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DUTCH ARITHMETIC, SAMURAI AND WORSHIP

Teaching Western Mathematics in Pre-Meiji Japan

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ABSTRACT

This paper discusses the scarce occasions in which Japan came into contact with Western arithmetic and algebra before the Meiji restoration of 1868. It concentrates on the reception of Dutch works during the last decades of the Tokugawa *shogunate* and the motivations to study and translate these books. While some studies based on Japanese sources have already been published on this period, this paper draws from Dutch sources and in particular on witness accounts from Dutch officers at the Nagasaki naval school, responsible for the instruction of mathematics to selected samurai and *rangakusha*.

1 Motivation

The history of traditional Japanese mathematics (*wasan*) is a gratifying subject for study as it confronts us with basic questions on the development of mathematics. The relative isolation of Japanese intellectual culture during the Edo period provides us with almost experimental conditions for the question if mathematics evolves in some necessary order or pattern. If it does, we should observe the same developments in the mathematics of an isolated Japan as they appeared in the West during the early-modern period. The answer to this question is not straightforward. *Wasan* practitioners achieved important results independently from the West.[1] The most salient ones are the development of *bōshohō* ("side-writing", a kind of symbolism in algebra), the foundations of infinitesimal calculus and Seki's work on infinite series which baffles Smith and Mikami (1914, 14). On the other hand, the complete lack of mathematics in the study of the physical world, the specific esthetics of *sangaku* problems and the modes of proof and demonstration are some of the idiosyncrasies which can best be explained within the context of the Edo society.[2]

The end of the seclusion period (*sakoku*, 1635–1868) gave rise to a situation of an equal interest. The confrontation with Dutch mathematics at the end of this period raises the issue how foreign knowledge can and should be incorporated within existing traditions. Of the possible strategies of adaption, integration or replacement the Meiji regime chose drastically for the latter one, abandoning

[1] The most comprehensive overview of *wasan* in a Western language is by Horiuchi (1994). The book is recently translated into English: Horiuchi (2010).

[2] For one of the few studies on the relation of *wasan* and physics see Ravina (1993).

its own rich and flourishing *wasan* tradition. The possible choices are exemplified by the first two Japanese works on Western mathematics.

I will situate the appearance of these two works within the context of foreign military threat and the subsequent development of a Japanese naval force. Previous studies have been published which approach this historical overturn based on Japanese sources (Sasaki 1994, 2002). This account is mostly based on witness accounts of Dutch teachers at the Nagasaki naval training program. The Dutch played a major role in placing education in Western mathematics as a condition for their support to the Japanese enterprise in naval warfare.

2 Samurai and warships

Before the second half of the nineteenth century there was probably no influence of Dutch mathematics in Japan, and if there would have been any, it was very limited. Mikami (1913, 177–8) summarizes the situation as follows:

> Some of the mathematicians in the first part of the 19th century were able to read Dutch works, though their knowledge of the language was of an exceedingly limited kind. A certain number of Dutch astronomical works were possessed by the Astronomical Board of the Shogunate, but we know practically nothing of what were the mathematical treatises brought from Holland to Japan in those days. Nor are we able to find traces of the Dutch influence upon the writings belonging to this epoch. No quotations, no references are found. The relation of the Dutch science and the mathematics cultivated in Japan still remains unexplored. It is almost the whole of the Dutch influence, of which we know, that some of the writings of Kawai [Kyotoku, Kaishiki Shinpō, 開式新法], Shiraishi, Ichino [Mokyo] and others contain some deformed Roman characters as symbols. Reflecting on the incorrectness with which the names of the authors are spelled, their knowledge learned from Dutch works appears to have been very limited if any. We have no knowledge of any Occidentalist, who was at the same time a mathematician.

