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Cognitive Foundation Skills Following Vocational Versus General Upper-Secondary Education: A Long-Term Perspective

Maria Rasmusson [a], Karsten Albæk[b], Patrik Lind[c] and Mats Myrberg[d]

[a]Department of Education, Mid Sweden University, Sundsvall, Sweden; [b]The Danish Center for Social Science Research, VIVE, København K, Denmark; [c]IFAU, The Institute for Evaluation of Labour Market and Education Policy, Uppsala, Sweden; [d]The School of Education and Communication in Engineering Science, KTH Royal Institute of Technology, Stockholm, Sweden

ABSTRACT

The present study aims at investigating the long-term cognitive effects of vocational education and training (VET) in Sweden and Denmark using data from the PIAAC Survey of Adult Skills. While Sweden has moved towards a more academic vocational education, Denmark has kept the apprenticeship system. Using multiple regression analysis we estimate the contribution of VET versus general upper-secondary education to the proficiency in literacy. The results show a higher literacy performance in those Swedish age groups in more academic VET programmes compared to the older Swedish age groups and to all the Danish age groups. A reasonable interpretation is that the amount of cognitively challenging subjects at the upper-secondary level gives a lasting imprint on literacy proficiency later in life.

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Literacy; vocational education; upper-secondary education; cognitive foundation skills

Cognitive Foundation Skills (CFS) is the term used by OECD (OECD, 2012) to designate "cross-cutting cognitive skills that provide a foundation for effective and successful participation in the social and economic life of advanced economies" (OECD, 2012, p. 10). The OECD PIAAC includes "Numeracy," "Literacy," and "Problem Solving in Technology Rich Environments" under CFS. These skills could be considered as "generic skills", that is, skills that enable people to build competencies to cope with a wide variety of working life, citizenship, and everyday demands. Cognitive Foundation Skills are also defined as trainable (OECD, 2013b). The most researched of these CFSs is literacy, namely "the ability to understand, evaluate, use and engage with written texts to participate in society, achieve one's goals, and develop one's knowledge and potential" (OECD, 2013a, p. 61). Literacy research ranges from ethnological studies with a focus on situated use of reading and writing skills, to large-scale surveys with sophisticated statistical scaling methods claiming theoretically valid international comparisons of skills across countries with a wide variation in cultural and economic conditions. International literacy surveys are mostly school based, for example the PISA (15 year olds), PIRLS (9/10 year olds), and (IEA reading literacy, 1991) (9 and 14 year olds). None of these studies allow for studying developmental patterns, though. The OECD's PIAAC (OECD, 2012) offers an opportunity to study trajectories of literacy across a wide age range (16 to 65), and relate it to:

- basic demographic characteristics and background of respondents;
- educational attainment and participation;
- labour-force status and employment;

CONTACT Maria Rasmusson maria.rasmusson@miun.se Department of Education, Mid Sweden University, Holmgatan 10, 851 70, Sundsvall, Sweden.

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- social outcomes;
- literacy and numeracy practices and the use of skills. (OECD, 2013b, p. 38)

Paccagnella (2016) describes a general literacy trajectory through ages 16 to 65 in the 23 participating PIAAC countries with a steep upward curve from age 16 to 20, a peak around 30 years of age, and a slow, almost linear decline from 35 to 60. There are, however, differences in levels, as well as patterns between countries. Differences in levels are especially apparent for age groups 35–54 years (Paccagnella 2016, p. 12). Differences in average literacy level between age groups are influenced both by cohort specific factors (like school quality at the time the cohort attended school) and age specific factors (age dependent decline after 30 as described above). Educational attainment during childhood and youth has a significant and strong effect on the lifetime literacy trajectory level – interestingly enough – but not on the form of the trajectory. Adult education does not seem to change any of these patterns (Gustafsson, 2016; Sulkunen & Malin, 2017).

