

# In Pursuit of Futility? On the Role of Wasan in the History of Science

KARAI SL, Antonia

## 1. Introduction

*Wasan*, Japan's idiosyncratic mathematical tradition, came to flourish during the country's period of national seclusion, with a *longue durée* of some 250 years throughout which people contributed to the discourse in various ways: by publishing books, through oral transmission, and through the dedication of *sangaku*, votive tablets featuring mathematical problems, in shrines and temples. Benefiting from a jump start from Chinese mathematics, *wasan* developed its own dynamics with the growing network of Japanese mathematicians. Across the country, numerous temple and private schools, the latter usually run by masters trained and licensed in specific schools of thought known as *ryuha* (流派) (Rubinger 1982), offered education on mathematics and other subjects. Yet unlike other fields like medicine or astronomy, *wasan* was not as easily shaken by pre-Meiji contact with Western sciences, and might have continued to dominate thereafter, had it not been deliberately demoted with the Meiji government's instalment of Western-style mathematics education at public schools in 1872 (Horiuchi 2010, XX-XXI). As Yoshio Mikami and David Eugene Smith remark,

it would seem that the scholars of the early nineteenth century were quite doubtful as to the superiority of the European mathematics over their own, which is a rather unexpected testimony to the independence of the Japanese in this science. (Mikami, Smith, 1914, p. 272).

Ultimately, it was voices from outside the discipline who ventured to introduce Western mathematics, as a historically necessary prerequisite for the coveted

technological and scientific advances of the West (Koizumi, 1975, 12-3). Institutionally speaking, *wasan* was abruptly relegated to the past whilst still present – and it seems that the political decision to cut short one tradition to be officially replaced by another consequentially cast a curious shadow on *wasan's* historiography.

Whilst only Japanese scholars published on the topic before 1900, the early twentieth century into the last decade thereof did not see much discussion of *wasan* in English-language scholarship, until the debate picked up in speed afresh with the turn of the millennium (Kümmerle, n.d.; Ogawa 2001). Before that, however, the few international publications on *wasan* often revolved around the comparison with Western mathematics. From a point of historiography, such a vantage point tends to put the cart before the horse: rather than investigating *wasan* as a cultural phenomenon from its inception, its wax and wane is assessed against a knowledge system that did not have much impact on its actual development. The result is a curious sort of counterfactual history whereby the legacy of *wasan* is measured against a teleological end point it might not have ever meant to reach – and consequently opportunities to study it as a cultural, historical and sociological phenomenon remain untapped. The following will showcase some examples to then expand on the complexities involved and comment on future possibilities.<sup>(1)</sup>

## 2. A Tale of Two Mathematics: Historiographical trends on the topic of *wasan*

When in 1872 the new powers that be rang the death knell on *wasan* as Japan's primary mathematical dis-

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(1) The terms "West" and "East" will be used in a rather loose manner, generally referring to the European-American sphere and Asia respectively.

course, antiquarian efforts rushed to preserve its legacy in token anticipation of its demise. The scholar Endo Toshisada (1844-1915), for example, fearing for a national heritage on the brink, collected and copied numerous rare manuscripts (Horiuchi 2010, XX). Tsuruchi Hayashi (1873-1935), amongst the first authors to publish on the history of *wasan* in a Western language, collected close to 15,000 *wasan* books, later bequeathed to Tohoku University (Heeffer 2008, 21). As early as 1914, Yoshio Mikami and David Eugene Smith published *A History of Japanese Mathematics*, which continues to serve as an important point of reference for English-language scholarship on *wasan*.<sup>(2)</sup> The work aims to introduce outsiders to major works and trends of *wasan*, in a bid to communicate its characteristics, achievements and the “peculiar genius of the old school”, idiosyncratic for “the everlasting taking of pains, for ingenuity in untangling minute knots, and thousands of them” (Mikami and Smith 1914, 280). The nostalgia for *wasan*-fostered virtues contrasts curiously with the less-than-measured excitement for its poster children, first and foremost Seki Takakazu (1642-1708) – a “wonderful teacher”, a trailblazer and innovator for sure, but “that he was a great mathematician, the discoverer of any epoch-making theory, a genius of highest order”, the authors cannot find “the slightest evidence.” (Mikami and Smith 1914, 127). Their assessment conceivably draws from the juxtaposition with his European contemporaries – and granted the path taken by the latter led to the state of affairs that ousted Japanese mathematics, Seki cannot but lose in comparison.