The situation changed dramatically on July 1853 with the arrival of commodore Matthew C. Perry and a flotilla of four warships at Uraga Harbor. His insistence on forcing the opening of Japan had a dramatic threatening effect on the shogunate. Several actions were taken as a response including the fortification of coastal areas such as Tokyo bay. On 7 August a messenger was sent to the Dutch *opperhoofd* (chief merchant) at Deshima with two questions: what is the cost of a frigate and steam warship and can the Dutch deliver these?[3] An approximate answer was given to the first question and he was told that an answer to the second required consultation with the Dutch government. They were told that it could take up to three years before such ships would be delivered to Japan. On 15 October the governors of Nagasaki communicated the decision by the Edo government to found a naval force according to Western principles and asked the Dutch for help. The Dutch responded with a list of demands in order to assist them in that. However, they made clear from the beginning that it makes no sense to deliver Western frigates without the proper training of Japanese naval officers. The proposal by the last *opperhoofd* Donker Curtius to send Japanese youths to Holland for an intensive training

[3]We here closely follow the Dutch account by Van der Chijs (1867, 414–498), including the Dutch translation of the official Japanese documents.

program was declined with an unambiguous warning not to raise this delicate topic again. Instead, it was chosen to train Japanese naval officers near Deshima. The Dutch delivered a list of subjects that needed to be taught to the new officers by Dutch military teachers. They listed 14 disciplines, putting the mathematical courses on top:[4]

1. Geography and navigation according to Western principles using European maps
2. Astronomy
3. Arithmetic according to the Western method
4. Algebra *(stelkunst)*
5. Geometry
6. . . .

continuing with crafts specific to naval and military expertise. The Dutch response stressed the fact that “war ships carrying officers and personnel without experience in these disciplines would lead to a disadvantage rather than be of any use”. A clearer statement of the utility of Western mathematics to modern warfare will be hard to find. The motivation to establish the *Bansho shirabe-sho* (Institute for the investigation of barbarian books) in 1856 should also be seen in direct relevance to the military threat.[5] The Dutch were considered instrumental in the acquisition of Western knowledge necessary for a defense. Thomas C. Smith (1948, 131) quotes one Mito official who stated in 1854 that “the necessity of defense against the barbarians requires that we know them and know ourselves; there is no other way to know them than through Dutch learning”.

After months of negotiation the Dutch government sent the paddle steamers *Soembing* and *Gedeh* to Japan, lead by captain Gerhardus Fabius. The *Soembing* arrived at Nagasaki on 22 August 1854 under the command of Gerhard Christiaan Coenraad Pels Rijcken, the *Gedeh* on 21 July 1855. The *Soembing* was equipped with six big guns. It functioned as the training ship for the newly established Nagasaki *Kaigun Denshu-sho* (Nagasaki naval school). The *Soembing* was handed over to Japanese authorities on 5 October 1855. Dozens of young samurai were sent to Nagasaki by the shogunate to be trained as naval officers. Several had already some experience with Dutch as *rangakusha*. Some of the students we know by name and became important to the Japanese naval command. Kaishu Katsu (勝 海舟，1823–1899) had studied European military science from Dutch books. He was assigned the command of the *Kanrin-maru* in 1860 and became a statesman. Utida Tsunejirō became a naval commander. Horie Kuwajirō (堀江 鍬次郎，1831–1866) had studied chemistry from Dutch text books and became one of Japan’s earliest photographers. Other students include Matsumoto Ryojun who studied Dutch medicine. Some student of the naval school were sent to the Netherlands from 1862 such as Enomoto Takeaki (榎本武揚，1836–1908) Uchida Masao (Kojirō, 1839-1876), who worked at

[4]Translated from the official notes of 15 Oct 1853, van der Chijs (1867, 415–416). For a discussion of the other courses, related to navigation and military science, see Arima (1964).

[5]Any Dutch book that could be found on one of the ships at Deshima became a precious item and circulated within a small group of Japanese scholars called *rangakusha*. Most of the Dutch books ended up in *Bansho shirabe-sho* together with the astronomical observatory. In 1863 it was renamed *kaiseijo*. In 1869 these books moved to the newly established Imperial University, now The University of Tokyo.

the *Kaisejo* after his return in 1867, and Akamatsu Noriyoshi (Daizaburo, 1841-1920) who became Vice Admiral.[6]