School-based literacy surveys like PISA and IEA reading literacy have been used as indicators of changes in school quality in Sweden over the years (Holmlund et al., 2014). The compulsory school reform era in Sweden from 1950 to 1970 has been subject to a number of studies. In a register-based study of long-term effects of the Swedish comprehensive school reform during the 1950s and 1960s, Meghir, Palme, and Simeonova (2013) conclude:

> All results show clear and strong evidence that the reform improved cognitive ability by 7% to 15% of a standard deviation. This demonstrates that increasing compulsory schooling can improve cognitive outcomes even at this relatively advanced age. Moreover it indicates that those who would have otherwise opted out of school can benefit by being kept in school. Both these results are important because they may justify interventions beyond early childhood at least from a benefit perspective. (p. 20)

One study of the Swedish comprehensive school reform (Grundin, 1977) demonstrated positive effects on literacy outcomes among young adults. The upper-secondary school reforms from 1970 (also part of the comprehensive reform strategy) to 2000 have been less researched. Axelsson (1989), Myrberg (1981), and SOU (1981, p. 98) are among the few examples where survey data has been used in reform follow-up studies.

In a Danish study (Nielsen Arendt, 2005) primarily aimed at estimating health effects of schooling, the compulsory school reforms of 1958 and 1975 were used as an instrumental variable. Three age cohorts were identified according to whether they encountered these reforms or not. The study shows a significant effect of the 1958 reform but not of the 1975 reform on educational attainment as well as on self-reported health, smoking habits, and body mass index.

Studies of reforms of vocational education and training (VET) are less common. Most attention in the literature has been paid to labour market outcomes rather than pedagogical outcomes. Many of the published studies of labour market outcomes have used school-to-work transition only covering the years immediately following graduation as an outcome measure.

Surveys of adult literacy like PIAAC, IALS, and the ALL have great potential to assess long-term consequences of educational reforms at the macro level as well as for the sub-groups. Of special interest here is the long-term development of literacy proficiency for students from vocational tracks as opposed to general tracks at the upper-secondary level. So far, no studies in this vein have to our knowledge been published. The situation in the Nordic countries can to some extent be looked upon as a natural experiment. Dobbins and Busemeyer (2015) in a study of educational policy formation present Denmark and Sweden as "most similar cases" that "bear remarkable similarities over a wide range of socioeconomic and education-related factors" (p. 6). The two countries have still developed their VET systems very differently.

VET in the Danish and Swedish Upper-Secondary Systems

The Nordic countries differ in important respects when it comes to organization of vocational education at the upper-secondary level. The structure and development of the educational system at the

compulsory level followed the same path up until the last 20 years in the Nordic countries, starting with the "Golden Era" of the 1950s and 1960s (Oftedal Telhaug, Mediås, & Aasen, 2006). At the same time, the vocational systems differ in many respects (Olofsson & Wadensjö, 2007). Denmark and Sweden represent the contrasts, with a largely school-based Swedish system with a limited number of vocational tracks, while Denmark has a system with a large number of specialization profiles within an apprentice-based system. The Swedish system has gradually moved toward a comprehensive upper-secondary system since the 1960s , with a core of general subjects common to both VET and theoretical tracks. During the 1960s the vocational school system expanded rapidly. Full-time courses replaced part time courses, which was the dominating form during the 1950s (SOU, 1981, p. 98). The system was, however, still very heterogeneous. Until the comprehensive reform of 1970 ("Lgy70") was implemented in the autumn of 1971, Swedish VET varied from a number of weeks length of training to four years. The aim of the VET programmes before 1970 was to qualify for professional work within specific vocational fields. There was little or no room for general subjects in the curricula (SOU 1981, p. 98). Elementary school (7 years "folkskola") was normally the entrance requirement to VET before 1970. The curriculum was dominated by practical training or apprentice systems. The foundation course in agriculture was, for example, two years in length, but applicants with "sufficient entrance knowledge and experience" (mostly sons of farmers who hade been working at their parents farm) were accepted directly to the second year. The curriculum consisted of "all existing farm work assignments, alternately both in stables and stalls, as well as spelling, written composition and arithmetic" (SCB, 1984, p. 174). Courses preparing for jobs as healthcare assistants followed locally decided curricula up to 1960, when a national curriculum containing 400 hours of school-based studies and 29–32 weeks of practical assignments was introduced (SOU, 1962, p. 4). At the same time, the vocational track preparing for telecommunication repair extended over three years, mostly school-based, with a fair amount of applied physics. The quality of VET courses before the 1970 reform varied enormously (Nilsson, 2016).

