Perspectives on science in Dutch nineteenth-century general periodicals, or ideas on the use of scientific education

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INTRODUCTION: SCIENCE IN THE NINETEENTH-CENTURY SOCIETY

The second half of the nineteenth century in the Netherlands is characterised by a strongly increasing influence of science and technology. The period between the end of the 1870s and the First World War in Holland is even called "The Second Golden Age of the Natural Sciences". Much is written about the development of science and technology in this period from the point of view of scientists. But there were so many more people, whose lives were influenced by these new developments. Workers in industrial corporations, saw their way of working changing considerably over a very short period of time? Farmers saw their ideas about running a farm being influenced by the findings and inventions in botany, chemistry and zoology. Most visible were the changes in daily life: the darkness was driven away from houses and streets by gaslight and a little later by electric light; geographical distances were physically diminished by new means of transport, like trains and steam boats. Emotionally they were bridged by new means of communication such as telegraphs - first with wires, later wireless - and telephones. New methods of preserving perishable goods, made it possible to eat peas, cauliflower and even asparagus in winter. With new scientific knowledge, ideas about health and hygiene were spread, leading to better ventilation, safer heating of the houses and organised removal of faecal material. The discovery of germs in water stimulated the construction of water-pipes and sewerage as strictly separate systems. Increasing knowledge about the spreading of illnesses resulted in programs of vaccination and other preventive measures, such as broadening streets, improving houses and controlling labour conditions.

Not all these developments were considered to be positive, of course. Partly because they demanded a change of attitude towards work- and lifestyle, and partly because there were some practical disadvantages. An example is the increasing international competition in trade. As a result of the new means of transportation and the new ways of preserving food, American farmers became competitors for the European farmers. Economically, it became impossible to neglect or postpone the new inventions in industry and farming, because this would cause a permanent backward position in international competition. In short, the developments in science and technology, taking place in the course of the nineteenth century, have had their influence on the whole population. Knowing that, it is interesting to try and find out which images of science were formed and held among broader groups of this population than just the scientists, technologists and politicians themselves.

SCIENTIFIC INTEREST AMONG THE PUBLIC AND SPREADING OF SCIENTIFIC KNOWLEDGE

We saw that science and technology brought influential changes in the lives of the people of the nineteenth century. It has even been suggested, that Dutch society in the nineteenth century was characterised by "middle class scientism", a broadly carried interest in science and related topics. This scientism has mainly been described as a political current, which influenced top-research in the "Second Golden Age of Science". These "scientistic" politicians, mostly from liberal backgrounds, stimulated education and research in different fields of science. What I would like to know is whether this scientism can be found outside political circles and outside the liberal class. Which ideas did industrial workers, farmers, housewives etc. have about science and technology? Did they have any interest in science at all? Were they positive about scientific developments or did they fear them? What did they actually know about science? And, very basically, did they relate the changes in society to science?

To find answers to these questions, we will have to find the sources of scientific knowledge that came into reach of these people. These are cheap popular books and periodicals, public lectures and exhibitions and last but not least education. The numbers of sources are overwhelming. Some publishers published special series of popular scientific books for reasonable prices. Public lectures on scientific topics were visited by considerable numbers of people. The numbers of school books published in the period between 1860 and 1920 are almost uncountable. But these numbers only give us confirmation of an existing interest in scientific subjects, and don't reflect ideas about science and its applications among those people. To get an impression of this kind of information, we will have to go into written sources with considerable impact on a broad spectrum of people: general periodicals (1).

GENERAL PERIODICALS ON SCIENCE

Nineteenth-century Dutch general periodicals are the main focus of my research. In the second half of the nineteenth century, natural sciences more and more became a topic in general weekly and monthly magazines. Except for some periodicals which were primarily oriented on religious questions, most magazines published frequently on scientific topics. Some periodicals had a special column of articles on natural sciences, others mostly put them under a more general heading. But science could also be qualified as "literature" or "religion".

A quick search through a selection of influential Dutch periodicals of the nineteenth century, shows an outline of four main points of attention: Popularisation and education of science, application of scientific knowledge - we might now call it technology -, the unsteady relationship between science and religion and scientific expeditions.

These articles might not be mirrors of the ideas of the nineteenth-century public, but they may be considered as important factors in shaping people's opinions. For

that reason, I have tried to deduce some images of science from these sources, which could be considered as representative for certain groups of people. Here, I will illustrate my findings with the example of the introduction of scientific subjects in primary and secondary schools. The main question will be: Which images of science were held by the advocates and opponents of the introduction of natural sciences in primary and secondary education?