Classes commenced on board of the *Soembing* in the bay of Nagasaki on 24 Oct 1855 and lasted until May 1859 when the institute was moved to Tsukiji.[7] The Dutch officers were lodged on Deshima but could freely move around Nagasaki by the end of 1855. Pels Rijcken was responsible for the training program until another screw-driven steam warship, the *Kanrin maru*, was delivered by a second detachment on 21 Sept 1857. Its commander Willem Johan Cornelis Huyssen van Kattendycke took over on 1 Nov for the following two years. Also both these commanders were involved in teaching. Pels Rijcken taught navigation, cannonry and mensuration. Other instructors included Cornelis Hendrikus Parker de Jonge, the physician dr.Jan Karel Van den Broek, H. O. Wichers (2nd class officer) teaching geometry, algebra, trigonometry, navigation, and from 1858 also descriptive geometry. C.J. Umbgrove (3rd class officer) was teaching "arithmetic in whole and broken numbers, proportions and root extraction". Several witness accounts of the training program by Dutch officers have been preserved. W.J.C. Huyssen van Kattendycke kept a diary from which extracts have been published in 1860. Van den Broek (1862) wrote a flaming response, revealing much of the sensitivities and rivalries of the first detachment. The naval doctor J.C.L. Pompe van Meerdervoort (1867–8) kept notes during his five year stay in Japan and as such provides the most extensive witness account of life at Deshima during that period. He taught medicine to 150 students of which 61 graduated as medical doctors in 1862. His account of Japan, based on his notes, was published in a two-volume book.[8] H.O. Wichers kept a diary from 1857 to 1859, which remains unpublished but is preserved at the museum of the Dutch Navy in The Hague.[9] He became a Dutch marine minister in 1877. Van Kattendycke (1860, 23) lists some details on the mathematics courses. Teaching was done through the aid of interpreters. However, the Dutch complained that the Japanese translators did not understand the Dutch language enough and that they had problems with translating the technical terms. Geometry and algebra were taught 5 hours per week by a 2nd class lieutenant. Arithmetic was taught for 9 hours per week by an administration officer.

Van Kattendycke (1860, 73) was at first skeptical about the assignment: "Pompe's teaching could be brought to direct use, by the treatment of diseases in Nagasaki, but algebra and navigation, or put differently, everything related to mathematics, what could be expected from that?" We also should take into account the social context of Edo intellectual culture. Mathematics exemplified the divide between *samurai* and *chonin* (merchant) cultures. Smith and Mikami (1914, 46) note that "samurai despised the plebeian soroban, and the guild of learning sympathized with this attitude of mind". As abbaco arithmetic and algebra were associated with the merchant class in sixteenth-century Europe, so it was during the Edo period in Japan. Rikitaro Fujisawa (1912, 22), in a comprehensive report on mathematics education in Japan writes that "The intellectual education was essentially classical in nature, and profoundly influenced by the Confucianism tinged with the chivalrous spirit of feudal

[6]These names appear on a roll kept at the National Diet Library, Japan, ms. 93 in the Katsu Kaishu manuscript collection.

[7]Some sources, such as Arima (1964) give Feb 1859 as the end of the Nagasaki naval school. This does not fit with the Dutch records.

[8]The book is translated into English and Japanese. He also published some medical studies related to his stay in Japan: Pompe van Meerdervoort (1859), on the cholera epidemics in Japan: Pompe van Meerdervoort (1998). *His Korte beschouwing der pokziekte en hare wijzigingen* was translated in Japanese by Mitsukuri Genpo but never printed.

[9]Instituut Voor Maritieme Historie, "Dagboek verblijf in Japan als instructeur Japanse marine", 1857–1859, Inventaris van de losse stukken, archive nr.266.

times. To do such things as calculation was thought condescending beneath the dignity of the samurai rank. They even went to the length of boasting of their ignorance in the art of computation practiced by trades-folk, who were looked upon as an inferior class of people". This does not mean that the samurai class detested mathematics—as there were samurai mathematicians—but the esthetics of *sangaku* appealed more to their intellectual aspirations than the practicalities of merchant arithmetic.[10] So it must have been a culture shock for students from the samurai class to get confronted with down-to-earth calculations which they associated with merchant arithmetic. Its direct relevance to naval warfare was not always apparent and posed problems of motivation.

