once prominent place in the Dutch mathematical community.

1 Introduction

Starting around 1800, mathematics went through a process of purification that would last the entire century—and arguably longer. The new, purified ideas about mathematics changed curricula at universities and secondary schools, and would continue to develop the once diverse field of mathematical sciences to deepen into the view of pure mathematics founded in logic instead of reality [Alberts 1998], [Gray 2008]. This process, which initially took the form of describing reality in a more general way, has been described in detail as essentially an academic endeavor [Pycior 1981], [Beckers 2001a], [Bullyncx 2006], for its pedagogical merits [Beckers 2003], [Bullyncx 2008] as well as from a political perspective [Barany 2011]. This new mathematics would begin playing a role in technical education—military education in particular. The aim of this paper is to show how this new mathematics corresponded to principles underlying military education in The Netherlands during the early nineteenth century. Mathematicians would renegotiate the purification of their field up to (and beyond) the point where the essence of mathematical proof was to provide absolute certainty, without any reference to reality—be it in an abstract arithmetical or in a logical frame [Ferreirós 2007], [Gray 2004]. By the 1870s, mathematics had changed to such a degree that it no longer corresponded to the needs of Dutch military training: the military remained steadfastly attached to an early nineteenth century conception of mathematics, whereas mathematics had, by then, evolved further.

The new mathematics of 1800 naturally had a place in both military and technical education. But while it was recognized that navigators and surveyors needed some mathematical expertise, for all other roles within the military, most notably the officer ranks, mathematical knowledge would not be made a prerequisite before 1828. Within both the Navy [Davids 1990] and the Mercantile Marine [Davids 1991], mathematically trained scientists and engineers endeavored to claim expertise or specialization, but only succeeded in the late nineteenth century [Verbong 1993]. The growing prominence of the profession merging mathematical and engineering training has been described as a sociological process of professionalization of engineers [Lintsen 1980], and as a political process of rising technocracy, intertwined with the growing need of academics to make themselves useful [Lintsen & Vermij 2002]. It has also been described from the viewpoint of the changing role of mathematics in Dutch culture. Technical educational institutions began introducing the new mathematics early in the 19th century because the language was convenient, or because of its (alleged) educational benefits: students who knew their mathematics would be able to read and produce accurate technical drawings, assess technical data, recognize possible improvements on technical appliances and would in general be better in sound reasoning. The mathematically trained newcomers would contest their practically trained contemporaries by cleverly wrought arguments. Likewise, however, practiced experts would not take

their mathematical adversaries seriously: they claimed expertise in their field, stating that mathematics could potentially serve the context or “comfortable surroundings” of the study, but offered little in practice—which obviously counted, and which they represented and had been representing for ages [Beckers 2003, 95–102].

While the Dutch navy was actively experimenting with steam engines during the period 1825–1850 [Dirkzwager 1992], and provided key technical expertise for major ship building from 1825–1875 [Dirkzwager 1993], work in these two endeavors was done by people in the field, people of practice. There were no mathematicians, or mathematically educated engineers, involved. Similarly, their work sparked very little interest from mathematicians at the time. This dynamic was even more evident in the field of artillery: guns were handmade by those who had practical knowledge of their construction, maintenance and who would be most likely to use them. This remained the case throughout most of the nineteenth century up to the 1880’s, when indeed, theory caught up with practice thanks to the development of series production of large guns and ammunition. It was at this point that involving civil engineers with theoretical training in mathematics became almost a prerequisite to successful innovation [Verbong 1993], [Lintsen & Vermij 2002].

In this paper I will track the changes in mathematics curricula and the status, among mathematicians, of the mathematics professors at the Dutch Military Academy, thereby illustrating that military education was of great importance for the spread of mathematical knowledge in The Netherlands during the first half of the 19th century. I will begin by providing some background of how Dutch (military) education was structured during this period, then discuss how mathematics was defined within the Dutch Mathematical Society and the Royal Academy of Sciences, which ultimately served as the basis for the mathematics curriculum in Dutch military education and guided the role of the mathematics instructors of the Military Academy within the aforementioned institutes. Finally, I will show how the Military Academy lost its once pivotal role disseminating mathematical knowledge in the 1860s—and indeed, how Dutch mathematics effectively estranged itself from military education.

2 Military education in The Netherlands— an outline

The Dutch Republic has existed since the end of the sixteenth century and has known periods of great wealth. After gaining independence from the Spanish Crown, the Dutch proceeded to building an extensive empire based largely on trade concessions. By the eighteenth century, mainly due to the rise of France and England, the economy and political power had dwindled to more modest levels in line with a small European state.

The Republic was predominately ruled by wealthy families who yielded their power from within the prominent cities. The Dutch nobility had relatively little political influence, with the notable exception of the family of Nassau Siegen, princes of Orange (in title, not in fact), who managed to secure a position as stadholder, which effectively amounted to the head of the army. This family managed to maintain this role, but only did so by calling on the cooperation of the governing bodies of the cities.

The arrival of French troops during the revolutionary wars in 1795 triggered several regime changes that would only stabilize under the reign of King Louis Napoleon (1806-1810). In 1810 the country was declared an official part of the French empire by Napoleon Bonaparte, until in 1814 King William I of Orange (son of stadholder William V), who had fled the country in 1795, took the throne. His kingdom had been expanded to include Belgium. In a revolt in 1830, the Belgians gained independence from the Dutch kingdom aided by French troops. A parliamentary democracy was finally established in The Netherlands in 1848.