Nilsson (2016) points out the severe shortage of labour force in Sweden during the 1950s and 1960s as a motive to open up for VET courses aiming at semi-skilled professions that an apprentice system could not cater for. Still, the courses were of a narrow character, focusing on specific vocational needs (Nilsson, 2016). Following the Swedish comprehensive school reform of 1962 the VET commission of 1964 proposed a comprehensive system at the upper-secondary level with a two year course programme for all fields, with mandatory general subjects in all tracks. The commission phrased the overarching aims of VET as "Citizenship and general education," "Basic general vocational skills," and "Specific vocational skills." The proposal formed the basis for a government bill and a parliament decision in 1970. There were no major differences expressed around this, either between the labour market parties or between the political parties.

The Building and construction programme may serve as an example of the structure of VET in Lgy70 (SOU 1981, p. 98). During the first term an overarching vocational subject covering all specialities within the field took a major share of the timetable (around 27 out of 38 hours of instruction). The remaining 11 hours covered 4 hours of language arts ("svenska"), 2 hours physical exercise, 1 hour of vocational orientation ("arbetslivsorientering"), 1 hour for local disposition, and 3 hours of optional courses (a foreign language or mathematics chosen by the majority of students). In reality, the options were restricted due to organizational factors. During the second year vocational studies was concentrated to a specific field (e.g., carpentry), while no general subjects were studied. In a number of programmes outside traditional industry and crafts (i.e., the commercial programme, nursing etc.) general subjects study continued with the same structure and volume as during the first year. With the curriculum reform of 1994 ("Lpf94"), the share of general subjects in the VET programmes increased substantially. Ledman (2014) gives an estimate of around 30% of the timetable in the building and construction programme allotted to general subjects (half of this was language arts, mathematics, and English).

In all, Nilsson (2016) concludes that " … the transition from vocational schools in the 1950s and 1960s into broad vocational programmes with a substantial theoretical content in the 1970s was

rather smooth and free from conflict" (p. 30). Furthermore, an important driving force behind this was that many more pupils than expected opted for the theoretical track during the 9th school year of the new curriculum of 1962, and fewer chose the vocationally oriented track. The period 1978–1994 represented further steps towards a comprehensive upper-secondary system in Sweden, with the reform of 1994 as a landmark with eligibility for higher education after completed VET programmes. From 1970 to 1994 the share of general subjects in the VET curriculum increased substantially. Ledman (2014) illustrates this development with the "Building and Construction program," where general subjects represented 20% of the curriculum in the 1970 curriculum, and 30% in the 1994 curriculum. Cedefop (2014) reports a STEM index of 99 (EU average 100), corresponding to roughly 29% of Swedish VET students graduating in STEM subjects.

The Danish VET system has been subject to several reforms since the 1960s. Several political attempts to introduce a comprehensive upper-secondary system have been made since the 1960s, but without really affecting the "apprenticeship-stabilizing coalition" (Dobbins & Busemeyer, 2015, p. 9). The Initial Vocational Education reform, "EFG", of 1977 introduced a common school-based year for all VET programmes, with a clear comprehensive profile. The traditional apprentice system did, however, continued to dominate Danish:erhvervsfaglige grunduddannelser [EFG]. Related to the EFG reform of 1977, a special commission ("*Almen-udvalget*") was appointed to strengthen the role of general subjects in VET. Rather than an increased share of general subjects in the timetable in VET, the commission suggested that the general subjects should be integrated with the vocational subject (Grünbaum, 1994, p. 116). This means that only crude estimates can be made concerning the volume of general subjects in the Danish VET system.