The first year was difficult as we read from a report by Pels Rijcken (Van der Chijs 1867, 462): "Without a soroban they were not able to make the most elementary calculations". Students were afraid to ask questions, even when they did not fully understood what was being taught. Only when the Japanese students met with the teaching officers outside of the classroom—a practice which was encouraged—did they find the courage to ask questions.[11] After several weeks, on 8 Dec 1855 the courses were reorganized and the conditions improved. More attention was now given to the teaching of Dutch language and basic arithmetic. After a year most of the students mastered the basic of mathematics in Western style (Van der Chijs 1867, 465). They could operate on numbers, solve the more difficult arithmetical problems and use algebra. They could solve linear problem with several unknowns, solve quadratic equations and use logarithms with ease. Those who had done algebra were also taught solid geometry and from Oct 1856 onwards plane and spherical trigonometry. All these students could read Dutch texts and consulted Dutch text books. In the early morning of 29 March 1857 the *Soembing*, in Japanese renamed as *Kanko Maru* (観光丸) was put under steam and sailed off to Tokyo manned by a 105 Japanese crew. All of them had followed 15 months of training by the Dutch. In April lessons were resumed for the new arrivals and the students who were left behind. In March 1859 the Dutch were surprised and the students disappointed to hear that the operations of the naval school would be moved to Edo (Van der Chijs 1867, 489-490). The move took place in May and all teaching on Nagasaki officially ended. However, some students still followed lessons at Deshima until the second detachment left on 4 Nov 1859.

The first Japanese works on Western mathematics

The *Seisan Sokuchi* (*A short course on Western Arithmetic*) by Riken Fukuda published in 1856 and the *Yōsan Yōhō* (*The method of Western arithmetic*) by Yanagawa Shunsan in 1857, listed by Mikami (1909) were the first Japanese works describing Western style arithmetic. It is not clear to what degree the appearance of these books is related to two new established institutes. However, several facts point into such direction. First note that the publication dates coincide with the establishment of the *Bansho shirabe-sho* institute. The idea of such institute was suggested by Katsu Kaishu to Abe Masahiro (Jansen, 1958). Katsu, one of the students of the naval school, was involved later with the selection of subjects for study and translation by the institute (Hommes 1993, 33). The overlap in subjects taught by at the *Kaigun Denshu-sho* is remarkable. Also, the 575 books used by the Dutch ended up in the library of the *Bansho shirabe-sho* (Hommes 1993, 76–7).

[10] *Sangaku* are intricate geometrical problems from the Edo period which were often displayed at the entrance shrines and temples. See Fukagawa, H. and Rothman (2008) for an excellent work in English on this tradition.

[11] Private teaching by the Dutch officers became more the rule than an exception in 1858 as reported in Van der Chijs (1867, 488).

Not only did the Dutch arithmetic books spread, the very teaching of arithmetic went beyond the direct needs of the naval training school. Van Kattendycke reports that following a suggestion by Donker Curtius, a class of 25 to 30 children of translators between 8 and 15 were taught the basics of arithmetic. However, this project was abandoned after a fire on Deshima (on 7–8 March 1858).[12] The interest of the Dutch in Japanese mathematics and science also went beyond the practical needs for organizing training. Donker Curtius collected about hundred thirty books authored by *rangakusha* during his stay in Japan.[13] He owned a copy of *Yōsan Yōhō* (nr. 60 in the Catalogue by Serrurier, 1879) as well as a copy of *Seisan Sokuchi* (catalogue nr. 62a). These are the only works on European mathematics in his collection and probably the only works in this category at that time. In 1861 he sold his books to the Dutch government and the collection is now kept at Leiden University Library (Kerlen, 1996). One medical instructor of the first detachment, Van den Broek, collected 27 rare manuscripts and books by *rangakusha* which were only recently rediscovered by Herman J.Moeshart (2003) at the Library of Arnhem in Holland. Both had a reasonable knowledge of the Japanese language. Donker Curtius dispatched a manuscript on Japanese grammar already in 1855 to Hoffmann, who was then a professor of Japanese at Leiden. Van den Broek (1862, 133), who felt sabotaged in his plans to publish his own dictionary, complained about the manuscript that "words were spelled so poorly that it was of no use at all". Hoffmann spent considerable effort to improve it to a publishable work (Donker Curtius, 1857). Apparently there was a demand for Japanese dictionaries and grammars as it was soon adapted to French (Pages, 1861). So, the interest of the Dutch and Japanese in each other's language and knowledge was at least reciprocated.