Ultimately, less than 50 years after the Meiji Restoration, Mikami and Smith consider the age of *wasan* concluded with the hope cut short that one of its proponents might produce groundbreaking work. In that sense, the beginning and end, in fact, the whole periodization of *wasan* is not qualified by the existence of a discourse – it is defined by the impact of its output. As per their dejected summary statement,

From the standpoint of opportunity Japan did remarkable work; from the standpoint of mathematical discovery this work was in every way inferior to that of the West.

(Mikami and Smith 1914, 280)

Deliberately or not, Mikami and Smith thus set the tone for the English-speaking historiographical trend of almost a century that presents *wasan* as “exquisite rather than grand” (Mikami and Smith 1914, 280), retroactively doomed by the comparison with the Western tradition. In the process, the debate rarely proceeds unimpassioned – almost a century later, in fact, Annick Horiuchi remarks that “reflections on *wasan* in the course of the last century were never free of an ideological content”, whereby defenders of *wasan* advertise independent, prior discoveries of theorems also known in the West, and detractors denote its inferiority and the feudal nature of its organization, which doomed *wasan* to intellectual sclerosis (Horiuchi 2010, XXI).

When it comes to the historiography of science in general, it seems the compulsive Western vantage point is a by-product of the global predominance of the West’s scientific legacy in the present day. As Shigeru Nakayama, one of the few scholars publishing in English and Japanese on premodern Japanese science, remarks,

the main current of the Western scientific enterprise is now the common heritage of the history of science profession, capably summarized at the textbook level all over the world. Even in Asia the definition of the discipline draws on the Galilean-Newtonian tradition. Thus, East Asian historians of science are involved in the same enterprise as Westerners. (Nakayama 1995, 81)

The assumption of a commonly shared endpoint of scientific knowledge, derived from the Western tradition, means that for the best part of the twentieth century, less critical commentators tend to measure the scientific progress in non-Western countries by its proximity to the practices and institutions established in the West, with priority disputes being central to the discussion (Nakayama 1995, 82, 83).

Nakayama’s observation is revealing insofar as the history of science, more than historiography in other areas, might have an inherent bias to tackle. In most other fields of history, a Whiggish or teleological line of argument would be considered epistemologically questionable. Historiography of science, however, somehow contends with the assumption that col-

(2) The book continues to be reprinted to this day, most recently in 2022, 2020 and 2019.

lective scientific progress has a definitive end point in the present – and that any long-term pursuit of knowledge should be expected to advance towards this point. Nakayama himself does not believe in a necessary convergence of this kind, but he remarks in all candour that until the 1960s, any papers written for a Western audience “were neither understood nor accepted unless they were framed to fit the assumption that the goal of East Asian science should be to assimilate modern Western science.” (Nakayama 1995, 83). For better or for worse, such a teleological bent would be less obvious in scholarship on Western science, but positively glaring in the case of the East.

In the case of *wasan*, the Meiji government’s deliberate break with the past naturally disqualifies *wasan* from this imagined convergence with the science of the day. This circumstance is further thrown into relief by the comparison of *wasan* with concurrent developments in the West before said break even occurred. A recurring trope, for example, is the failure of Japan to produce anything akin to what is usually termed Europe’s “Scientific Revolution”, a topic James Bartholomew devotes a whole article to (Bartholomew 1976).