The Danish Vocational Education and Training law (the EU law) of 1989 (introduced in 1991) represented an attempt to unify the school-based and the apprentice systems. Throughout the last 40 years the balance between general subjects content aiming at opening up for further studies and citizenship competency on the one hand and high quality vocational knowledge and skills on the other has been a focal issue in the debate. This tricky issue was dealt with via Problem Based Learning where:

> … the theoretical part of the curriculum should be based on professional issues, and as far as possible be integrated in the practical part, to ensure that the student is able to see its vocational relevance and make room for professional specialization. (Kap, 2015, p. 121)

How this is solved is to a large extent left to the local schools and employers. Olofsson and Wadensjö (2007) give an estimate of 25% of the current timetable in Danish VET allotted to general subject. Cedefop (2014, p. 29) reports the percentage of VET students graduating in STEM subjects is 17.2% compared to the EU average of 29.2%. A follow-up study of the reform concludes that " … there are continued problems with student motivation for the general subjects, as well as the integration of these subjects in the vocational training" (Grünbaum, 1994, p. 122). The EU law has so far not meant an increase in transition to tertiary education from VET. Helms Jørgensen (2017) concludes that the transition rate has actually decreased.

In the end of the 1970s nearly two out of three applicants to upper-secondary education in Sweden applied for a VET programme (SOU, 1981, p. 98). Since then, general tracks have gained in popularity while vocational tracks have lost (SOU, 1986, p. 2). The labour market parties were seriously worried that the negative trend would prevail if measures were not taken (Lundahl, 1998). The negative trend is equally apparent in Denmark.

A steady increase in the share of continued study after compulsory school prevailed in both countries throughout the period covered by our cohorts from the 1960s, when around one-in-two went on to some form of upper-secondary study after compulsory schooling to the last decades, with nearly 100% continue studying. The vocational programmes met an increase in the number of students from the early 1970s to mid 1980s in Sweden, followed by a sharp downward tendency from the 1990s onward. From the mid-1960s to the mid-1970s the proportion of VET students in

Denmark was reduced from 35% to about 25%. Later, the share of Danish VET students increased to about 40% in the beginning of the 1990 (Albæk, 2009).

While nearly two out of three students in Denmark chose a VET programme in 1985, 10 years later the share has shrunk to a little more than 50%. Furthermore, the Danish apprentice system has met an increasing dropout rate since the 1990s, where the introductory school-based period seems to be a problem for many students (Helms Jørgensen, 2017). At the same time the percentage of Danish upper-secondary students who chose a programme with some kind of professional profile (including commercial and technical programmes preparing for higher education) has risen from 60 to 72%. Several attempts have been made to increase the attractiveness of VET in Denmark, so far without success.

Part of the problem with general subjects in VET is negative attitudes to reading among the students. Hall (2009), in a study of the reform of VET 1991 with three year VET courses and an increased share of general subjects, reported an increased dropout from VET during the implementation of three-year VET programmes in Sweden in the end of the 1980s. She does not, however, interpret this as en effect of the increased share of general subjects in the curriculum.

Fouganthine (2012) in a follow-up study of a cohort children born 1980 (most of them entering upper-secondary education 1996) reports that over 50% of those with a diagnosed reading an writing problem early in compulsory school had a VET programme as highest attained education compared to 20% in a matched comparison group. In the comparison group, 50% had an exam at the tertiary level as their highest attained education compared to 17% in the group diagnosed with reading and writing problem. Choosing VET was seen as a last resort to get away from unresolved reading and writing problems throughout compulsory school. This was already apparent during the 1970s. Grogarn (1979) in a study of VET students born 1959/1960 reports that nearly every second student in the Industry or Vehicle engineering programmes suffered from reading and writing difficulties when they entered upper-secondary education. At the same time, Meghir et al. (2013) and Grundin (1977) report positive effects on cognitive skills of the comprehensive principle, but at an obvious price paid by students at risk for reading and writing problems. In this respect, VET has come to act as a "cleaning lady" for unresolved learning difficulties from compulsory schooling.