Before I look at the two works in detail let us remind us the unique historical conditions under which the books appeared. As Sasaki has pointed out at several occasions (Sasaki 1994a, 1994b, 2002), evolutions in mathematics are best understood from the social history in which they occur. The *sakoku* policy already provided us with almost experimental conditions for the study on the contingency of mathematics. The Kanagawa treaty of 1854 effectively ended two centuries of seclusion policy and is an interesting experiment as was the closure of Japan: What is the best way to introduce *yōzan* or Western science and mathematics to Japan? As a comparison, the transition from Roman numerals and calculation with the Gerbertian abacus to the use of Hindu-Arabic numerals took several centuries in Europe. In Japan, the transition from *wasan* to *yōzan* was an even more drastic one and took only some decades to accomplish. The choice for such drastic reform was undoubtedly inspired by the military threat and was part of the transformation of the *bakufu* and *samurai* culture to a modern Japan.

Let us now have a closer look at the two Japanese works and how they relate to Dutch works on arithmetic.[14] It seems that there were two options for a Japanese author of a book on Western mathematics in 1855. Either they approach it from the *wasan* tradition and explain how Western mathematics functions different and relates to existing methods and practices. Or they approach it as *rangakusha* with respect for the original language, terminology and presentation of the Western works. Both these books represent one of these options. From a first comparison it becomes clear that the *Seisan Sokuchi*

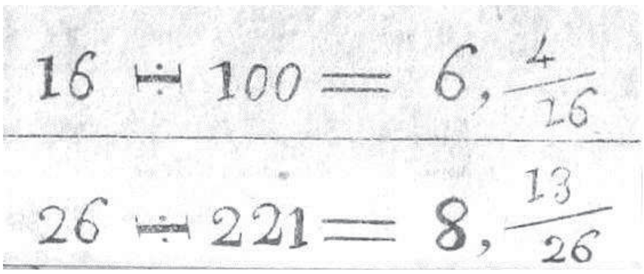
[12]Huyssen van Kattendijke (1860, 74). The story is confirmed by Van der Chijs, (1867, 483).

[13]In this he followed the German physician Philipp Franz von Siebold (1769–1866) who stayed at Deshima from 1823 to 1830, who already brought a large collection of Japanese books and manuscripts (together with paintings, instruments etc.) to Europe. The items are described by J. Hoffmann (1845).

[14]For a modern facsimile edition see Shin'ichi (1979).

is more integrated with *wasan* than the *Yōsan Yōhō* is. The author of the first, Riken Fukuda (1815–1889) of Osaka, was a *wasan* scholar and he made a considerable effort to transliterate Western methods of arithmetic within existing *wasan* knowledge of mathematics. Western numerals and signs for operations are completely absent from the book. Multiplication tables, to be found in every elementary work on arithmetic since Fibonacci's *Liber abbaci*, are presented in the *Seisan Sokuchi* with Japanese numerals. In the *Yōsan Yōhō*, on the other hand, Hindu-Arabic numerals feature prominently in the first section on numeration.[15] Yanagawa Shunsan (柳川春三, 1832–1870) was from a very different background.[16] He was the son of a tool maker in Nagoya, who studied literary Chinese and Dutch at a young age and was reputed for his calligraphy. He moved to Edo and Nagasaki where he worked as a *rangakusha*. In 1861 he moved to the *Kaiseijo* translation bureau in Kanda. Like Horie Kuwajirō, he was interested in photography. In 1864 he was appointed teacher at the *Kaiseijo* and became publisher of the *Shimbun Kaisō*. In 1867 he founded *Seiyō Zasshi*, the first Japanese periodical. With the Meiji restoration in 1868 he became the head of the *Kaiseijo*. Yanagawa also published a Japanese edition of a Chinese translation of a work on Western learning *Zhihuan qimeng* (Elementary lessons in the circle of knowledge) in 1862.[17]

