Formal education, practical learning and social mobility in Scandinavia
A historical empirical analysis of high school and engineer graduates from around 1850 to WWII

Project description

Kristin Ranestad

Purpose
Much research has been done on the relationship between basic and technical education and economic growth, but there is not much empirical evidence on its specific functions and direct impact on innovation. We thus still know little about the limitations of formal education and its direct applications in daily work and innovation processes. This project aims to change this, however, through the use of unique sources available in Sweden, Norway and Denmark. In Scandinavia, universities and technical schools had the tradition, between the 1820s and the 1970s, of publishing biographies of graduates. This project proposes to use these so-called ‘yearbooks’ to provide a systematic historical analysis on the micro level of two key subjects, much debated in economic history, namely (1) the direct roles of formal education and ‘learning by doing’ for innovation and economic performance, and how this played out in different industries and (2) education and its historical impact on social mobility, and differences in this regard between genders and regions.

The yearbooks are complete collections of biographies of high school and engineering graduates for given years. The biographies were normally written by the graduates themselves, based on questionnaires, and include detailed information about where they were born, their parents, their fathers’ occupation, scholarships, which school they went to, higher and technical education, travels, study and work abroad, trainee positions and work positions at companies in their own country over time. The publications were normally made 25 years and/or 50 years after graduation, which allows detailed analyses of the graduates throughout their whole working career. It is possible to link the biographies to complete historical censuses on an individual level.

A systematic historical analysis of the functions of education in Scandinavia is timely for at least two reasons. First, both basic and technical education systems are usually considered to be a significant reason for Scandinavia’s strong economic performance over the past two centuries. Detailed historical analyses are scarce, however, of the direct use of formal education, its practical functions for industrial development and the combined use of theoretical learning, learning by doing, networking and knowledge transfer from abroad in work settings and innovation processes. Second, social differences have been relatively small and social mobility has been high in all Scandinavian countries, but whether education has been an important historical driver of this is unclear. Basic and technical education

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systems developed early in Scandinavia, but their historical functions for men and women to move from one socio-economic level to another and to switch between industries, and whether there were regional differences, is yet to be discovered. I propose a systematic empirical historical investigation of entire formal and practical education processes, travels and career paths of a representative collection of high- and technical school cohorts in Scandinavia from the mid-nineteenth century to 1940, a period when these ‘catching-up’ countries of the Industrial Revolution went through a radical transformation in terms of industrial and economic development.

In my PhD research, I used graduate biographies for Norway to investigate the role of mining engineers and formal and practical education in mining. This project seeks to draw on a similar approach and the same sources, but on a more extensive scale. The total number of biographies in the high school and technical Scandinavian student yearbooks - the first one from Denmark starting in 1822 and the last one for Norway ending in 1975 - is estimated to be well over 200 000.\(^2\) I seek to analyse a representative sample of the biographies during the two years of the Post-doctoral fellowship period in Lund and subsequently apply to Riksbankens Jubileumsfond and Handelsbanken, for example, for additional funds to complete the database.

**Database**

A large part of the research project will consist of making a database based on a representative sample of the biographies. An Optical Character Recognition (OCR) program will be used to convert scanned images of the biographies into readable text formats. The following table is an example of how the database might look. All the categories related to (1) education and social mobility and (2) technical and engineering education and industrial development will be filled out for all the graduates (name, gender, birthplace, parents, occupation of father, high school education, higher education etc.). When it comes to (3) engineers, networking and knowledge transfer from abroad, many of the categories will be left blank because the travels abroad varied extensively from graduate to graduate. Some engineers went to many countries, some studied abroad, and others worked. The database aims to capture as many aspects of the graduates’ education and work as possible. ‘X’ is filled in categories which do not apply to the person in question:

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\(^2\) The high school yearbooks for Norway, for example, include in total around 76 000 biographies from 1831 to 1943; in 1831, there were only 117 high school graduates, the number increased to 242 in 1895 and in 1943 there were 3500 graduates. Adding the yearbooks for Denmark and Sweden the total number of biographies probably surpass well over 200 000.
### Examples from the database:

1. **Education and social mobility**

<table>
<thead>
<tr>
<th>Country</th>
<th>Name</th>
<th>Gender</th>
<th>Birth place</th>
<th>Name father</th>
<th>Work father</th>
<th>Name mother</th>
<th>Year of graduation (high school)</th>
<th>Higher education (type)</th>
<th>Year of graduation (higher education)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>Jacob Roll</td>
<td>M</td>
<td>Asker</td>
<td>Olaf Roll</td>
<td>Port director</td>
<td>Hanne Kristine Roll</td>
<td>1866</td>
<td>Mining engineering</td>
<td>1878</td>
</tr>
<tr>
<td>Norway</td>
<td>Kirsten Arntzen</td>
<td>F</td>
<td>Bergen</td>
<td>Olaf Theodor Sundbotten</td>
<td>Chief of machinery</td>
<td>Kitty Mohr</td>
<td>1938</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Denmark</td>
<td>P. M. Gertz</td>
<td>M</td>
<td>Copenhagen</td>
<td>M. Cl. Gertz</td>
<td>Professor, Dr. phil</td>
<td>Anna Møller</td>
<td>1897</td>
<td>Law</td>
<td>1903</td>
</tr>
<tr>
<td>Denmark</td>
<td>Carl Joseph Schwenn</td>
<td>M</td>
<td>Aarhus</td>
<td>Rudolf Schwenn</td>
<td>Lawyer</td>
<td>Pouline S.</td>
<td>1907</td>
<td>Art</td>
<td>1910</td>
</tr>
</tbody>
</table>

2. **Formal technical and engineering education and industrial development**

<table>
<thead>
<tr>
<th>Country</th>
<th>Name</th>
<th>Gender</th>
<th>Year of graduation</th>
<th>Country of study</th>
<th>Institution</th>
<th>Industry (career path/specialisation)</th>
<th>1st position</th>
<th>Year employed</th>
<th>Name of organisation</th>
<th>Highest obtained position</th>
<th>Year employed</th>
<th>Name of organisation</th>
<th>Year retired/died</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>Thomas Georg Münster</td>
<td>x</td>
<td>1878</td>
<td>Norway</td>
<td>University of Oslo</td>
<td>Mining</td>
<td>Amanuensis</td>
<td>1874</td>
<td>University of Oslo</td>
<td>Mining superintendent</td>
<td>1906</td>
<td>Public mining office</td>
<td>1918</td>
</tr>
<tr>
<td>Norway</td>
<td>Peter Kjelseth</td>
<td>x</td>
<td>1890</td>
<td>Sweden</td>
<td>Chalmerska Institutet</td>
<td>Mining</td>
<td>Employed</td>
<td>1891</td>
<td>Sulithjelma Mines</td>
<td>Surveyor</td>
<td>1915</td>
<td>Orkla Aktiebolag</td>
<td>?</td>
</tr>
<tr>
<td>Denmark</td>
<td>H. Höncke</td>
<td>x</td>
<td>1908</td>
<td>Switzerland</td>
<td>Polytechnikum in Zürich</td>
<td>Railway</td>
<td>Extra engineer</td>
<td>1908</td>
<td>Københavns Vej- og Kloakanstalt</td>
<td>Chief of track office</td>
<td>1922</td>
<td>State railway</td>
<td>?</td>
</tr>
<tr>
<td>Denmark</td>
<td>Svend Ejnar Berthelsen</td>
<td>X</td>
<td>1915</td>
<td>Denmark</td>
<td>Den polytekniske læreranstalt</td>
<td>Electro-engineering</td>
<td>Employed</td>
<td>1915</td>
<td>A/S Nordiske Kabel- og Traadfabrik</td>
<td>Head engineer</td>
<td>1929</td>
<td>Holm &amp; Sønners Fabrikker A/S</td>
<td>?</td>
</tr>
<tr>
<td>Sweden</td>
<td>Carl Olof Reuterma n</td>
<td>x</td>
<td>1892</td>
<td>Sweden</td>
<td>Bergskolan in Filipstad</td>
<td>Chemical industry</td>
<td>Chemist</td>
<td>1893</td>
<td>Bofors</td>
<td>Director</td>
<td>1900</td>
<td>Bofors</td>
<td>1923 (retired)</td>
</tr>
<tr>
<td>Sweden</td>
<td>Gunnar Hugo Schubert</td>
<td>x</td>
<td>1887</td>
<td>Sweden</td>
<td>Chalmers tekniska högskola</td>
<td>Ship building industry</td>
<td>Employed</td>
<td>1889</td>
<td>Bergsunds mek. Vrkstds AB</td>
<td>Member of directory</td>
<td>1920</td>
<td>Bergsunds Mek. Vrkstds AB</td>
<td>?</td>
</tr>
</tbody>
</table>
3. Engineers, networking and knowledge transfer from abroad