Within the Dutch Kingdom, William I worked from 1814 onwards towards building a nation state. One of the means he deployed to achieve this was by utilizing education. A state regulated and controlled system of primary education was founded, building on what had started during previous years and substituting (effectively eliminating) the eighteenth century locally funded school system. Within these schools, the Dutch language and knowledge of arithmetic, as well as national history and the newly adopted metric system, was used to standardize knowledge in the kingdom [Lenders 1988]. At the same time a system of state funded higher education was developed. This system was designed to secure the flow of higher state administrative personnel and consisted of gymnasias (12 to 16 years old) and universities. Three state universities were founded as well. The University of Leyden, the King's favorite, received the most funding and remains to this day the university where the royal family is educated [Smid 1997].

Education for the middle classes, skilled laborers, merchants and technicians was not provided for by the government in 1814. This was left to free enterprise. In 1863, secondary education for this population was made available through legislation drafted with the founding of the so-called *hogere burgerscholen*. While in practice, there was quite some continuity between private institutions and these new schools, this did create new career perspectives for mathematics and physics graduates resulting in an increased number of students studying mathematics [Smid 2006].

One important career path for this middle group during the first half of the nineteenth century was to enter the military, which necessarily required military education. Indeed, some of the private schools—as well as the later *hogere burgerscholen*—presented themselves as suitable preparatory environments for the exams required to enter the Kingdom's military schools. A polytechnic institution was established in Delft in 1843, but would not

receive solid financial backing until 1864 when it was formally re-established as the Polytechnic School. Military engineers were favored in many ways and were often prioritized for hiring before civil engineers [Lintsen 1994, 112–115]. Engineers educated within polytechnic education from the very beginning strove for recognition. Polytechnic schools would eventually succeed in drawing more students from state funded secondary schools (once established in 1863), which gained recognition for the profession of engineering technicians [Lintsen 1994, 128–144], [Krüger 2014].

3 General Johan Voet as a proponent of a new curriculum

Military training before 1815 took place in several institutes in the Dutch provinces. Much of the curriculum was voluntary. One could, for example, take classes at one of the Dutch universities, where professors in mathematical sciences would present courses in fortress building, navigation and surveying (among other subjects) from the seventeenth century onwards [Dopper 2014]. Although these courses could contribute to the standing of the officer, there were no formal mathematical requirements of the officers, so attendance was not obligatory. Course curricula depended heavily on capable teachers but the university board did not always bother to attract these teachers [Krüger 2014, 25–97].

One of the men who would change that situation was Johan Voet (1758–1832). Voet was in charge of one of the republic's first military schools established in Zutphen (1789). This particular school offered training to officers, but notably was not attached to a university. Voet would continue to head several military educational institutions throughout the period of the French Revolution and the reign of Louis Napoleon, and was, after the occupation by Napoleon, reinstalled by King William I of Orange, as directing commander of the Infantry and Artillery School founded at Delft in 1815 [Janssen 1989].

Voet was known for being in favor of a more compulsory curriculum which included mathematics courses. His view on mathematics was decidedly practical—much in line with how mathematical sciences were viewed throughout the 18th century. He favored textbooks that introduced some fixed rules for future military commanders. This is perhaps best illustrated by considering specific texts that were used for mathematics education in these institutes. For example: the officers of the gunmen in the 1806 textbook by Lieutenant L. vander Muelen (fl. 1789–1807), one of the teachers of the marine cadets, had to be able to calculate the number of projectiles in a heap of given stacking, after having counted, for example, the number of projectiles in the square basis of a stack. Several rules were established that needed to be followed depending on the way the pile was stacked. At the end of his

book, Van der Muelen provides algebraical explanations for how these rules worked [van der Muelen 1806, 138–158], but that was only for the interested reader and not compulsory.

What was made part of the curriculum was a description of several types of canons using words like “cylinder” and “cone-like” [van der Muelen 1807, 10]. Most notably, Van der Muelen mentions that all elegant theories about aiming with guns had one thing in common: they didn’t work in practice. He advises the officers to actually observe a gunner using his canon [van der Muelen 1806, 114]. Having a good gunner meant having an experienced man around 1800. This statement remained true until the end of the nineteenth century, when the advent of the conveyor belt and new precision production techniques would allow for mass production of weaponry. It was only then that theoretical predictions about trajectories would be viewed as more reliable than the gunmen’s “practically educated” guess [Aubin 2014, 314–322].

One may ask whether the texts by Van der Muelen were actually mathematical texts. This involves asking a key question: what was mathematics about? In the Dutch case, turning to two prominent institutions during this time is essential: the Dutch Mathematical Society and the Dutch Royal Academy of Sciences.

4 What did the Dutch think that mathematics was about?

General Voet, together with one of the other high-ranking officers, Ulrich Huguenin (1755–1833), was elected in 1815 as an honorary member of the Dutch Mathematical Society. This society was initially founded in 1778 by laymen with a vested interest as their work essentially involved mathematics. The argument presented to members was that mathematical knowledge would improve Dutch commerce and industry. Most of them could attest to that fact as witnessed in their daily lives as merchants, teachers, surveyors, and bookkeepers. Artillery—as presented by Van der Muelen at the military schools—was represented as being mathematics. Electing Voet as an honorary member was part of a new policy by the Society that, at the time, was striving for more political power to influence educational policy within the new kingdom. Their ultimate goal was to push for more mathematics—whatever they thought that was—as a compulsory component of the curricula that served as a base for publicly funded education. Military officers were considered as natural allies in this endeavor [Beckers 2001b].