A salient aspect of Yanagawa's book is that throughout the Dutch pronunciation of operations is added in katakana. Such a practice has no function at all for learning Western arithmetic unless . . . the teaching would be in Dutch, or is intended for *rangakusha* with some knowledge of Dutch. After numeration it is explained how whole and broken are to be pronounced (*Yōsan Yōhō*, 1857, 11a). This approach runs easily into problems as language conventions do not follow the rules of arithmetic. For example, the number 321 is pronounced in Dutch 'driehonderdéénentwintig' and is in an order different from English or Japanese. It would sound as "three hundred one and twenty". As this would present difficulties, in the book this example is rendered as 3 hundreds, 2 tens and 1 ones (*Yōsan Yōhō*, 1857, 11b).



division in the *Yōsan Yōhō*

Also differences in writing conventions between European and Japanese languages pose problems. As shown in Figure 1, this representation of division would be correct if you read it from right to left: 6, 4/26 is the result of dividing 100 by 16. However, if it is read from the left to the right (or top to bottom as it appears in the book) the statement $16 \div 100 = 6, 4/16$ would be wrong (Yōsan Yōhō, 1857, 12a). The use of a comma is also puzzling. While the comma is used as a decimal point,

[15]Yanagawa Shunsan, *Yōsan Yōhō*, 1857, p. 9a. All references refer to the original edition counting from the title page as 1a, 1b, 2a. . .

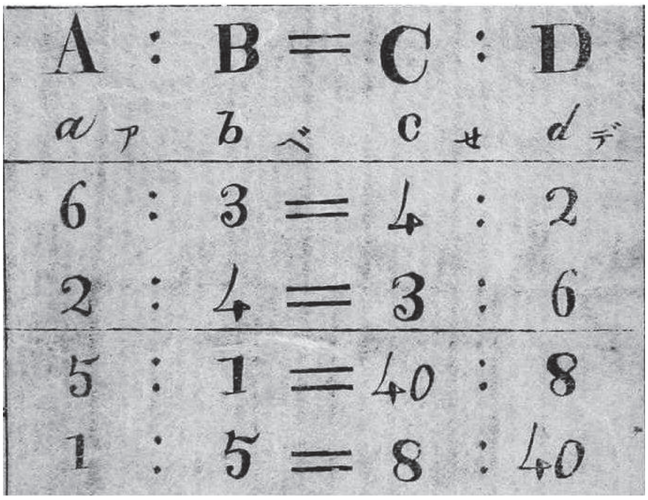
[16]These biographical data are based on Munson (2005). There also exists a Japanese biography of Yanagawa by (1940) of which I did not have the opportunity to consult.

[17]Liu Jianhui (2000), translated by Fogel (2009).

the combination of the comma and fraction does never appear in Dutch arithmetic books.

Not only are the Dutch pronunciations listed for numbers up to a million, also the multiplication tables are transliterated as if they were drilled in Dutch. We find in the book the katakana for "één maal één is één", "twee maal twee is vier", "twee maal drie is zes", "drie maal drie is negen", "acht maal negen is tweeënzeventig" and "negen maal negen is éénentachtig" (respectively the products 1×1, 2×2, 2×3, 3×3, 8×9, 9×9). Again, the Dutch pronunciation of such tables is irrelevant for learning Western arithmetic unless it is intended to be taught in Dutch. The Dutch names for basic operations of arithmetic and terms such as 'fractions', 'equality' and so on are given in katakana as well as.[18] One specific term in the long list is peculiar. 'Eigenlijdigheid' as such is not a Dutch word. It is derived from the uncommon term 'eigenlijdig' which was used only in the medical sense, meaning the local illness of body part which does not affect the other parts.[19] Its use in a book on arithmetic is surprising and may reveal some familiarity of the author with Dutch medical literature.

