



From Bataviaasch Genotschap van Wetenschappen to Parc Vaccinogene: Development of the History of Science in History Learning

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Abstract. Technological developments in various fields will affect the pattern of human life. The world of education should respond by making changes that are deemed necessary, starting from paradigm shifts to technical matters, including historical education. The STEAM approach is more widely used in science learning (Physics, Chemistry, Biology, and Mathematics) but can also be applied in social humanities learning, such as history. However, the application of STEAM needs to be initiated by the readiness of the material on the history of science and technology, which becomes the teacher's material to develop the approach. Historical method is used in this article because exploring the history of science requires steps in finding sources, verifying, interpreting, and then writing them down. Various materials on history of science and technology in Indonesia that can be developed, for example relating to colonialism and Western Imperialism in Indonesia, include: epidemics and pandemics of the 19th and 20th centuries, the development of vaccine research during the Dutch East Indies, the modernization of the Dutch East Indies in the 20th century, scientific developments (botany, astronomy, architecture, civil engineering), transportation and communication (roads, railways, telegraph, radio), and the development of new cities in the early 20th century.

Keywords: Bataviaasch Genotschap van Wetenschappen · History of Science · Learning history · STEAM

1 Introduction

The difficulties in developing the history of science and technology in Indonesia is that the writing is at the minimum level even though science and technology, just like other fields in life, are the elements that formed a society in the past [1]. Most historians would avoid such themes because of their inadequacy of science and technology knowledge. As a result, scientific history writing is dominated by experts of each field [2]. Many problems can be answered with an adequate study of the history of science and technology, including Indonesia's current technological backwardness compared to other modern countries [1]. At the high school level, Indonesian history is dominated by national and local history materials, which still focus on political, social, and economic studies.

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The development of scientific history materials can be the basis for the STEAM approach application in history learning. However, researchers are still in doubt whether or not this approach can be applied to learning subjects other than mathematics and natural sciences, including history [3, 4]. The STEAM approach is more widely used in mathematics learning (physics, chemistry, biology, and mathematics) but it can also be applied in social humanities learning, such as history [5].

Integrating STEAM in various social humanities learning is an urgent need in the era of the industrial revolution 4.0 [6, 7]. The STEAM approach leads students to work and think like scientists. The importance of implementing the approach not only in mathematics but also in social humanities (including history) is based on research results that show the implementation of the approach in various disciplines, such as being uprooted from the cultural and historical roots of the local community [7]. The STEAM approach helps students to achieve positive learning, critical thinking, technical skills, and problem-solving [8].

The application of STEAM in history learning must first begin with exploring the history of science and technology in Indonesia as the initial material to be delivered by the teacher in class. The following step is to describe the history of science and technology that teachers can deliver in class through various approaches, models, and methods adapted to the characteristics of the material, students, curriculum, and learning objectives. History teachers will find it challenging to integrate STEAM into their curriculum without a complete understanding of scientific developments, including their history [9]. The history of science and technology provides a learning experience for students where science, technology, engineering, art, and mathematics are related, thus encouraging students to think more broadly about problems that occur in the real world [10].

Concerning science and technology during the colonial period, before independence in 1945, all research and development activities were carried out by the Dutch intellectual elites with a scientific tradition from Europe, and there was no evidence of significant contributions from the natives. Technology transfer to the Indonesian people barely occurred except in secondary education, in the placement of workers in small workshops and factories [11]. This article will explore the development of science and technology in the Dutch East Indies during Western Colonialism. The teacher can use the selected material in history learning, especially the material on Colonialism and Western imperialism in Indonesia, found in eleventh grade of Senior High School.

The material regarding the period of Western colonialism and imperialism that is not widely discussed in textbooks is related to the development of science and technology in the Dutch East Indies, which impacted modernization and social change. The modernization process began with the emergence of research in various fields in the 18th century. Scientific activities in Indonesia were started in the 16th century by Jacob Bontius, who studied Indonesian flora, and Rompius with his famous work entitled "Herbarium Amboinese". In Batavia (now Jakarta), Pastor J.M. Mohr built the observatory for the development of astronomy and meteorology of the Dutch East Indies in 1761.

2 Method

The method used in this research is historical method. Historical method is used to describe events that occurred in the past. This article focuses on developing science and technology history materials that can be integrated into history learning. Thus, the study is centered on the search for historical sources related to the historical material of science and technology. This study follows what was stated by Gottschalk [12]: “Historical method is the process of critically examining and analyzing records and relics of the past.” The historical method is a systematic set of rules for effectively collecting historical sources, conducting critical assessments, and proposing a synthesis of the results achieved in written form [13]. In addition, historical method is a process of critically reviewing, explaining, and analyzing the recordings and relics of the past [14].