PERIODICALS ON SCIENTIFIC EDUCATION

The liberal interest in spreading scientific knowledge is illustrated by the efforts in the second half of the nineteenth century to introduce scientific subjects in primary and secondary education for children from all social classes. In the new liberal constitution of 1848, Thorbecke promised influential changes in laws on education. It took some time to realize this, but in 1857 the first law - on primary education - was passed. Six years later, the Secondary Education Act followed. Many periodicals paid attention to the introduction of these laws and the consequences they would have for the educational programs. One of the most visible changes was the introduction of the natural sciences as obligatory subjects. For primary schools, this was limited to natural history and geology, for secondary schools, physics, chemistry, mechanics and cosmology were added.

In the general periodicals, much attention was paid to the introduction of the natural sciences in all types of schools. In 1855, Pieter Harting is one of the first to start the discussions on the advantages of this development. The fundamentals of the natural sciences, he claims, are useful, not only for those who are educated for a special position in society, but for those on any level of education.

Most of the articles I found in the general periodicals - mostly written by scientists, education specialists and philosophers - were positive about this change. In general, they agreed on the importance of general scientific knowledge among all members of society. The reasons why they regarded this to be important, however, differed considerably. Broadly speaking, three attitudes towards the importance of an early confrontation with scientific knowledge can be distinguished. 1. Knowledge of nature and its functioning creates more respect for Creation or Nature. 2. Knowledge of nature and its functioning is indispensable in the scientific world of the nineteenth century. 3. Study and understanding of nature are essential for the general Bildung of every member of the society as it improves the senses and helps to solve problems of a more general kind.

Behind each of these opinions, a perspective on elementary scientific education is hidden, which I would like to unravel. The first image is the most traditional view: the physico-theological perspective on science. In this view, nature is considered as Gods creation. God made the world, with everything on and in it, and determines its functioning. This influences the ideas about the way in which scientific research to nature can or even must be carried out. God is expected to give signs to the scientist - or natural philosopher - by which means he can discover deeper truths about nature,

and with it, about God. For the physico-theological scientist, taking stocks and systematising the objects of nature were the main aims of natural science. Gaining knowledge about nature, would lead to more respect and admiration for God, who created all this. As a result, practising science was expected to increase human morality. This image of science had its consequences for the way of thinking about the importance of scientific education. By teaching young children natural scientific subjects, they would get a better picture of creation, more admiration for its regular functioning and last but not least, they would become morally better persons.

This perspective on nature and its science, was influential until the late nineteenth century. In the course of the century, however, a second perspective on science appeared by its side. It considered the natural sciences as keys towards progress and prosperity. Knowledge of science was essential to win and keep a forward position in the world. Science and its applications - technology -, therefore, should be part of everyone's knowledge. In practising science from this point of view, the emphasis was put on explaining how natural laws regulate phenomena, how these laws were applied in technology and how scientific methods can be improved. This perspective on science is behind most of the articles on applied science or technology appearing in the general periodicals. Applied on education, according to this point of view, pupils should be taught in particular the practical knowledge, the elementary theory which formed the basis for this, and the attitude of turning theory into practice.

This utilitarian attitude towards science, however, was not shared by the entire society. Especially people from a didactic background emphasised the importance of a scientific attitude, a way of looking at the world and thinking about it. Scientists doing research from this point of view, tried to find regularities in nature, in order to determine the laws behind them. Having found laws, they used them to predict future phenomena. Their main goal was not to improve the sciences or add new knowledge to the existing knowledge, but to satisfy their own curiosity, to stimulate their need to learn etc. Related to education, this implies teaching science primarily in order to train the senses and to structure the pupils' way of thinking. The emphasis is put on a critical attitude towards the question why things are the way they are, and why they happen the way they happen. In this view, teaching science is a means of reaching individual Bildung, general cultivation, intellectual illumination. The pupils learn to develop a critical attitude towards the world around them, they learn to observe, reason and conclude carefully.

NATURAL SCIENCES IN EDUCATIONAL PROGRAMS

From the previous we know that from the late 1850s onward, attention was paid to the position of natural sciences in the educational programs of primary and secondary schools in the Netherlands. We see a considerable increase in the role of scientific subjects in the educational programs of all these schools (2). But what did the children actually learn there?