Bartholomew is actually trying to contextualize, rather than downplay, premodern science in Japan in an attempt to showcase a robust intellectual tradition independent from the West. Yet his vantage point is based on assumptions about the sociological, ethical and epistemological framework developed in the West. When analysing the development of a scientific community in Japan after the Meiji Restoration, for example, Bartholomew remarks that the word “scientist” might not be well applied in the Tokugawa context, granted there was “neither an institutionalized research role nor anything like a modern scientific community”, “[j]ournals did not exist” and “[e]ven those customs of European science that developed in the early modern period – a dispassionate attitude and a stress on objectivity – were not always accepted in Japan”, complete with practices that would seem “unprofessional” and “unmodern” to the contemporary reader, such as keeping “vital information from qualified colleagues or refuse to publish their findings” (Bartholomew 1989, 10). Elsewhere, Bartholomew remarks on a “basic tendency in Meiji Japan...to conflate science and technology” whereby “many scientists ignored western rhetoric about ‘science for its

own sake’ and justified their work almost entirely on the basis of social utility”, also due to the fact that in Edo Japan, “social class barriers had not yet separated western basic science from applied technology, whereas in premodern Europe, science had belonged to the aristocracy and technology to the urban and rural lower class.” (Bartholomew 1993, 107). To what degree science in the West really followed the ideal of an open, collaborative model in the Early Modern period, is disputable, as also the presumed division between science and technology. This assumption seems to spring from an idealization of the present, not an actual observation of the past. As it is, Bartholomew is trying to introduce Japan as an alternative model and presumably framing the debate in terms familiar to his audience. Even so, above statements seem overly generalized in the premodern European context and anachronistic in the Japanese realm.

Approaching the matter from a different angle, Mark Ravina’s article of 1993 examines the epistemological barriers and esoteric bearing of *wasan* to understand why it failed to support Edo scholars’ understanding of Western sciences. As Ravina remarks,

Rather than study the physical world, *wasanka* chose to deal with purely mathematical problems, often posing equations of remarkable complexity merely to demonstrate their skill. .... *Wasan* is thus more notable for what it did not accomplish than for what it did. It left no trace of its achievements on Japanese scientific thought.

(Ravina 1993, 206-207).

Ravina’s article is focused on missed opportunities with regard to Western sciences; his contribution provides somewhat less insight into what *wasan* did do in support of native sciences. Keiji Nagahara and Kozo Yamamura, for example, single out major advances in the fields of stone-built architecture, techniques of mining and surveying, specifying that this process was also linked to *wasan*. (Nagahara and Yamamura 1988, 80, 89). Whether these fields classify as “science” or “technology” in the modern sense might not be clear, nor whether such a classification actually helps to elucidate the historical process at work. What their research does imply, however, is that fields of practical knowledge and concomitant research did profit from the mathematical discourse at the time.

Even so, Ravina does point to a circumstance that makes *wasan* a historiographical riddle when it comes to positioning its role within the history of science: the fact that *wasan* masters of the Edo period did not necessarily understand themselves to be pushing the frontiers of collective knowledge or to take their primary cues from the natural world, but to be practicing mathematics akin to an art. This attitude is occasionally advertised in *wasan* books, such as *sangaku* collections. Thus, the preface to the *Sangaku kochi* (算学鉤致), a compilation of *sangaku* problems by Ishiguro Nobuyoshi, and the *Sanpo Koren* (算法琥璉) by Tadayoshi Kobayashi, both published in the first half of the nineteenth century, contextualize mathematics as one of the Confucian Six Arts, at a self-conscious distance from practical utility (Ishiguro 1819; Kobayashi 1836). Yet when considered in detail, the notion of splendid isolation from real-life pursuits does not hold up across the board. As Tsukane Ogawa notes, scientific questions in fields like calendrics, architecture or trade did provide impulses for mathematical thinking – and conversely, the famous *wasan* scholar Fujita Sadasuke apparently considered the dedication of *sangaku* useless (Ogawa 2001, 145-6).