This Mathematical Society was linked to a certain extent to the Military Academy given that many of those directly involved in military training were also members: Voet was among the first, but he would not be the last. What Voet did not realize was that within the Society there were two factions at

work. The most visible at the time was the group who held a more practical view of mathematics within the broader field of mathematical sciences—the one that Voet also would have subscribed to. Another group, however, believed that the core of mathematical knowledge was about understanding theorems and proofs—who regarded the essence of mathematics to be purely theoretical. They regarded mathematics as an ideal way of becoming a good citizen: either in a meritocratic, or a more exalted way—mathematics could make you a better person. Not only should mathematics, according to this group, be a compulsory subject in all forms of education, mathematics should be presented as a sensible abstraction of reality, one that could be used to derive all rules of thumb which were considered to be mathematics according to other Society members. Presented in this way, mathematics offered a perfect means of sound reasoning, from axioms and definitions, which were considered to be obvious truths that formed the foundation of, or were derived from, Creation. They were thinking about the new mathematics as referred to at the beginning of this paper.

Not only did this group succeed in making their ideas of mathematics more generally accepted, thereby changing the character of the mathematical society [Beckers 2001b], they even gradually moved on to become a research mathematics oriented society by the 1870s—thereby trying to find common ground with a new rising academic ideal of mathematics as the purest form of sound reasoning on an international level. In this conception of mathematics, the obvious truths were no longer necessarily sensible abstractions from Creation but were more or less chosen at will. The Society's success, despite its small academic base, may be illustrated by the fact that in the 1890s it managed to publish the review journal *Revue semestrielle des publications mathématiques*, which, if only for a few decades, brought the Society international renown [Alberts & Beckers 2010].

The Royal Institute, founded in 1808 and later renamed as the Royal Academy of Sciences, might also help to grasp the importance of new mathematics. This institution was essentially modeled on the royal academies of Paris, London, St. Petersburg and Berlin. It was founded by King Louis Napoleon first and foremost for the purpose of providing scientific advice at the request of the Crown. At the start, the mathematical department of the Academy would advise the King in matters pertaining to dikes, polders, and the metric system, which was in line with the broad eighteenth century conception of the mathematical sciences. William I liked the idea of a scientific institute attached directly to the Crown, so much so that he continued to support the Institute and used it as an instrument in his nation building schemes [Gerritsen 1997]. Recruited from the prestigious institutes, but not necessarily all academics, members of the Royal Academy during the first half of the nineteenth century would be encouraged to subscribe to a practical view of science—of mathematics in particular. However, by the 1870s the members of the Academy leaned more and more toward treating practical questions issued from the government as starting points for theoretical inquiries.

Although they were very much aware of their double role in this scenario, the members of the Royal Academy at this time came almost exclusively from the academic community and, as such, typically tended to subscribe to an academic research agenda [van Lunteren 2004], and therefore were also inclined to treat mathematics from the perspective of purely academic interest.

To summarize, mathematics in the early 19th century carried more practical connotations. That said, this notion began to shift within both the Mathematical Society and the Royal Academy of Sciences. The Mathematical Society, for example, started placing greater interest on the pedagogical value of this new conception of mathematics [Beckers 2001b]. In the 1870's the Society would evolve further to become more academic in its mission and would make greater efforts to stay in step with international views on pure mathematics [Alberts & Beckers 2010]. The role of mathematics at the Royal Academy would also become more fundamental. Although slowly, and without the pedagogical sidestep, the view of mathematics by the members of the Academy moved towards purified mathematics. Through the contributions of the Academy it becomes evident that mathematics became the fundamental language of physics, expressing its theoretical framework that could be verified experimentally [van Lunteren 2004].

5 The artillery school at Delft

In 1814 the newly appointed King of The Netherlands, William I, decided to establish a Military Academy, as all the other kings in the world appeared to have such an institute. Thereby, he effectively sanctioned plans that had been taking shape within the military since 1789, when the aforementioned Huguenin, Voet and Van der Muelen were actively involved in military education. Indeed, one could argue that artillery schools had been around since the 1780s, but that is not relevant for the topic of this paper. What is relevant is that the King specifically appointed Voet as the director of studies, and through this decision opted for someone he knew, was in favor of some form of (practical) mathematical training. Moreover, he made sure that a number of civilian professors were available to teach the young cadets to become proper commanding officers [Janssen 1989].

Among the first civilian professors in mathematics at the military school in Delft was Jacob De Gelder (1765-1848). As a self-taught mathematician, teacher and surveyor he was also a member of the Mathematical Society—and, in fact, the one who suggested that the board of the Society invite Voet to become an honorary member. Within the Mathematical Society, De Gelder represented a more modern view of mathematics, which became more clear in the early part of the 19th century when he published several textbooks on arithmetic, analytic geometry, algebra and plane geometry [de Gelder 1806, 1808-1809, 1811-1813*b*,-, 1816] in which he addressed “abstract”

theory: starting from definitions and axioms, that were sensible abstractions from reality, he offered theorems and proofs as a logical basis for building a purely mathematical theory. In his textbooks De Gelder offered problems (exercises) from various fields of knowledge, not only to make sure that the pupils understood the theory, but moreover to show that there were so many applications that it would be highly beneficial to learn more! De Gelder was convinced that mathematics represented a perfect theory of abstract quantity, the quantities being sensible abstractions from reality. More mathematical knowledge would, according to him, be beneficial to understanding and using practical applications [Beckers 1996, 2003].