In primary schools, scientific education was limited to natural history, which mostly meant reading about animals and plants, and geography. In the more

advanced primary schools (MULO), some attention was paid to agriculture. On this level, natural history and elementary geology are suggested to be important in improving morality. Showing young children the beauty and perfection of nature, is said to help them understand the goodness and perfection of God, who made all this. This knowledge could make them morally better persons. Although science does not seem to oppose religion in this, opposition arises from religious side: Natural sciences would cause doubt in young children about biblical dogma's, as they seem to be contradicted by their scientific knowledge.

After the Secondary Education Act, we see a division of school types specialised according to the future position of the pupils - which usually corresponds to the positions of their fathers. On the middle-class schools (burgerscholen), visited by children from craftsmen and small farmers, the law dictated mathematics, physics, chemistry, natural history, geology, and mechanics, technology and agriculture. In practice, we see an emphasis on arithmetic, geometry and mechanics and besides some of the basic knowledge of physics and chemistry, which was considered to be useful for future craftsmen. Natural history was only taught on a few schools. Children visiting middle-class schools were educated for a job in crafts or agriculture. It could be expected, that the emphasis in the debates on scientific education was on the practical skills. Although there were people who stressed the importance of applied science, voices could be heard in favour of a general scientific attitude. The chemist Jan Willem Gunning was one of them. He says that he wants to stimulate their attention to trace the working and application of chemical truths in nature and life surrounding them. Scientific education on this type of schools should be more general than just the practical application of scientific knowledge.

In the debates on the higher types of secondary education, HBS and Gymnasium, it is all about the question whether the aim of education should be cultivation or practical skills. The secondary schools (Hogere Burgerschool or HBS), visited by children from higher middle-class backgrounds, were not so much oriented towards the future practice of their students, but provided a general education useful for trade, industry and public service. Mathematics, physics, chemistry, natural history, geography, mechanics and cosmography formed the scientific part of the program. After finishing the HBS, the pupils could finish their education at the Polytechnic in Delft.

The traditional Gymnasium, based on the studies of classical literature and arts, could not stay apart from this emphasis on science and many of them founded a second department, where more attention was paid to the natural sciences. Although humanities had traditionally been considered as the best or even the only possible source of general cultivation, in the second half of the nineteenth century, the advocates of the natural sciences argued that these subjects have the same cultivating capacities as literature and arts. In this vision, the study of natural phenomena trains the senses, stimulates research and improves understanding. Besides mathematics, the students were taught elementary knowledge of physics, chemistry, geology, mineralogy, botany and zoology.

The description of the contents of these subjects, however, were hardly more precise than "basic knowledge of..." This implied, that teachers were more or less free to fill in the details and methods of these subjects. In the general periodicals, many disputes have been fought among educational specialists, scientists and teachers about the necessary topics to teach and the most suitable method of doing this. Moreover, review articles of schoolbooks appeared to be useful to spread one's ideas about scientific education.

An important point of discussion is whether books could be useful in teaching science or that science could only be learned in practice. If science is supposed to provide Bildung, the pupils must see with their own eyes what happens when a physical or chemical experiment is carried out, make their own hypotheses, reach their own conclusions. If they learn all this from books, this might result in knowledge of bare facts, but not in scientific insight. However, if the aim of science is mainly to increase respect for the Creator of nature, books can play a major role in spreading scientific knowledge. In case of a primarily utilitarian view on the use of scientific knowledge, books can contribute to the theoretical knowledge of the pupils, but the practical applicability of this knowledge must be learned from experience in practice.

IDEAS ABOUT SCIENCE AND TECHNOLOGY AMONG THE PUBLIC

With these three perspectives on science, sketched above, and the scarce details about the practice of teaching science, however, we have not yet answered the primary question: Which images of science existed among the nineteenth-century public? The contents of several articles in the general periodicals might give us some clues about it.

The educational reforms have been effective in at least one sense: More children than before were confronted with scientific knowledge, and the amount of knowledge - whatever the level - increased. Moreover, they became aware of the role of science behind many changes in daily life. Understanding the basics of the functioning of instruments, these possibly became less of a thread to the new generation.

On the middle-class and technical schools, science was taught from a utilitarian perspective. The emphasis was on its applicability, which will probably have given the pupils the impression, that science was primarily something which could improve your chances on a good job in crafts and industry. They realised that good knowledge of science and its applications was essential to be competitive to others.