<table>
<thead>
<tr>
<th>Country</th>
<th>Name</th>
<th>Education</th>
<th>Travel abroad (yes/no)</th>
<th>Return to Norway/Swe/Denmark (yes/no)</th>
<th>Scholarships</th>
<th>Country 1</th>
<th>Year arrival</th>
<th>Purpose of travel</th>
<th>Name of company/org affiliation</th>
<th>Country 2</th>
<th>Year arrival</th>
<th>Purpose of travel</th>
<th>Name of company/org affiliation</th>
<th>Participation in industrial exhibition</th>
<th>Year return to Norway/Swe/Denmark</th>
<th>Work after return</th>
<th>Position after return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>Carl Anton Bjerknes</td>
<td>Mining engineering</td>
<td>yes</td>
<td>yes</td>
<td>Public fund</td>
<td>Germany</td>
<td>1855</td>
<td>study</td>
<td>University of Götingen</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>1881</td>
<td>1858</td>
<td>University of Oslo</td>
</tr>
<tr>
<td>Norway</td>
<td>Johan Herman Lie Vogt</td>
<td>Mining engineer</td>
<td>yes</td>
<td>yes</td>
<td>Rathke fund</td>
<td>Sweden</td>
<td>1882</td>
<td>study</td>
<td>Bergskolan i Filipstad</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>1884</td>
<td>1885</td>
<td>University of Oslo</td>
</tr>
<tr>
<td>Norway</td>
<td>Olaf Steen</td>
<td>Chemical engineer</td>
<td>yes</td>
<td>yes</td>
<td>x</td>
<td>Germany</td>
<td>1894</td>
<td>study</td>
<td>Hochschule in Charlotteburg</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>1900</td>
<td>1908</td>
<td>Stavanger electro-steel works</td>
</tr>
<tr>
<td>Denmark</td>
<td>Svend Svendsen Junge</td>
<td>Electro engineer</td>
<td>yes</td>
<td>yes</td>
<td>x</td>
<td>Germany</td>
<td>1913</td>
<td>work</td>
<td>Siemens-Schuckert</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>1915</td>
<td>1918</td>
<td>Braendsels olieavnævnet</td>
</tr>
<tr>
<td>Denmark</td>
<td>Kaj Arnold-Larsen</td>
<td>Electro engineer</td>
<td>yes</td>
<td>yes</td>
<td>x</td>
<td>Germany</td>
<td>1910</td>
<td>study</td>
<td>Theimischeg Technikum</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>1913</td>
<td>1915</td>
<td>Engineer regime</td>
</tr>
<tr>
<td>Sweden</td>
<td>Pontus Bernt Rhodin</td>
<td>Engineer</td>
<td>yes</td>
<td>yes</td>
<td>x</td>
<td>Germany</td>
<td>1878</td>
<td>study</td>
<td>Charlotteбург Techn. Hochschule</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>1904</td>
<td>1907</td>
<td>Barnängens Kemiska Fabrikers AB</td>
</tr>
<tr>
<td>Sweden</td>
<td>Sven Johan Sjöholm</td>
<td>Engineer</td>
<td>yes</td>
<td>yes</td>
<td>x</td>
<td>England</td>
<td>1906</td>
<td>study</td>
<td>Russland</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>1907</td>
<td></td>
<td>Kvillebäckens Gum ter &amp; mek. Verksted, Gothenburg</td>
</tr>
</tbody>
</table>
Applications

The project will be divided into three main analyses, which will be based on different elements of the database.

1. “Education and social mobility in Denmark and Norway from around mid-19th century to 1940”

Aims: To analyse the functions of high school education for vertical and horizontal mobility across genders and regions over generations.

Theoretical foundation: Goldin and Katz analyse the basic educational system in the United States in the twentieth century and find that the share of people with secondary level education increased much more than in European countries. They relate this dramatic increase to both the lowering of inequality and economic growth. Scandinavian countries are characterised as countries with small social differences and high social mobility, but we know little of the relationship of high school education for social mobility in Scandinavia from a comparative historical perspective.

Method: The high school biographies of Denmark and Norway, published from 1824 to 1940s, will be used in combination with census data to analyse education and social mobility from a historical perspective. Three aspects of education and the moving between socio-economic levels are explored over generations, namely (i) the share of age groups graduating from high school, (ii) the social background of the people finishing high school and (iii) high school as a springboard to higher or technical education. Collaboration with economic historians who have experience with research on social mobility will be highly relevant here:

- Was formal education a driver for social mobility? If so, how, and for who?

The following questions will be used as guideline questions to the student biographies and census data:

- How big a share of given age groups finished high school? Were there gender differences? Did some regions have a higher share of high school graduates than others? What social background did people with high school have? Did high school graduates acquire higher or technical education? Were there changes over time?

Empirical material: High school student yearbooks for Denmark (years 1822-1930) and high school graduates for Norway (years 1831, 1851, 1854-1943). See ‘student yearbooks’ (pp. 7-8), for reference details.

2. “The functions of engineers and technicians in Scandinavian industrial development from the 1850s-1940”

Aims: To explore and compare the knowledge functions of formal education and practical experiences outside school settings across industries, and the three countries, over time.

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**Theoretical foundation:**

Analyses of technical education and industrial performance usually base their investigation on the number of universities and schools and number of engineering graduates. Comparisons are made on the assumption that ‘the more engineers the better’. It is important to consider the number of technicians and engineers – which in many countries increased during the nineteenth century -, but I propose to combine such studies with analyses of formally trained technicians and engineers, and how they used their knowledge and experience, and why they would be important for certain working positions.