*Wasan* is not only difficult to pinpoint in terms of purpose but also with a view to professionalization. In terms of social organization, the *wasan* schools (or *ryuha*) followed the *iemoto* system akin to Japanese arts like *ikebana* or calligraphy whereby schools taught and licensed their students. In the case of mathematics, the system might not have strictly adhered to the framework as established in other fields, however, *wasan* schools did have a system of licensing whereby a student progressing to a certain level could qualify as a teacher of that school (Ogawa 2001, 145). Consequently, mathematical knowledge doubled up as commercially valuable intellectual property. The public discourse thus often shows a dynamic of signalling knowledge without fully disclosing it, in form of *idai*, so-called “Bequeathed questions”, scholars would solve and reciprocate in kind, or *sangaku*, publishing problems without disclosing the full solution. This part of the public discourse served less to exchange knowledge than to circulate problems – and the participation in this activity was not exclusively professionally or scientifically motivated but also done for pure enjoyment (Horiuchi 1998). Particularly in the case of *sangaku*, the reason for dedication could be manifold, be

that to signal community spirit, advertise a school or simply flaunt personal achievement. Often enough, a *sangaku* contributor would not specify an affiliation with a school or master, or even primarily identify as a *wasan* scholar, as e.g. a survey of the *sangaku* extant in Kanagawa prefecture testifies (Kawase 2015). Thus, *wasan* was not relegated to a professional sphere, but involved a social fabric with contributors of all kinds, hardly captured by the institutional framework of Western science.

The historiographical riddle posed by *wasan* might thus be directly proportional to the variegation of intent and participants and the fact that the bulk of collective activity neither necessarily nor deliberately avowed to collective progress. Positioning famous Japanese mathematicians within the history of science may be a more straightforward task, yet cutting out their penumbra also diminishes our potential for understanding the sociological breeding ground to their discoveries. The question still beckons, if a discourse is partly bent on futility, what role *does* it play in the history of science? There may be no straightforward answer, but the fact remains that there *was* a body of knowledge that evolved and propagated throughout Japan during the Edo period and interacted with other fields, even though its composition, media and participants did not follow standard assumptions about the role of science in modern times. What role *wasan* can play in the history of science might be more fruitfully addressed when the existing body of evidence is considered in its own right, less with a view to “success” or “failure” of its proponents’ output than by investigating the actual development and the collective effect. If considered in detail, such research can provide nuance to generalized assumptions about the history of mathematics in Japan if not elsewhere in the world as well – and the availability of unexplored material in form of printed books, manuscripts and *sangaku* implies there is scope for discovery.

Promising avenues of investigation include the interplay between oral teaching, printed media and *sangaku*, the relationship between centre and periphery and the dynamics of economic, political and social stimuli or barriers to the dissemination of mathematical knowledge. *Sangaku*, which had been dedicated throughout the country, provide a segue for investigation: to date, over 900 *sangaku* are declared extant; records of, conservatively speaking, over 1500 *san-*

*gaku* lost but recorded in literature are preserved (Fukagawa 1998). Tsukane Ogawa stresses that “it would be fallacious to consider that the essence of Japanese mathematics reveals itself in *sangaku*” (Ogawa 2001, 138). Yet even if *sangaku* cannot be expected to cover the field in depth, they can still serve as pointers to areas worth investigating. For one, the distribution of *sangaku* across the country is far from even. *Ryuha* like the famous Seki school or the Saijo school dominated in some regions and famous masters projected a strong brand at a distance – to the point of fake signatures in peripheral regions (Horiuchi 1998, 143). Moreover, local peculiarities can be identified on *sangaku* dedicated in areas such as Fukui, Ishikawa, Niigata or Kagawa, such as folkloristic elements, artistic flourish or traces of foreign influence. What beckons further exploration, thus, is how periphery and centre relate to each other when it comes to the promulgation of mathematical knowledge and potential cross-pollination with other domains of society.

What has also been little explored to date is the interplay between the different media. *Sangaku* as items are bound to a locality, but collections of *sangaku* problems were published as printed volumes, reaching far-flung audiences. The spread and reciprocal nature of *wasan* is visible in the proliferation of certain problem types across the country, and their transformation and increasing complexity, but the dynamics of this process involving *sangaku*, print and oral transmission has not been investigated systematically to date. Analysing the spread and evolution of these problems from a data-driven perspective might provide insight into standard paths of learning otherwise kept under cover. Current state-of-the-art technologies in computer vision and text mining should provide useful tools to explore this material in a systematic fashion. Additionally, manuscripts such as the *Dochu Nikki* (道中日記), Yamaguchi Kazu’s travel journal of the early nineteenth century documenting numerous *sangaku* and the author’s encounters with locals and scholars, give anecdotal insight on the social dynamics behind the discourse.