De Gelder was perhaps overly ambitious in his plans for the mathematics curriculum at the military school, and was soon disappointed by the fact that his students didn't meet up to his expectations. The students varied considerably in their abilities. Moreover, he concluded, not all students were devoted to studying, which was further compounded by the fact that students would typically live somewhere in the city of Delft. Instead of taking it up with commander Voet, who proved less responsive than he had hoped, he wrote directly to the King, pleading for a revision of the military school: in essence he suggested a curriculum that, naturally, involved more mathematics, but also proposed that the students be housed on the school grounds and further, suggested changing the admission procedure to include an entrance exam. This action led to a row between De Gelder and Voet. In the end, De Gelder was promoted and relocated away from the military school to a professorship at Leyden University [Janssen 1989, 348–351], a promotion that clearly illustrated that De Gelder was well connected. De Gelder's ideas would remain in play and influential. For example, his friends in high places made sure that it was his textbooks that defined the mathematics curriculum in the state funded gymnasia after 1826 [Smid 1997].

The row that triggered this chain of events started with De Gelder's insubordination. Underlying this conflict, however, was the fact that Voet held a more old-fashioned view of what mathematics was about [Beckers 1996]. De Gelder focused on the formulae and treated algebra in such a way that the cadets knew what they were doing (ideally, that is), by making, for example, the formulae for the number of projectiles in a pile a mere exercise, whereas Voet was quite satisfied with his cadets being able to use a formula—as previously with Van der Muelen. De Gelder did eventually adapt his work didactically to be more accessible by his military pupils. He did this in part by replacing a number of the theoretical discussions on the truth of certain axioms with short exposés to clearly illustrate to his cadets the fact that these truths were indeed derived from nature [de Gelder 1816]. But his goal was essentially to promote the new view on mathematics that he also promoted within the Dutch Mathematical Society: to usher his students into a mathematics that was a pure form of knowledge about Creation and of critical importance to to “real” engineering knowledge.

After the row, committees were established to evaluate military education and De Gelder's former assistant Isaak R. Schmidt (1782-1826) took over the mathematics courses. Schmidt started by translating the textbooks by S.-F. Lacroix to use as a guideline for the courses. The textbooks on algebra [Schmidt 1819], geometry [Schmidt 1822a] and descriptive geometry [Schmidt 1821] were very much in line with what De Gelder had aimed for—parts of the original text by Lacroix had even been supplanted by Schmidt's or De Gelder's view on the subject [cf. Beckers 2000]. Schmidt also introduced analytic geometry as a new subject, treated as the application of algebra and solving of equations to the subject of geometry, up to the conic sections [Schmidt 1822c]. Schmidt even started teaching calculus to the artillery cadets [Schmidt 1822b]. Schmidt and De Gelder were both active within the Dutch Mathematical Society and agreed on the role mathematics should play within military education. Slowly, but surely, the mathematics curriculum expanded.

6 Military Academy at Breda

In 1828, the Academy moved to Breda and started afresh as the Royal Military Academy. As De Gelder had suggested, a broad mathematics curriculum became compulsory, entrance exams (including mathematics) became commonplace, and students were to be housed within the Academy. Voet retired because of his age, but he did so grudgingly; ultimately, he disapproved of the central role mathematics had gained in the military curriculum [Janssen 1989, 348].

Indeed, the role of mathematics in the curriculum expanded. The books by Schmidt were kept in use. Apart from algebra, geometry and descriptive geometry became fixed subjects within the new curriculum for all the cadets, and the artillery cadets saw their lessons in calculus and analytic geometry cover more topics: for example, from 1828 onward, the artillery cadets also were taught to re-calculate formulae of curves if one changed from one rectilinear coordinate system to another. Moreover, the calculus lessons were structured to include more general curves and surfaces. At first, foreign textbooks were used for this purpose, but these would be replaced by texts in the vernacular from 1830s onwards [Jonkhert 1836]. The entrance exams guaranteed that it would be possible to help most students to achieve that level. What were the reasons for introducing these new subjects? First of all, the new commander of the Academy, Isaac Paul Delprat (1793-1880), was teaching dynamics and hydrodynamics and his teaching presupposed mathematical knowledge. He had been trained at the *École des ponts et chaussées*, and was anxious to raise the prestige of his academy to the same level. With a couple of new teachers, Delprat started from the books being used at the time and gradually expanded the curriculum beyond where Schmidt had left it.

The influence of mathematics within military education may be illustrated by the use of a whole new series of textbooks but also, in a more general sense, through almost continuous expansion of the overall mathematics curriculum. Since the late 1830s, and during the 1840s, a series of textbooks was published by the Royal Military Academy destined to be used in the Academy's courses. These textbooks no longer followed French examples *per se*. Most notably, the examples would use the Dutch (metric) system of measures and weights. Analytical geometry was expanded beyond what Schmidt and De Gelder had in mind: for example, the new 1842 analytical geometry textbook that was used at the Academy contained not only conic sections, but also general polynomials, cylindrical and spherical coordinate systems, and moreover started from a more general (not necessarily perpendicular) coordinate system [Badon Ghyben 1842].