By those who did not see the importance of scientific knowledge in time, science might be seen as the dictator of modern society. For them it must have seemed that the rules of science determined what was good and bad. By these means, science was expected to stimulate a materialistic attitude towards life, in which financial and material benefit seemed to be the only factors of importance. This attitude can for example be found in orthodox-protestant circles, among conservative catholics and among farmers. The nineteenth century shows an increasing division between

traditional farmers, whose fathers, grandfathers and great-grandfathers set a tradition of farming, on the one hand, and the new, scientifically educated farmers, mostly of higher middle-class origin, on the other. These new farmers usually had a better financial background, were better educated and were therefore better prepared to take risks, which made them dangerous competitors for the traditional farmers.

Education for all, by means of public elementary schools, influenced the way of thinking about science in another category of people. For the lower social classes, science became their only hope for improvement of the situation in which they lived. Previously, it had been highly improbable that these people had any awareness of the scientific basis of the changes in social circumstances of the poor. Knowledge of science hardly reached further down than the lower middle class. The poor did not have access to the same sources of information, such as periodicals or newspapers, books and lectures. Now that they had a chance to receive at least some basic education, it became possible for the intelligent children among them, to reach a better position in society. This argument was even more realistic for the lower middle-class people. Scientific knowledge could give them perspective on social mobility. Now that education was available to everyone, intelligence and perseverance brought secondary education within reach of the lower social classes.

The image of science as an element of a general Bildung, is only found in articles from authors of a humanities background and by education specialists. I did not find evidence for this, but I do not expect support for this perspective outside the liberal, upper-class circles. Bildung gains importance only for those who don't have to worry about keeping their families alive and well. It is a quality of life that only plays a role in an elite kind of life. In general, we get the impression, that - at least for the authors of the articles - science was primarily something which could make your life more easy and comfortable.

Although the favours of science and technology are said to be independent of social status, in practice the opinions will have differed. People from the higher social classes could experience the benefits themselves, people from lower backgrounds could see them from a distance, but could only dream of experiencing them themselves. The articles which emphasise the applicability of science, form the majority of the articles on scientific topics in general periodicals. This may be a coincidence, but on the other hand, it is not improbable that the practical application of scientific knowledge was for most people the only interesting part of science. What use do scientific theories have in daily life, when you can not use them in any application? The theoretical part of science may be good and useful for scientists, but did not have any tangible value for "ordinary" people.

CONCLUSION: ATTITUDES TOWARDS SCIENCE AND ITS INFLUENCE ON SOCIETY

As we have seen, perspectives on science as they existed among a broad cross-section of nineteenth-century Dutch society, are no ready-made statements to be

found in any kind of literature. But a broad orientation on scientific topics in influential sources – popular general periodicals - can give us some indications. Reading those, however, we must keep in mind by whom these articles have been written and with what purpose. Moreover, we can never be sure that the perspectives on science presented in these articles are the same as the images of science readers deduced from them. But nevertheless, we can be certain that periodicals and newspapers have been important in shaping the opinion of the reading public.

Another certainty we have, is that in the course of the nineteenth century, it becomes increasingly difficult for a citizen from any social class to avoid being confronted with science or scientific knowledge. Basic education, public lectures, popular scientific books and specialised periodicals overwhelmed nineteenth-century citizens with science and related topics. This must have resulted in at least general impressions, and at most strong images of sciences among the public.

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NOTES

1. For this project I have studied several general periodicals, selected on their ideological background, readers public, price and period of existence. Catholic periodicals: *Studiën* (1868-1941), *Het Dompertje van den Ouden Valentijn* [c.s.] (1867-1920), *De Katholiek* (1842-1924), *De Katholieke Illustratie* (1867-1967). Protestant periodicals: *Boekzaal* (1811-1863)/*Stemmen voor Waarheid en Vrede* (1864-1925), *De Heraut* (1850-1913), *Eigen Haard* (1875-1941), *De Hollandsche Illustratie* (1864-1919). Liberal periodicals: *De Gids* (1837-), *Economist* (1852-), *De Tijdspiegel* (1844-1921), *De Huisvriend* (1843-1879)/*Vragen des Tijds* (1875-1930), *Wereldkroniek* (1894-1970). Socialist periodicals and their predecessors: *Nieuwe Tijd* (1896-1918), *De Dageraad* (1855-1898), *Recht voor Allen* (1879-1900) /*De Vrije Socialist* (1898-1961), *De Nieuwe Gids* (1885-1943), *Kroniek* (1895-1907), *Geïllustreerd Zondagsblad van het Volksdagblad* (1895-1908).
2. Over the full *HBS* period of five years, 34% of the time is devoted to natural science and mathematics, while 29% is devoted to languages and literature and 18% to history, trade and political sciences. [1868].