Lastly, in some regions, the dedication of *sangaku* continued steadily throughout the Meiji period, particularly in Saitama and the Tohoku area where dedications were made as late as the Taisho period (Fukagawa 1998). Where Mikami calls an era to a

close with the wane of groundbreaking contributions, *wasan* as a social, cultural if not practical pursuit continued, governmental edict in spite. The nature and development of this lingering habit still beckons exploration; in the meantime, it is clear that at a grass-roots level, *wasan* ended less abruptly than some scholars imply, and archival research in the respective regions could elucidate this circumstance and its impact in more detail.

As said, the investigation of *wasan* requires some standard assumptions about Western science and its introduction to Japan to be thrown overboard. Western-born tenets about the ethical values and social infrastructure circumscribing the “scientist” as such might be hindrance more than help. This also goes for presumed boundaries between professionals, amateurs, institutions and disciplines. Some issues of categorization, moreover, refer to the discipline as such. For one, standard demarcations such as “geometry” and “arithmetic” do not necessarily apply in the context of Japan (Horiuchi 2010). In fact, according to Kota, with the Meiji government’s introduction of Western mathematics, arithmetic, algebra and trigonometry seem to have posed less of a challenge to *wasan*-trained students than Euclidean geometry, due to its distinctly different nature, regardless visual similarities (Kota 2018, 339). In addition to the disciplinary mismatch, decoding *wasan* problems expressed in merely textual terms can pose a linguistic challenge, not to speak of the fact that most sources on *wasan* are written in *kanbun*, a sinographic writing standard used in Japan from the Middle Ages until early modern times. The forms of notation that do exist in *wasan* texts are not uniform and beckon contextualization, and, as Tsukane Ogawa notes, the transliteration of *wasan* equations into modern notation can obfuscate the understanding of historic approaches, if not foster false assumptions (Ogawa 2001, 147).

The significant expertise needed to engage with the primary material thus poses a challenge for international scholarship, with unintended effects on the choice of material and the mode of presentation. As Nakayama observes, generalists on the history of science typically cannot engage with sources that require such deep skillsets, leaving the histories beyond their ken to native specialists. Thus, when engaging with a specific country’s scientific history, non-native scholars often focus on the standard works whilst native

scholars branch out into lesser known or undiscovered sources. (Nakayama 1995, 81). The division between “insiders” and “outsiders” also tends to affect the angle of presentation. As Nakayama, again, contends, language pre-determines audience, and audience pre-determines content: whilst the native audience is “usually interested in what helps to resolve issues of current concern to them”, international audiences show interest on “unique local characteristics” the peculiarity of which might be lost on the native audience themselves (Nakayama 1995, 87). With a view to *wasan*, this would presumably result in a topical split running alongside the linguistic one – and a successfully shared discourse would need to rely on collaborative efforts across borders and barriers, not only to bridge the skills gap but to communicate divergent research interests.

Two recent bibliographies compiled by Harald Kümmerle and Tsukane Ogawa signal hope in that regard (Kümmerle n.d., Ogawa 2001). The past two decades have seen the publication of numerous articles reviving the topic of *wasan*, often with a focus on education. The lists also include a small number of monographs or edited volumes. Amongst the latter, Annick Horiuchi’s *Japanese Mathematics of the Edo Period*, translated from French, offers a detailed account of the evolution of *wasan* up to the age of Seki Takakazu, providing a sound basis for further scholarship. Fukagawa and Pedoe’s *Sacred Mathematics* introduces the phenomenon of *sangaku* to a lay audience beyond Japanese borders, as do a small number of English-language publications by Japanese authors. The latter in particular present *wasan* not as a lost cause but as a hidden gem of Japanese culture, albeit in some cases tending towards “(self)-orientalisms”, as Kümmerle notes (Kümmerle n.d.). Isolated cases like Unger, meanwhile, shed light on *wasan*’s technicalities by translating and interpreting primary texts for an English-speaking audience with an interest in mathematics (Kümmerle n.d., Ogawa 2001).