The faithful rendering of Dutch arithmetic in the *Yōsan Yōhō* had the advantage that Western symbolism was introduced at this early stage. Figure 2 shows the notation for proportions with the use of letters $A : B = C : D$, which are transliterated in katakana (*Yōsan Yōhō*, 1857, 27b). The book is probably the first Japanese work to use the symbol x for the unknown, in relation to proportions: $a : b = c : x$. (*Yōsan Yōhō, 1857, 15a*). The choice for using Western symbols was a deliberate one as we read in the introduction. The author complains about the lack of systematization in *wasan* works: "People find [occidental calculation] difficult to learn because they do not retain the Dutch ciphers But in fact it is much easier to understand than to operate the *soroban* and saves us a lot the trouble of memorization".[20]



proportions in the *Yōsan Yōhō*

He is possibly referring to the *Seisan Sokuchi* which did not retain the symbolism of Dutch arithmetic. Also interesting is that Yanagawa compares the symbols for the unknown x, y, z with ideograms as shown in Figure 3 (*Yōsan Yōhō*, 1857, p. 8a).

A comparison of the *Yōsan Yōhō* with several Dutch arithmetic books from Hayashi's list does not

[18]For a discussion of these terms and their use for the official "Government course guidelines for elementary school, Arithmetic" issued later see Kiyosi (1996).

[19]According to the historical dictionary *Woordenboek der Nederlandse Taal*.

[20]Translated from the French from Horiuchi (1996, 260).

reveal any direct source.[21] In all probability, Yanagawa's book is not a translation of a Dutch book on arithmetic but rather a commentary or a collection of notes on Dutch arithmetic. The notes may have been collected while consulting Dutch arithmetic books but it might also possible that these were based on the lessons that were taught at the Nagasaki naval school. I have already situated the book in a context where knowledge of Dutch terms for operations is important and the use of Dutch phrases to memorize multiplication tables. Another indication is the kind of problems we find treated in the book:[22]

> One battle ship in Germany has 80 guns and 2000 crew members. One frigate has 36 guns and 600 crews. How many guns and crew members do five battle ships and 10 frigates have?

With Huyssen van Kattendyke complaining that his Japanese students could not always appreciate the relevance of arithmetic and algebra for the art of navigation, it makes sense to set arithmetical problems within the practical context of naval warfare.[23]

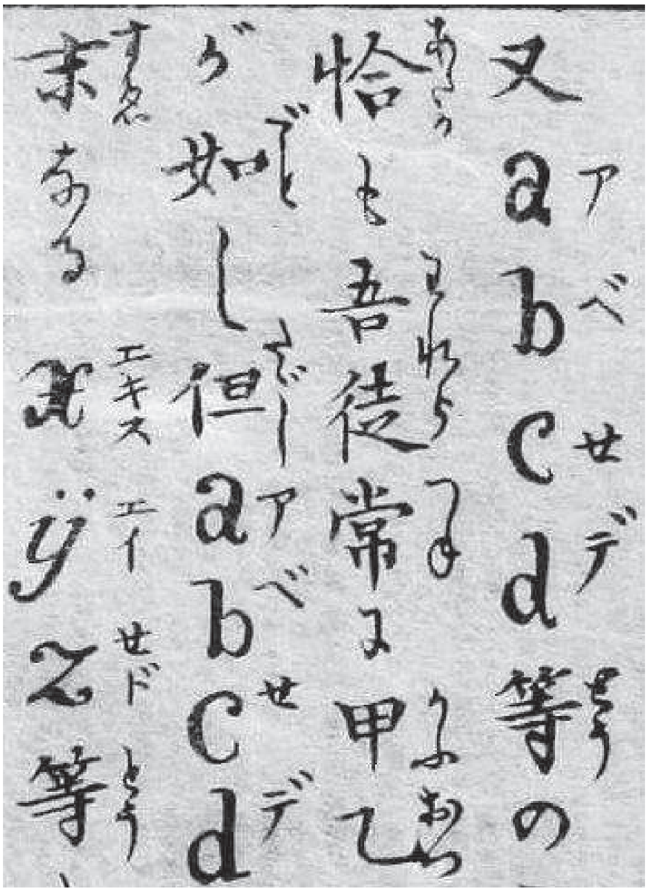
It comes as no surprise that there is a strong parallel between the educational philosophy of the Nagasaki naval school—and consequently early Meiji education—with what Danny Beckers (2003) has called the 'propaedeutic function of mathematics' in the Netherlands during the first half of the nineteenth century. Despite the strong emphasis on mathematics in the Nagasaki naval training program, the intention was not to create able mathematicians but to use mathematics as a basis to transform the samurai mind to modern Western thinking and learning. The main proponents of the new educational program in Holland at that time were the Leyden professor Jacob de Gelder, I.R.Schmidt and Rehuel Lobatto from the Delft polytechnic school and J. Badon Ghijben en H. Strootman from the Breda military academy. These mathematicians produced the textbooks we find used in Japan during the 1850's and trained the teachers of the Nagasaki naval school.[24] Beckers (2003, 238) describes the rise of the propaedeutic function of mathematics as "the successful mix of belief in progress, educational ideas and the rise of modern nations" which thus provides the best fit for the needs of the new Meiji era of the Japanese society. If indeed we may attribute such important influence of the Dutch to education in Japan of the early Meiji period, the relevance of Holland, the Dutch language and *rangaku* rapidly evaporated. While some students of the naval school were sent to Holland for further study, together with instructors of the *Bansho shirabe-sho* such as Nishi Amane and Tsuda Mamichi, they soon found out that the Dutch language was of minor importance in the intellectual, cultural and political centers of the West. Jansen (1958, 595) reports that Matsuki Kōan of the institute complained that he could hardly find any Dutch books and that the "Hollanders themselves all read their books in French and German". With the opening of Japan, two centuries of *rangaku* came to an end and English, French and German books soon replaced the Dutch works as sources of Western learning.