Vocational Education and Working Life

While total employment rates are fairly similar in the Nordic countries, unemployment, and especially youth unemployment, differ a lot, with Sweden and Finland at the loosing side, and Denmark and Norway as winners. This pattern has persisted throughout economic recessions and depressions over the last 20 years (Olofsson & Wadensjö, 2007). Sweden suffers from higher youth unemployment rates than the EU average, while Denmark has considerably lower rates. This has been interpreted at least partly as a sign of apprentice systems' advantage compared to school-based systems when it comes to improving young peoples' labour market prospects. Straková (2015) did, however, fail to demonstrate this advantage in a study of the Czech dual VET system:

> The analyses show that in spite of its high vocational specificity, the efficiency of the Czech education system in facilitating transition to the labour market is relatively low, as are the achievement outcomes of its apprentices. This high differentiation, moreover, contributes significantly and increasingly to educational inequalities. (p. 168)

On the other hand, Forster, Bol, and van de Werfhorst (2016) in a study based on data from 22 PIAAC countries conclude:

> In all countries, people with vocational degrees are more likely to loose their job late in their career, possibly because of a lack of adequate skills. But if anything, strong dual systems offer a safeguard for those with vocational qualifications. Such systems do not adversely affect employment either at the start or at the end of a career. (van de Werfhorst, Forster, & Bol, 2016, p. 1)

Apprentice systems have been described as restricting young peoples' further educational prospects (Hanushek, Schwerdt, Woessman, & Zhang, 2015). Considering technological change and at higher risk of being laid off after the age of 50, those with a more specific (i.e., vocational) education should be in more need of re-training, competency updating, and refresher courses.

Furthermore, apprentice systems have been said to be overly sensitive to market fluctuations (Cedefop, 2012b; Olofsson & Wadensjö, 2007). Concerns have also been put forward that changing occupational structure and skill profiles would be a drawback to VET systems (Hanushek et al., 2015), which try to match specific desires from the labour market parties. This has also been an argument both in Danish and Swedish VET reforms, with a tendency to broaden the different tracks and restrict the number of specific options for the students.

Current Swedish educational policy has put apprentice systems forward as a solution to increase the popularity of vocational education, so far with a fairly meagre outcome. To sum up, apprentice systems seem to serve two purposes in current Swedish educational policy – to offer better prospects for pupils facing failure in the regular system and to serve the Swedish industry with qualified young people.

The labour market in both Denmark and Sweden has changed significantly over the last 50 years. The structural changes in Sweden from 1965 to 2000 may serve as an example. In 1965, the agriculture sector represented 12% of the labour force; 35 years later the corresponding share was 2%. Services within the public sector represented 15% of the labour force in 1965. In 2000 the public sector share had doubled (Confederation of Swedish Enterprise, 2001). The total number of people employed has increased substantially in both countries. A substantial share of this increase is accounted for by increased labour market participation among women. Women dominate a rapidly growing public sector, including the education system and health services. Traditional sectors dominated by men have (i.e., the farming, forestry, fishing, and manufacturing industries), on the other hand, decreased both in numbers and percentage shares,. Behind these quantitative changes lie structural changes related to technology and organization of jobs. Swedish forestry work during the 1950s was for example dominated by "artisanal methods," seasonal work and a good supply of young men with only seven-year elementary school as their educational background (Lundh Nilsson, 2013). From the late-1950s a rapid change in organization and technology occurred, resulting in increased qualification demands. Basic forestry courses were changed from apprentice schemes of 12 to 16 weeks to a common 1–1.5 year basic course. During the decades to come the number of people in Swedish forestry, agriculture, and fishing occupations was reduced from nearly half a million in 1960 to 75,000 2012, mainly due to technological and organizational changes (Lundh Nilsson, 2013).