It is also important to consider other ways of learning outside a classroom setting. Nobel Laureate in economics Gary Becker found that some types of knowledge can best be acquired in a practical working situation, while other types of knowledge require specialisations. A vital point here is that innovation, in addition to theoretical knowledge, depends on personal contact and transfer of knowledge from person to person. This is much due to the large degree of ‘tacit knowledge’ that exist, i.e. knowledge that cannot be expressed, which is rather learnt through observing and learning by doing.

The argument that different types of knowledge can be acquired in a variety of ways, will be an important basis of the project.

**Method:** During my PhD research, I investigated the connections between formal mining education, learning by doing, practical experience and innovation in mining by analysing the career paths of the Norwegian mining engineers. This part of the research draws on this method, but takes a wider approach as it seeks to compare the functions of formally trained technicians and engineers across sectors (the mechanical workshop industry, or others) in the three countries over time. Official statistics concerning number of workers and educational institution- and company archives will be used as complementary sources to the student biographies:

- How was technical and engineering education used? Which functions did formally trained technicians and engineers have? Were there any differences between the countries?

The following questions will be used as guideline questions to the student biographies and other sources:

- How many graduated from the technical and engineering programs (for example construction-, electro-, mining-, mechanical engineering etc.)? What did the technician- and engineer graduates do after graduation? Were there any relations between the graduates’ formal education and their line of work? Which types of work positions did they acquire? What characterised their work and daily tasks? How big a share of the total workforce (of each industry) was...
engineers and technicians? Were there any differences between the countries? Were there any changes over time?

**Empirical material:** student yearbooks for Norway, Sweden and Denmark. See ‘student yearbooks’ (pp. 7-8), for reference details, archives of educational institutions and company archives.

3. “Travelling engineers and knowledge transfer to Scandinavia from the 1850s to 1940”

**Aims:** To explore travelling engineers and the role of knowledge transfer from abroad in innovation processes.

**Theoretical foundation:** It seems like Scandinavian countries had a particular ‘outward-looking’ and ‘open’ attitude and many engineers, and workers, left Scandinavia in the nineteenth and twentieth centuries. The historian Gudmund Stang found that between 1870 and 1930 there was a gradual increase of Norwegian engineering graduates leaving Norway. In my PhD thesis, I find that around 75 percent of the mining engineer graduates from Norway between 1789 and 1940 went abroad to 1) study at an educational establishment, 2) do geological surveys or to acquire information about specific techniques, or to 3) do practice or work at a mining company in countries such as Germany, Sweden, England and the United States. Most of the mining engineers returned to Norway after a couple of years. After their return, they acquired managing and strategic technical working positions and they used their theoretical and practical learning experiences from abroad extensively in innovation processes. Per-Olof Grönberg, from a broader perspective, shows how Nordic engineers transferred knowledge to Sweden, Norway, Denmark and Finland. There is strong evidence that this massive travelling abroad led to knowledge transfer and innovation in the Nordic countries, but more detailed comparative analyses of how knowledge from abroad was used in different industries are required.

**Method:** The investigation draws on Grönberg, Stang and Ranestad’s approaches, but it seeks to deepen and further the investigation. The analysis will include comparisons of the functions of learning experiences from abroad of formally trained technicians and engineers in different industries in Sweden, Norway and Denmark (mechanical workshops, and others) over time. Engineering reports, technical journals and company archives will be used as complementary sources to the student biographies:

- Did engineers, technicians and architects from Sweden, Denmark and Norway go abroad? Did they transfer knowledge back to Scandinavia? How was this knowledge used?

The following questions will be used as guideline questions to the student yearbooks:

- How many formally trained technicians and engineers working in industries (such as mechanical workshop industries) had education or experience from abroad? Where did they go?
study, or work? What did they learn? Was any of the knowledge and experience from abroad used after they came back to Sweden, Norway and Denmark? Were there changes over time?

**Empirical material:** see research project no. 2. See ‘student yearbooks’ (pp. 7-8), for reference details, technical journals, engineering reports and company archives.

**References**


**Student yearbooks**

**Norway**


Ingeniører fra Kr.a Tekniske Skole 1897 (1922): Kristiania: A. W. Brøggers Boktrykkeri A/S.


Studenterne, biografiske oplysninger [high school student yearbooks] (1831-1943): Kristiania/Oslo.


**Sweden**


Chalmerska ingenjörföreningens katalog över civilingenjörer, arkitekter, tekn. licentiater och tekn. doktorer med examen från Chalmers tekniska... (1977): Göteborg : Chalmerska ingenjörföreningen.


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**Denmark**


*Studenterne, personalhistoriske oplysninger [high school yearbooks] (1824-1930)*: København.