[21] Hayashi (1905) with some additions in Hayashi (1909a, 1909b). In particular I looked at the arithmetical works: de Gelder, J. *Allereerste gronden der cijferkunst*, s'Gravenhage en Amsterdam: Gebr. van Cleef, 1824; Wiskundig Genootschap, *Verzameling van nieuwe wiskundige voorstellen*, Amsterdam: Weijtingh en Van der Haart, vol. 1: 1820, vol. 2: 1846; and the elementary algebra by J. Badon Ghijben, H. Strootman, *Beginselen der Stelkunst, bevattende: De behandeling der stelkunstige vormen , de oplossing der vergelijkingen van den eersten en tweeden graad, De treorien der gewone logarithmen, reken –en meetkunstige reeksen en kogelstapels*. Breda: Koninklijke Militaire Academie, 1840 (2nd ed.).

[22] *Yōsan Yōhō* (1857, 34b). The problem is quoted by Shigeru (2000, 446).

[23] Huyssen van Kattendijke (1860). I have no evidence that this problem is derived from the *Kaigun Denshu-sho* but as the available Dutch books do not contain such examples and its first appearance in a book of 1857 while the lessons took place in Nagasaki makes a connection very likely.

[24] Pels Rijcken, the main instructor in mathematics and officer in charge of instruction of the first detachment, was trained at the Breda military academy.



the introduction of literal symbolism in the *Yōsan Yōhō*

3 Conclusion

The confrontation with Dutch mathematics at the end of the Tokugawa period raises the issue how foreign knowledge can and should be incorporated within existing traditions. Of the possible strategies of adaption, integration or replacement the Meiji regime chose drastically for the latter one, abandoning its own rich and flourishing *wasan* tradition. The possible choices are exemplified by the first two Japanese works on Western mathematics. The *Seisan Sokuchi* tried to adapt Western procedures to *wasan*. Yanagawa criticized such approach and intended his *Yōsan Yōhō* to be a faithful rendering of Dutch methods and procedures but also terms and symbolic notations. I have situated this revolution in Japanese mathematics within the context of foreign threat and the development of a Japanese naval force. The Dutch played a major role in placing education in Western mathematics as a condition for their support to this enterprise. I have pointed out several connecting lines between the Nagasaki naval training program and the newly established *bansho shirabe-sho* institute. The educational approach taken in the Dutch books used for the training program fitted very well the ambitions of the Meiji regime. The influence of Dutch learning in the latter years of the Edo period may have been greater than believed.

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