A severe shortage of qualified labour force in many manual trades prevails in the Nordic countries, while the Nordic VET systems fail to produce sufficient numbers of skilled workers (Nordforsk, 2016). At the same time, a number of jobs do not require much of training and/or work experience. The PIAAC background questionnaire illustrates differences both between and within countries in this respect. A substantial share of jobs on the youth labour market require less than a month of work experience to cope with in a satisfactory manner (PIAAC raw Tables, ages 16 to 24). This share is substantially lower for the 25–34-year-olds. The figures are almost exactly the same for Sweden and Denmark. Pollman and Mayer (2004), in a study of labour market outcomes for consecutive cohorts of VET graduates from the 1930s to the 1980s, find a decreasing return to German crafts- and industrial apprenticeships, but an increased return for graduates from commercial apprenticeships. The European EU foresees a shift to more skills-intensive jobs in the near future, with a rather modest creation of new jobs (Cedefop, 2012a). The bulk of labour force demand is according to the forecast replacements due to the ageing European population. A risk of over-supply in certain fields of higher education is also projected. In addition, a trend towards an integrated European labour market will mean increased demand for foreign language skills in the labour force. The UK Commission for Employment and Skills projects skill needs in the British labour market up to 2022 (UKCES, 2014). A polarization trend with an increase of both high- and low-skilled jobs is projected. Automatization resulting from ICT applications will affect skill demand

in middle-level as well as high-level professions. "Higher level skilled jobs which require workers to use cognitive skills are less readily substituted by automation. Equally, some lower skilled jobs in caring, leisure and hospitality occupations require worker/customer interaction and are less easy to automate" (UKCES, 2014, p. 6). Partly due to an ageing population, a continued need for retraining is foreseen. Autor and Price (2013) describe a continuous increase in "non routine interpersonal tasks" in the US labour market from 1960 to 2000, while "non routine manual tasks" and "routine cognitive tasks" have decreased correspondingly. The rise in non-routine cognitive tasks is especially pronounced among female workers. A continued projection after the year 2000 shows a flattening out of these trends for men as well as for women.

Olofsson (2015) describes a modern working life, requiring broader competency where school-based and workplace-based learning contribute to manifold learning, integrating general subjects, soft skills, and communicative skills within VET. The effects on future skill demands due to technological advances, globalization, and other factors are still open to speculation. It seems evident, though, that changes in labour market structure as well as technological changes require more of generalized skills. This does not, however, diminish the demand for specific vocational skills. Ackerman and Cianciolo (2000) describe a pattern of skill acquisition involving initial cognitive demand followed by perceptual and psychomotor demands. This initial "cognitive threshold" phenomenon will most likely be a growing concern in future VET, with VET facing demands for what was earlier considered academic skills parallel to offering traditional vocational skills. A projected bottleneck in skill demands focusing on upper-secondary VET, together with the "cognitive threshold" in a swiftly changing work situation in many occupational fields, raises a number of questions with mixed political and scientific significance that PIAAC together with register data might cast light upon. The situation in the Nordic countries can to some extent be looked upon as a natural experiment.

Research Questions

How does choice of VET versus General studies at the upper-secondary level affect long-term literacy trajectories?
Does an increase of cognitively demanding content in VET affect this development?

The reform history of VET in Denmark and Sweden during the last 50 years serves as a testing ground for the research questions.

Methods and Results for the Swedish and the Danish Case

In this section, a description of the PIAAC data used in the study will be provided, followed by a presentation of methodological issues and considerations as well as results from the Swedish case and the Danish case.
The analyses of the Swedish and Danish data have been performed with the following software: Stata (StataCorp, 2015), SPSS (SPSS Inc, 2013), and IEA IDB Analyzer.

The PIAAC Data

Our primary data source is the Swedish and Danish results from the PIAAC. The OECD developed PIAAC to measure key cognitive skills needed for individuals to participate in society and advance in their jobs. Data was collected in 2011and early 2012.