The steps of this research refer to the process of research methodology and historical writing as follows:

Heuristics are the initial steps taken after determining the topic or research problem. This stage is marked by tracing, searching, and collecting historical sources needed for research. Historical sources can be classified in several ways, such as oral or written sources. In this case, the authors’ heuristic process is to find relevant oral sources to serve as primary sources in this study after finding some relevant oral sources in the form of books by visiting several libraries and searching for archives at ANRI (National Archives of the Republic of Indonesia) related to the nationalization of the Pasteur State Company, and MIPI (Indonesian Society for Governance Studies).

Furthermore, the research was conducted in the library of PT Bio Farma to find primary sources of the library. The authors found books related to a brief history of PT Bio Farma, the company profiles, and some information about the products produced by the company and the State Gazettes related to the establishment of PT Bio Farma. In addition, the authors also found articles by Dr. L. Kirschner, entitled *De Lanndskoepoek Inrichting en het Instituut Pasteur 1890–1935*. The Ministry of Health Library is located on Jalan HR. Rasuna Said, Kuningan, South Jakarta. In this library, the authors got numerous data about the role of Bio Farma in tackling smallpox in Indonesia. There was also *Staatsblaad van Nederlandsch-Indie* No. 163 of 1890, which explains the establishment of *Parc Vaccinogen*, and *Staatsblaad van Nederlandsch-Indie* No. 148 of 1895 describes the merger of the Pasteur Institute into *Parc Vaccinogen*.

In the UI (University of Indonesia) library, several kinds of literature were found and they are as follows: *Science and Scientists in the Netherlands Indies* by Verdoorn, Frans, editor; Verdoorn, Frans Verdoorn, editor (Board for the Netherlands Indies, 1945), *Handbook of the Netherlands East-Indies, 1930* (Division of Commerce of the Department of Agriculture, Industry and Commerce, 1930), *Six decades of Science and Scientists in Indonesia*, edited; Subajo Soemodihardjo, Stijati D. literary pradja (edit) (Naturindo, 2005), and *Van Batavia Naar Weltevreden: Het Bataviaasch genootschap van Kunsten en Wetenschappen, 1778–1867*, Groot, Hans; KITLV Uitgeverij, 2009.

Criticism is an activity to assess and analyze the sources obtained by conducting external and internal criticism. This activity is intended to find out whether the sources we have collected are relevant to the research to be carried out. This research needs to be done so that the facts presented can be trusted. The third step is Interpretation, which

is an effort to understand and find the relationship between historical facts so that they become a whole unit and rational. One event is linked to another event. So that it can create a harmony of interpretation related to the discussion studied about the history of science and technology during the Dutch colonial period; this stage can be done through historical thinking, where the author tries to understand a historical event by positioning himself as an actor so that it seems as if he can revive the historical event. Historiography is the last stage in historical research, which is a writing and compiling research results activity.

3 Result and Discussion

3.1 Modernization of the Dutch East Indies Through the Development of Science and Technology

Developing science and technology in the Dutch East Indies was closely related to colonial politics. In 1832, the Netherlands started a project to build irrigation lines in indigenous agriculture and plantations, including those owned by the government through the *Burgerlijke Openbare Werken* (BOW) for the sake of Cultivation. Dutch experts at the *Technische Hogeschool* in Bandung, such as D.G. Romijn and H. Vlughter, have studied various kinds of research to develop irrigation for agriculture and plantations. In addition to irrigation canals, Van Thiel started a dam construction project, although it failed several times because it was swept away by floods. Only at the end of the 19th century was the dam successfully built by observing and studying rivers with tropical climate characteristics [11].

Colonial politics crossed with Dutch scientists' interests regarding Indonesia's natural conditions, which have a tropical climate while also rich in flora and fauna diversity. Since 1840, there have been 11 journals published in Batavia on the ecology of Indonesia. Franz Junghuhn, 1842, began to collect data on geographical and natural changes in the Dutch East Indies archipelago. His efforts were assisted by the inhabitants of the Dutch colony, both government and non-government employees. Junghuhn explored volcanoes in Java in 1835–1848, and his research was published in the book "*Java: Deszelfs, Gedaante, Bekleeding, En Inwendige Structuur*" (Java: Form, Vegetation, and Its Internal Structure). The study was also carried out by the British scientist Alfred Wallace, who travelled around the archipelago from 1854–1862 to explore the distribution pattern of flora and fauna.