With regard to the interdisciplinary challenge that is *wasan*, Unger and Horiuchi both are rare exponents of Western-educated scholars who combine the requisite language skills and mathematical acumen. The same goes for Kümmerle, the compiler of the bibliography, a mathematician-turned-Japanologist. Fukagawa and Pedoe, meanwhile, share the knowledge of mathematics but not the language, bridging

the gap by collaboration. Collections of essays such as the volume published by Eberhard Knobloch, Hikosaburo Komatsu and Dun Liu on the occasion of Seki Takakazu’s tercentenary signal active international collaboration at work in the research on *wasan*. The collaborative work between Ogawa, Hosking and Mitsumoto (2018), finally, provides a model where much-needed groundwork for English-language scholarship, such as elucidating some basic terms in *wasan*, is combined with deep expertise.

The need to straddle linguistic, cultural and conceptual barriers by means of collaborations or cross-disciplinary skills might pose an inconvenience in some ways. On the upside, however, such a challenge also fosters exchange on a deeper level. A more thorough, cross-border collaborative exploration of *wasan* might not only help to clarify the phenomenon for inter- and national audiences. On an interpersonal level, the need for co-operation might also do a service to the historiography of Western science, insofar as the direct comparison with a distinct and distant mathematical culture might help to better define its own characteristics and, as Nakayama hopes, carve out “its contours ...more clearly” (Nakayama 1995, 84). To put it less kindly: the historiography of science in the West is necessarily rife with tacit assumptions that tend to surface in the treatment of other geographies – and the juxtaposition of said other geographies might be the best way to identify and counter them in turn.

### 3. Conclusion

The increased interest of recent in the wax and wane of *wasan* as a mathematical discourse on the popular level seems well in tune with the turn of the tides in the historiography of science and mathematics elsewhere: Beeley and Hollings’ edited volume *Beyond the Learned Academy: The Practice of Mathematics (1600-1850)*, for example, introduces the cultural and social setting in Europe where mathematics was practiced outside the institutional or scholarly framework, quite apart from elite circles. What is more so, the current trend is indubitably buoyed by the growing number of critical voices admonishing Eurocentric tendencies in the historiography of science. Amongst them, D’Ambrosio sees the broader recognition of alternative modes of knowledge generation and dissemination embedded in other geographies or cultures as “the only way we can escape the arrogance associated with

the Western concept of truth” (D’Ambrosio 2000, 91). Arguably, such arrogance might not be a conscious or even malicious attitude but simply an unintended consequence of national education and institutional socialization. Conceivably, both East and West have their own biases to tackle and in the long run, it stands to hope that goodwill and proactive debate would help to mitigate perceived grievance on either side.

Granted the collective efforts currently made at documenting, digitizing, transcribing and translating Edo period materials, the future for new research on *wasan* bodes well. The topic is not well-established in Japanese universities to date, with only few specialists operating across the country; English-language publications are scarce. Yet libraries such as Tohoku University Library, Yamagata Library and the National Diet Library are making materials available at a rate whilst platforms like *Minna de Honkoku* provide the tools to transcribe and translate these works to make them accessible across language barriers. Specialists will still be needed to mediate content and context; however, it stands to hope that digital technologies can help break the ice or at least put cracks in the language barrier.

To echo Mikami and Smith more than a century after the publication of their work, what role *wasan* is to play in the long run is not yet to be foretold; yet it is certain at this point that placing it squarely in line of a narrative that ends with its official abolition means curtailing the scope for its investigation. What should be clear is that methodologies, concepts and theoretical frameworks integral to the Western history of science might need revision if they are to play a role in the exploration of this material – but in the process, historiography of Western science might profit in turn.

### Acknowledgments

This contribution was written as part of the Sangaku Archive Project, financed by a KAKENHI Early Career Researchers Grant (Project number 24K15964)

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