Although the mathematics curriculum had clearly expanded in scope, mathematics was still a subject the cadets studied for its practical applications. The series of "mathematics textbooks", published by the Academy, included books on surveying, geography, statics, dynamics and hydrodynamics—the latter appearing in 1840 was written by Delprat himself [Delprat 1840]. Delprat also rewrote the dynamics textbook published by Schmidt [Schmidt 1825], bringing it more into line with the new ideas on how to introduce the subject. For example, he devoted an entire section to defining what was intended by "the same amount of time" and the definition of "a second".

Not all of these new textbooks, however, adhered to the newest ideas on how mathematics should be presented. The calculus textbook by Jacob Badon Ghyben (1798-1870) for example, focused on calculations [Badon Ghyben 1847]. It used a form of infinitesimals which at the time were considered suitable as a foundation for calculus but no longer corresponded to what academics considered a suitable way of doing calculus in 1860 [Beckers 2001a]. This calculus textbook, nevertheless, was used at the Military Academy until the 1890s, when it was replaced by a new textbook by N. Grotendorst [Grotendorst 1893], which essentially reworked the 1847 version of the book by placing less emphasis on the foundational chapters, skipping some of the examples, and adding the subject of differential equations.

The annual budget of the Military Academy from 1828 onwards exceeded the budget of Leyden University, the details of which were the subject of debate within the senate, but which were upheld several times [Aalders 1997, 118–121]. In this context, and in the simple sense that mathematics (both in the old and the new sense of the word) held a prominent place in the Academy's curriculum, whereas it attracted relatively few students within the universities, it becomes undeniably clear that the Military Academy in The Netherlands played an important role both increasing and disseminating mathematical knowledge.

In 1843 the Military Academy would face competition from the Polytechnic School founded at Delft. Here, civilian engineers received training more in

line with the academic view of mathematics. Competition between the two institutions was limited, however: the number of students attending Delft Polytechnic remained low, the school was continually underfunded and in many places, as mentioned earlier, military engineers were generally given preference over the civil engineers who had graduated from Delft. After 1870, the importance of the Military Academy to the mathematical community dwindled. The budgets of Delft Polytechnic and the state universities gradually increased, and they both grew in number of students and ultimately surpassed the Military Academy (in both budget and attendance). By 1870, the mathematics curriculum of the Military Academy was no longer considered up-to-date or in step with current knowledge by the mathematicians at the Dutch Polytechnic and leading universities.

7 The Military Academy and its mathematicians

The importance of military education for mathematics is reflected in the role of military men within the Dutch Mathematical Society and the Royal Academy of Sciences. As mentioned, Voet and Huguenin were elected as honorary members in the Mathematical Society in the 1810s; both held high military ranks. Voet contributed little more than his prestige while Huguenin published in the Society's journal [Huguenin 1844].

The mathematics professors at the military schools were spontaneously applying for membership of the Mathematical Society. From 1817 onwards, most of the mathematics professors had joined and were active members. Schmidt, Delprat and Badon Ghyben went as far as heading the board of the Society. Delprat acted as chairman of the board from 1826 until 1830, when he was called away for the country's defense. At the time, he appointed Jacob Badon Ghyben as his replacement, whom in 1835 was elected as his successor. Badon Ghyben served on the board of the Society until 1858. Schmidt and Badon Ghyben also contributed papers to the Society's journals [Schmidt 1844], [Badon Ghyben 1844b].

After 1858, C. J. Matthes (1811-1882) took over the role as chairman of the board, and effectively moved the Society in the direction of a modern mathematical society, contributing mainly to a new, academic view of mathematics [Beckers 2001b]. The new professors of mathematics at the Military Academy were no longer actively contributing to the Mathematical Society—and by the end of the nineteenth century, they were no longer among the members of the Society.

Within the Academy of Sciences, a similar diminishing influence can be seen. Delprat was the last military engineer to be elected to the Academy of Sciences. Delprat contributed to the Academy's journal, mostly in his

role as engineer, but he also contributed theoretical work on hydromechanics in [Delprat 1861]. Badon Ghyben contributed a paper on a geometrical problem of describing three circles into a triangle, given specific conditions [Badon Ghyben 1861]. But these would effectively be the last publications by mathematicians from the Military Academy. It was not as much that the Military Academy became less mathematical: in a way, the mathematics of the early nineteenth century finally became of actual use (although differences in opinion circulated about how mathematics should be taught, and whether classical geometry should be included). But mathematics at the universities was moving away (or moving on) from the early nineteenth century conception of what mathematics should be about [Alberts 1998, 13–22], and the Military Academy simply didn't follow.

The same tendency can be seen in the activity of mathematicians at the Military Academy outside the sphere of science: their influence on the essential meaning of mathematics had become nonexistent by 1870. The secondary school textbook market may serve as an example of this phenomenon. Prior to 1863, schools principally used textbooks by the teachers of the Military Academy (for example [Schmidt 1821, 1822a] and later [Badon Ghyben & Strootman 1838-1841], [Strootman 1841], [Badon Ghyben 1844a], [Kempees 1854], [Badon Ghyben 1858]). Albeit, among other things, these schools prepared their students for future careers at the Military Academy, so that made perfect sense. Continuity between the old and the new school systems was fairly strong, such that, for example, the same textbooks were used until the late 1860's [Smid 2006]. But the new school system, the *hogere burgerscholen*, also drew a lot of highly trained mathematicians who started writing their own texts that were predominantly used for instructing students from the mid-1860's onwards. While these textbooks did not differ dramatically from the elementary textbooks written by authors from the Military Academy, they deviated slightly in terms of didactic content and prepared students for the curriculum of the Polytechnic School [Krüger 2014, 323–338; 509–514].