Knowledge of botany developed in the Dutch East Indies with the existence of Bogor Botanical Gardens. Blume and P.F. von Siebold were two of the foremost scientists. Blume was the head of *Botany at Rijksherbarium* from the Netherlands, and Siebold was an expert in growing *Iris* (a plant from Japan). At the end of the 18th century, the *Bataviaasch Genotschap van Wetenschappen* was formed. Then in 1817, C.G.L. Reinwardt founded the "Indonesian Botanical Gardens" in Bogor. Since 1840, the Bogor Botanical Gardens (Buintenzorg) management had been in the hands of the governor-general. This science institution was related to a large amount of funding for managing botanical gardens. Scientists born from the Bogor Botanical Gardens include J.E. Teysmann and J.K Hasskarl, who succeeded in establishing a connection between the Bogor Botanical Gardens and an international network of botanists. In 1844, with the

support of the colonial government, the botanical gardens succeeded in creating a catalog, herbarium, and library. However, it was very unfortunate that the next governor-general was not very interested in the botanical gardens as a center for developing botanical science and it certainly affect the funding.

In addition to the Bogor Botanical Gardens, there is also the Cibodas Botanical Garden, built around 1852. In 1856, Teuscher was listed as the administrator of the Cibodas Botanical Garden. Teysmann started to grow the Quinine in the botanical garden in 1852. J.K Hasskarl was assigned by the Dutch East Indies government (Pahud) in 1851 to acclimatize Quinine. The idea of introducing Quinine to the island of Java had previously been conveyed by several experts such as Reinwardt, Blume (1929), Fritze, Mulder (1838), Vrolik (1839), Miquel (1846), Fromberg and Junghuhn to the Dutch government [15]. In 1854, Hasskarl succeeded in planting a quinine tree in the Botanical Gardens of Cibodas, West Java. Hasskarl added quinine species, namely *C. pahudiana*, in 1854. His efforts were continued by Junghuhn and J.E. de Vrij in 1856–1863, but they eventually failed.

JHF Solleijn Gelpke was a Dutch official who cultivated rice in Indonesia in the 19th century. The biggest obstacle to rice cultivation in the Dutch East Indies at that time was some superstitious beliefs that were still attached to rice cultivation [16]. The Dutch government had carried out agricultural mechanization since 1914 on sugar cane plantations in Sidoarjo. In 1857, W.H. de Vriese researched agricultural conditions in the Dutch East Indies for three years. The results of his research contain a request for changes in the agricultural system in the colonies to be based on a scientific foundation.

The development of research in botany did not make the colonial government forget the development of the communication sector. In 1856, the Dutch East Indies government built a telegraph network system between Batavia (Jakarta) and Buitenzorg (Bogor). In the the following year, the Batavia-Surabaya telegraph network was also established. The development continued to be carried out in Sumatra and Singapore, as well as all the islands of Java, Bali, Lombok, and Sulawesi [11]. By 1900, telephone networks were already connected in Batavia, Cirebon, Tegal, Pekalongan, Semarang, and Surakarta [17]. Radio had been overgrown since 1918, which was initiated by the creation of a radio station in Bukit Malabar, Bandung. Thus, ANETA was born. It was the first Dutch East Indies radio station. ANETA's broadcasts were aired to Bandung, Yogyakarta, Semarang, Surabaya, Makassar, Manado, and other big cities in Indonesia [17]. Regular broadcasting appeared in 1933 through *Philips Omroep Holland Indie* and *Nederlandsch Indische Radio Omroep Min* (NIROM).

In 1842, a journal published in Batavia proposed a plan to build a railway network in Java [18]. However, the plan was not supported by Governor-General Rochussen in 1845 and instead encouraged researchers to focus their studies on non-political aspects. In 1869, Batavia began to build a horse tram that moved on rails. The railway line was first built in 1862 by the *Nederlandsch Indische Spoorweg Maatschappij* (NIS) company, namely the Semarang-Surakarta-Yogyakarta line. Since mid-1878, the railway line was built in stages from Bogor to Cilacap through the interior of Priangan. In terms of transportation itself, trains in the Priangan area operated in stages from 1881–1911. In 1888, eight railway lines in Java had operated, connecting 15 major cities. In addition to the train lines, since 1899, electric trams had been built in Batavia and expanded to

14 km in 1909. In 1918, the experts in the Dutch railway company mostly were Dutch, Chinese, and European-indigenous descent [17].