Another illustration of the diminishing influence of military trained engineers on mathematics was in water management. In The Netherlands, water management had historically always been closely linked with military strategy but was also of great importance to the nation's cities for the obvious relevance to trade routes. Since the late 18th century, an open struggle has existed among the various institutions overseeing water management policy and development, notably between the men of practice or experienced workers and military engineers. Since 1814, in his efforts to foster national cohesion, the King shifted responsibilities from local bodies to the national organization for water management. In doing so, many key positions were given to military engineers [Bosch 2014, 19]. After 1848, however, the civil engineers from Delft Polytechnic took over the key positions overseeing water management [Berkers 2014]. Their theoretical training in mathematics was valued above that of their military colleagues [Lintsen & Vermij 2002], [Beckers 2003, 138–150].

8 Concluding remarks

In a sense, one could say that mathematics education at the Military Academy remained in a fixed state since the early 19th century, whereas mathematics continued to develop, to “move on”. The only reason the Academy introduced the new mathematics into its curriculum during this period appears to be for pedagogical reasons, or for its educational value. Barring some hick-ups, the new mathematics was at the core of the curriculum at the Military Academy in 1828. The year 1828 also marks the year students from the middle classes trying to obtain a military rank were required to pass an entrance exam. New at the time, was the idea that mathematics was no longer about practical rules one simply needed to follow to find the correct answer, but mathematics became a subject that was about sensible abstractions of Creation, and sound reasoning. This early nineteenth century concept of mathematics, offered nothing less than an introduction (if not the sole introduction) to the language of Creation, aimed at, although not starting from, cultivating the idea that understanding Creation would serve the engineer endeavoring to mold Creation to mankind’s needs. The mathematics curriculum at the Military Academy would later be seen to expand further under the directorship of mathematically trained engineers such as Delprat.

Meanwhile, as the educational landscape in The Netherlands changed, so did ideas about mathematics. Instructors and scholars at the Delft Polytechnic and general universities, together with their engineering and mathematics graduates, were gaining both prestige and importance, thereby effectively redefining what mathematics was about. To them, mathematics was slowly becoming the language of structures. A language that started from solid definitions, and needed roots or foundations, instead of having ties to heaven or Creation. Seeking international recognition for their work mathematicians within both the Mathematical Society and the Royal Academy of Sciences would proceed to focus on ever more abstract views of mathematics. This led to a widening gap between the mathematics instructors from the Military Academy and the mathematicians from the former two institutions.

Nevertheless, at least until the 1860s, the Military Academy represented one of the foremost motivations for Dutch people to get themselves acquainted with mathematics: it required mathematical knowledge to enter, it was the place where most mathematicians were being trained, and it was one of the places where they could find a teaching position. Until the rise of polytechnic education and a corresponding secondary school system, the Military Academy had been considered the most prestigious, most well-known proponent of mathematics within the Dutch Kingdom.

The Dutch Mathematical Society recognized the important position of military education in the dissemination of mathematical knowledge and went to great lengths in the early 19th century to secure the cooperation of important military men. The role of the mathematics instructors from the

Military Academy within both the Mathematical Society and the Academy of Sciences is telling. In the beginning of the 19th century, mathematics professors from the Military Academy were nearly all active members of the Mathematical Society. In the 1830s, Delprat was even elected to the Academy of Sciences. This link between the two institutions virtually disappeared after about 1860. Nevertheless, up to that point, the Dutch Military Academy played an undeniably important role in the field of mathematics as it was, at one time, respected for leading the dissemination of mathematical knowledge.

Bibliography

- AALDERS, Matthieu Harry Willy [1997], *Tussen kazerne en universiteit : de discussie over opvoeding en onderwijs aan de Koninklijke Militaire Academie te Breda in de negentiende eeuw*, Nijmegen: GNI.
- ALBERTS, Gerard [1998], *Jaren van berekening. Toepassingsgerichte initiatieven in de wiskundebeoefening 1945-1960*, Amsterdam: AUP.
- ALBERTS, Gerard & BECKERS, Danny [2010], Wiskunstige Verlosting. De tijdschriften die het genootschap wel en niet uitgaf, *Nieuw Archief voor Wiskunde*, V(11), 20–26.
- AUBIN, David [2014], “I’m just a mathematician”: why and how mathematicians collaborated with military ballisticians at Gâvre, dans *The War of Guns and Mathematics: Mathematical practices and communities in France and its western allies around World War I*, édité par D. Aubin & C. Goldstein, Providence: American Mathematical Society, 307–350.
- BADON GHYBEN, Jacob [1842], *Beginnelsen der hoogere Meetkunst*, Breda: Boese & Comp., 4^e éd., 1875.
- [1844a], *Beginnelsen der Meetkunst*, Breda: Boese & Comp., 7^e éd., 1874.
- [1844b], Verhandeling over het theorema van Sturm, betreffende de hoogere-magts vergelijkingen, *Nieuwe Wis- en Natuurkundige Verhandelingen van het Wiskundig Genootschap*, 1, 89–126, 1874.
- [1847], *Beginnelsen der Differentiaal- en Integraalrekening*, Breda: Boese & Comp., 2^e éd., 1861.
- [1858], *Gronden der beschrijvende Meetkunst*, Breda: Boese & Comp., 3^e éd., 1869.
- [1861], Bijdrage betreffende het vraagstuk van Malfatti, om in een driehoek drie cirkels te beschrijven, die elkander en de zijden des driehoeks raken, *Verslagen en Mededelingen van de Koninklijke Akademie van Wetenschappen*, 12, 189–202.