The chemical industry in the Dutch East Indies was marked by the establishment of the first cement factory in Indarung in 1910. The Dutch also established paper factories in Padalarang and Leces. Daalennoord was a scientist who succeeded in making the TIB Getouw loom in 1922. His looms spread throughout the archipelago from 1930–1937 and helped the development of the textile industry in the Dutch East Indies. The machinery industry in the Dutch East Indies began with the establishment of NV de Bromo in Pasuruan (1865), NV De Industrie (1878), and CV Vulkaan (1918) in Surabaya. The industry was established to repair and procure plantation product processing machinery [16].

J.F.F. Moet, in 1880, asked the Dutch government to aid building roads aside from the railway line. The invention of machines that gave birth to two and four-wheeled vehicles also encouraged the colonial government to develop road transportation further. The Pos highway built by Daendels was already too congested and dirty, so another road needs to be built [17]. Air flights in 1928 were already crowded; most were European tourist flights but did not touch the natives' interests [17]. The Dutch pharmacist, H.F Tillema, propagated a lot about the importance of paved roads and clean water.

In addition to communication and transportation, mining technology were developing rapidly along with mineral sources discoveries in the Dutch East Indies. In 1823, the Colonial Government took over the tin mining in Bangka. Prins Hendrik der Nederlanden and Baron Tuyll van Seroskerken received concessions for the added tin [11]. The discovery of coal fields in 1868 at Oembilin by the Dutch mining expert W.H. de Greve encouraged many expeditions to locate mines for metals and other minerals [17]. Since 1881, oil and gas exploitation had contributed to mining technology development in the Dutch East Indies. P.P. Bijlaard is internationally renowned for his studies of steel structures which are the basis for the development of the science of mechanics of materials [11].

Cities in the Dutch East Indies, such as Batavia, Bandung, Semarang, and Surabaya, proliferated in the early 20th century. The growth of these cities was in line with the development of science and technology in urban planning, architecture, water distribution, sanitation, waste treatment, and clean water distribution [17]. Famous Dutch architects back then were Maclaine Pont, Wolf Schoemaker, Cuypers, de Vistarini, and H.P Berlage. Urban growth was related to the development of urban infrastructure, including the emergence of buildings and housing. Maclaine Pont was an architect who built various buildings in the Eurasian style, one of which was the ITB (Bandung Institute of Technology) building. C.P. Wolff Schoemaker was a well-known artist and teacher at ITB (he then became the lecturer of Soekarno, the first president of the Republic of Indonesia). He designed the Preanger Hotel, Concordia, and Villa Isola (the current Indonesian Education University Rectorate Building). The architects of the 1930s who criticized the development pattern in the Dutch East Indies at that time were Eduard Cuypers, B. De Vistarini, and Willem Walaven [17].

3.2 Plague and Pandemic Material

The COVID-19 pandemic is not the first pandemic in the archipelago. The influenza outbreak with the most significant impact was the 1918 Influenza Pandemic, also known as the Spanish Flu. The flu epidemic was the most vicious disease outbreak in human history because it had claimed millions of lives [19]. Infectious diseases can explode at any time, and in modern times, many outbreaks have occurred in various parts of the world. In 1890, the Russian Flu outbreak infected England, France, Germany, India, Australia, and the US, resulting in one million people dying [15]. This was the first pandemic to be recorded in detail. This influenza variant also attacked the Dutch East Indies in 1890 and spread in West Sumatra, Banjarmasin, and Magelang. In the same period, the Dutch East Indies was attacked by beriberi, which led Christiaan Eijkman to discover that the disease was due to a vitamin B complex deficiency and dispel Pasteur's theory that germs cause every disease. This discovery earned Eijkman the Nobel Prize in Health in 1929.

Research on vaccines was initiated with a study on antitoxin in Germany by Emil von Behring with Shibasaburo Kitasato (Japan), who succeeded in discovering the tetanus antitoxin. Paul Ehrlich used the principle of Behring's findings to prevent diphtheria. In 1894, Paul Emile Roux of the Pasteur Institute (France) succeeded in producing diphtheria and tetanus antitoxins. Eilerts de Haan (Head of *Parc-Vaccinogene* in Batavia) followed the bacteriology study conducted by Roux. After returning from Paris, *Parc-Vaccinogene* became a part of the Pasteur Institute in the Dutch East Indies [15].

History records that global outbreaks usually occur as occurrences of disease outbreaks and even develop into a pattern [19]. The main impact of the outbreak was the emergence of victims and emergency measures in the fields of health and treatment. However, its influence also extended to the economic, social, political, and cultural fields. The epidemic left hospitals running out of space to treat an overabundance of patients and created chaos.

The rapid progress of health science contributed to accelerate the process of human memory loss against the 1918 flu pandemic because these findings made people no longer worry about the disease and in the end, they forget such "old" problems [19]. This could be dangerous knowing that health problems will always exist and continue to attract attentions. Historians have a role in raising this issue so that the public's memory and awareness are maintained so they won't be negligent in preparedness and vigilance.

3.3 Handling Disease Outbreaks During the Dutch East Indies

Various disease outbreaks that killed many people in the 19th century prompted the Government to make serious efforts to overcome them. A Dutch health researcher named dr. G. W. Kiwiet de Jonge, that the health service until 1890 can be said to have made no significant progress in improving the health standard of the civilian population, especially the natives, apart from smallpox vaccination [20].

In 1780, variolation was carried out to temporarily prevent smallpox, although in a limited scope, it was introduced in Batavia. Smallpox killed many people [21]. The disease began to appear between 1775 and 1815 in several coastal cities of Java, Priangan, Yogyakarta, and Surakarta, which, according to a 1798 report, was the deadliest disease

in Yogyakarta and Surakarta. In 1871, a smallpox epidemic in Bali killed 18,000 people [15].

In 1804, the Government of the Netherlands East Indies began to issue the first Government Regulation regarding smallpox vaccination, *Resolutie, Vrijdag 21 September 1804*. At that time smallpox vaccine was imported from Europe to Batavia to carry out widespread vaccination. This imported vaccine is the result of the development of Edward Jenner. A British health researcher. Smallpox vaccine was carried by the intermediary of children with the method that the children are vaccinated against each other during the trip, thus ensuring that smallpox seeds remain alive [21].

On August 6, 1890, *Parc Vaccinogen* was tasked with tackling the smallpox epidemic that hit Indonesia. The establishment of *Parc Vaccinogenne* was closely related to the smallpox vaccine because it was intended as a place or facility for developing and producing the smallpox vaccine. Due to this, in its development, this institution was later named *Landskoepoekinrichting*, the Smallpox building, or the Smallpox Vaccine-Making Institute. In 1895 the Instituut Pasteur was merged into *Parc Vaccinogenne*, so in 1902 the name became *Landskoepoekinrichting en het Instituut Pasteur* [22]. The Pasteur Institute was an institution for developing rabies vaccines. After the merger, *Parc Vaccinogenne* had two divisions that developed different products: the smallpox vaccine and the rabies vaccine.

In 1804, the Dutch East Indies Government began to issue the first government regulation regarding smallpox vaccination: *Resolutie, Vrijdag 21 September 1804*. At that time smallpox vaccine was imported from Europe to Batavia to carry out vaccinations more widely. The vaccine brought in was developed by Edwar Jenner, a British health researcher. Vaccination measures using vaccines sent from Europe only cover residents in coastal cities of Java. This happens because it was difficult to reach the interior areas of Java due to limited transportation facilities and infrastructure between cities.

In 1820 the Civil Health Service (*Burgerlijke Geneeskundige Dients*) issued a Regulation of the Civil Health Service (*Reglement voor den Burgerlijke Geneeskundige Dients*), which coincided with the issuance of the Regulation for the Implementation of Smallpox Vaccination (*Reglement op de uitoefening der koepokvaccinatie in Nederlandsch-Indie*). A year later, the regulation was accompanied by a letter of instruction to community leaders and vaccinators (*Inlandche Hoofden en Vaccinateurs*).

The health institution established by the Dutch government was the *Eijkman Institute* in Batavia in 1887. In addition to the *Eijkman institution*, the Dutch government also established several research institutes and laboratories such as the one established in Medan by local plantation companies in 1906, which was the so-called Central Laboratory, used for their research and product development.

4 Conclusion

The development of material on the history of science and technology as the material used in applying STEAM is the material of Western colonialism and imperialism in Indonesia. In the 20th century, the Netherlands began to apply various technologies in irrigation, road systems, railways, shipping, and industry. Like other fields in life, science and technology shaped society in the past. Many problems can be answered with an extensive

study of the writing of the history of science and technology, including Indonesia's current technological backwardness. Early scientists from the Netherlands who came to the Dutch East Indies felt that they had a role in the mission of "enlightenment" to the indigenous population and were also interested in the natural conditions of Indonesia, which has a tropical climate and is rich in flora and fauna diversity. The development of science and technology in the Dutch East Indies was closely related to Dutch colonial politics, the arrival of disease outbreaks, and the need for modernization. These "apostles of enlightenment" had little impact on the colony's society due to their elitist nature, lack of strong social support, obstacles from the colonial government bureaucracy, and scientists who preferred a career in politics.

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