- BADON GHYBEN, Jacob & STROOTMAN, Hendrik [1838-1841], *Beginnselen der Stelkunst*, Breda: Boese & Comp., 2 vols.; 8th edition, vol. 1, 1873; 5th edition, vol. 2, 1870.
- BARANY, Michael J. [2011], God, king, and geometry: revisiting the introduction to Cauchy's *Cours d'analyse*, *Historia Mathematica*, 38(3), 368–388, doi: 10.1016/j.hm.2010.12.001.
- BECKERS, Danny [1996], Mathematics as a way of life: a biography of the mathematician Jacob de Gelder (1765-1848), *Nieuw Archief voor Wiskunde*, IV(14), 275–297.
- [2000], Positive thinking. Conceptions of negative quantities in The Netherlands and the reception of Lacroix's algebra textbook, *Revue d'histoire des mathématiques*, 6(1), 95–126, doi: 10.24033/rhm.97.
- [2001a], Definitely infinitesimal: Foundations of the calculus in The Netherlands, 1840-1870, *Annals of Science*, 58(1), 1–15, doi: 10.1080/000337901457678.
- [2001b], “Untiring labor overcomes all!” The history of the Dutch Mathematical Society in comparison to its various counterparts in Europe, *Historia Mathematica*, 28(1), 31–47, doi: 10.1006/hmat.2000.2294.
- [2003], “*Het despotisme der Mathesis*”. *Opkomst van de propaedeutische functie van de wiskunde in Nederland, 1750-1850*, Hilversum: Verloren.
- BERKERS, Erik [2014], Large scale projects in a liberal era, 1850-1900, dans *Two Centuries of Experience in Water Resources*, édité par J. Lonnquest, B. Toussaint, J. Manous & M. Ertsen, Alexandria: Rijkswaterstaat; US Army Corps of Engineers, 77–111.
- BOSCH, Toon [2014], Dutch water management in an era of Revolution, Restauration and the advance of liberalism, 1795-1850, dans *Two Centuries of Experience in Water Resources*, édité par J. Lonnquest, B. Toussaint, J. Manous & M. Ertsen, Alexandria: Rijkswaterstaat/ US Army Corps of Engineers, 11–48.
- BULLYNCK, Maarten [2006], *Vom Zeitalter der formalen Wissenschaften. Anleitung zur Verarbeitung von Erkenntnissen anno 1800, vermittelt einer parallelen Geschichte*, Thèse de doctorat, University of Gent, Belgium, www.kuttaka.org/ZfW.pdf.
- [2008], The transmission of numeracy: Integrating reckoning in Protestant North-German elementary education (1770-1810), *Paedagogica Historica*, 44(5), 563–585, doi: 10.1080/00309230802042714.

- DAVIDS, Karel [1990], Van vrijheid naar dwang. Over de relatie tussen wetenschap en zeewezen in Nederland in de 19de en vroege 20ste eeuw, : *Tijdschrift voor de geschiedenis van geneeskunde, natuurwetenschappen, wiskunde en techniek*, 13, 5–22.
- [1991], Technological change and the professionalism of masters and maters in the Dutch mercantile marine 1815-1914, *Collectanea Maritima*, 5, 282–303.
- DELPRAT, Isaac Paul [1840], *Beginselen der dynamica en hydrodynamica*, Breda: Broese & comp.
- [1861], Over eene benaderde Formule tot het berekenen van den waterafvoer in kanalen en waterleidingen, *Verslagen en Mededelingen van de Koninklijke Akademie van Wetenschappen*, 12, 209–227.
- DIRKZWAGER, Jan Margarethus [1992], De Nederlandse marine als pionier in de technische ontwikkeling. Ontwikkeling en gebruik van stoomketels in het tweede kwart van de negentiende eeuw, *Tijdschrift voor Zeegeschiedenis*, 11, 41–57.
- [1993], De Nederlandse marine als pionier in de technische ontwikkeling : Schroefvoortstuwing in het tweede en derde kwart van de negentiende eeuw, *Tijdschrift voor Zeegeschiedenis*, 12(1), 13–36.
- DOPPER, Jantien [2014], *A Life of Learning in Leiden. The mathematician Frans van Schooten (1615-1660)*, Thèse de doctorat, Universiteit Utrecht, <https://dspace.library.uu.nl/bitstream/1874/288935/1/dopper.pdf>.
- FERREIRÓS, José [2007], *Labyrinth of Thought. A History of Set Theory and Its Role in Modern Mathematics*, Basel; Boston; Berlin: Birkhäuser, 2^e éd.
- DE GELDER, Jacob [1806], *Handleiding tot de beschouwende en werkdadige meetkunst*, Amsterdam: Johannes Allart.
- [1808-1809], *Wiskundige Lessen*, Den Haag; Amsterdam: gebroeders Van Cleef, 2 vols.
- [1811-1813a], *Allereerste Gronden der Cijferkunst*, Den Haag; Amsterdam: gebroeders Van Cleef, 2 vols; 5 editions of both volumes.
- [1811-1813b], *Meetkundige Analysis*, Den Haag; Amsterdam: gebroeders Van Cleef, 1 vol., appeared as a serial textbook.
- [1816], *Allereerste Gronden der beschouwende en werkdadige meetkunst*, Den Haag; Amsterdam: gebroeders Van Cleef, 2^e éd., 1827.
- GERRITSEN, Willem Pieter [1997], *Het Koninklijk Instituut (1808-1851) en de bevordering van wetenschap en kunst*, Amsterdam: KNAW.

- GRAY, Jeremy J. [2004], Anxiety and abstraction in nineteenth-century mathematics, *Science in Context*, 17(1–2), 23–47, doi: 10.1017/S0269889704000043.
- [2008], *Plato's Ghost: The Modernist Transformation of Mathematics*, Princeton: Princeton University Press.
- GROTENDORST, N. C. [1893], *Beginnelsen der Differentiaal- en Integraalrekening*, Breda: KMA.
- HUGUENIN, Ulrich [1844], Ontwikkeling van eenige trigonometrische formules en reeksen, *Nieuwe Wis- en Natuurkundige Verhandelingen van het Wiskundig Genootschap*, 1, 1–29.
- JANSSEN, Jan A. M. M. [1989], *Op weg naar Breda. De opleiding voor officieren van het Nederlandse leger tot aan de oprichting van de Koninklijke Militaire Akademie te Breda in 1828*, Den Haag: Sectie Militaire Geschiedenis Landmachtstaf.
- JONKHERT, J. [1836], *Vervolg op de beginselen der hoogere meetkunst*, Breda: Broese & comp.
- KEMPEES, Jean Chrétien Jacques [1854], *Beginnelsen der Cijferkunst*, Breda: Broese & comp, 2. vols.
- KRÜGER, Jenneker [2014], *Actoren en factoren achter het wiskundeonderwijs sinds 1600*, Utrecht: FIsme, <https://dspace.library.uu.nl/bitstream/1874/301858/1/kruger.pdf>.
- LENDERS, Jan [1988], *De burger en de volksschool*, Nijmegen: SUN.
- LINTSEN, Harry [1980], *Ingenieurs in Nederland in de negentiende eeuw: een streven naar erkenning en macht*, Den Haag: Martinus Nijhoff.
- LINTSEN, Harry (éd.) [1994], *Geschiedenis van de techniek in Nederland. De wording van een moderne samenleving 1800-1890*, Zutphen: Walburg.
- LINTSEN, Harry & VERMIJ, Rienk [2002], Ingenieurs en het streven naar technocratie, dans *De opmars van deskundigen. Souffleurs van de samenleving*, édité par F. H. van Lunteren, B. Theunissen & R. Vermij, Amsterdam: Amsterdam University Press, 89–98.
- VAN LUNTEREN, Frans Herbert [2004], Wetenschap voor het vaderland. J.D. Van der Waals en de Afdeling natuurkunde, dans *De Akademie en de Tweede Gouden Eeuw*, édité par K. van Berkel, Amsterdam: KNAW, 43–106.
- VAN DER MUELEN, L. [1806], *Handleiding in de artillerie*, Rotterdam: J. Hendriksen.

- [1807], *Iets over de veldverschansing en het aanleggen van batterijen*, Rotterdam: J. Hendriksen.
- PYCIOR, Helena M. [1981], George Peacock and the British origins of symbolical algebra, *Historia Mathematica*, 8(1), 23–45, doi: 10.1016/0315-0860(81)90003-3.
- SCHMIDT, Izaäk Riewert [1819], *Beginselen der stelkunst*, Den Haag; Amsterdam: gebroeders Van Cleef, translation and adaption of textbook by S. F. Lacroix on algebra.
- [1821], *Grondbeginselen der beschrijvende meetkunst*, Den Haag; Amsterdam: gebroeders Van Cleef, translation of textbook by S. F. Lacroix.
- [1822a], *Beginselen der meetkunst*, Den Haag; Amsterdam: gebroeders Van Cleef, 3^e éd., 1838.
- [1822b], *Beginselen der differentiaal- en integraal-rekening*, Den Haag; Amsterdam: gebroeders Van Cleef.
- [1822c], *Beginselen der hoogere meetkunst*, Den Haag; Amsterdam: gebroeders Van Cleef, 2^e éd., 1826.
- [1825], *Beginselen der dynamica*, Den Haag; Amsterdam: gebroeders Van Cleef.
- [1844], Verhandeling over eenige eigenschappen van den regtljngen driehoek, *Nieuwe wis- en natuurkundige verhandelingen van het Genootschap te Amsterdam*, 1, 30–50.
- SMID, Harm Jan [1997], *Een onbekookte nieuwigheid*, Delft: Delft University Press.
- [2006], Between the Market and the State, *Paedagogica Historica*, 42(4–5), 575–586, doi: 10.1080/00309230600806849.
- STROOTMAN, Hendrik [1841], *Gronden der beschrijvende meetkunst*, Breda: Broese & comp.
- VERBONG, Geert [1993], Delftse ingenieurs tussen wetenschap en industrie (1875–1900), *Gewina*, 16, 248–260.