The Swedish PIAAC sample was based on a one-stage procedure including four stratification variables: gender, age, country of birth, and level of education. The Swedish population registry was used to define the sampling frame. A representative sample of 16–65-year-olds was selected and data was gathered face-to-face, mostly in the participants' homes. Literacy, numeracy, and problem-solving skills in technology-rich environments were assessed with a computer-based test. However, for respondents without sufficient computer experience there was also the option of a pencil-

and-paper test. Only 7% of the Swedish sample took the pencil-and-paper test (OECD, 2013a). Background data was obtained through an extensive questionnaire that covered demographics, education, social and linguistic background, employment, and use of skills at work and at home.

The Danish one-stage PIAAC sample was drawn at random and is representative of the Danish population aged 16–65 years. The Danish population registry was used to define the sampling frame. The Danish data was gathered in the same way as in Sweden, see above. Of the Danish respondents, 12% took the pencil-and-paper test (OECD, 2013a).

In the present study we have used literacy as a measure of skill. The PIAAC literacy items require the respondent to "understand, evaluate, use and engage with written texts," which is considered essential for "participating in society, to achieving one's goals, and to developing one's knowledge and potential" (OECD, 2013a, p. 59).

The PIAAC data give us a measure of cognitive foundation skills (i.e., literacy, numeracy, and ICT problem-solving) among the age cohorts of interest in the present study – 19–65 year-olds (born 1947–1993). These data, in combination with Swedish and Danish register data offer good possibilities to compare the cognitive foundation skills between individuals who attended VET and those who attended general upper-secondary education, in the relevant age cohorts. However, the limitations of the PIAAC survey in answering our research questions are the limited sample size in each age cohort and the cross-sectional nature of the measure of cognitive skills. Longitudinal data on the development of cognitive skills for each age cohort would have given stronger evidence on the effect on future cognitive skills from an increase in the amount of cognitively demanding content in upper-secondary VET. As longitudinal measures of cognitive skills are not available, our best alternative is to use register information on the participants' grades from the last year of compulsory school as a proxy for cognitive skills prior to upper-secondary school. Unfortunately the Danish register data for grades only cover the youngest ages in our Danish PIAAC sample ($n = 548$) and the results from analyses with grades in the Danish sample are only mentioned briefly below. As for the sample size limitations, we use age groups rather than single cohorts as our analysis unit.

The different age groups are based on the content of the vocational education tracks in the Swedish system, which has varied over time. Where the oldest former Swedish VET students had very little of cognitively demanding content in their curriculum, the youngest had significantly more. Thus, there is variation over time and these different age cohorts have, hence, also been influenced by other factors, such as changes in the Swedish compulsory school and overall changes in society over the same time period. Our best alternative in trying to isolate the association between the amounts of cognitively demanding content in VET and literacy proficiency later in life is to compare the Swedish results to results from the same analysis on Danish data. As the Danish VET system has been more stable over the same time period, this comparative analysis will aid the interpretation of the Swedish results.

The PIAAC measures each of the three skill domains on a 500-point scale, where each individual's proficiency is represented by 10 random draws from a distribution of proficiency scores, known as *plausible values*.[1] The proficiency distributions are formed based on the individual's own response patterns on the items taken and response patterns of other similar individuals, together covering a large portion of the total number of test items in PIAAC. It would be close to unfeasible to let all respondents answer all test items and each individual was thus only tested on a subset of items and in maximum two of the three skill domains. This introduces uncertainty around the estimate of a specific individual's true proficiency as the response patterns of similar individuals, used to form the proficiency distribution, might either over or underestimate the true proficiency of a specific individual. The use of the 10 plausible values rather than one single estimate per respondent reduces the uncertainty and allows for estimates of a population's average proficiency, which is the main aim of PIAAC. The population model used for PIAAC scaling consists of Item Response

[1]When computing a plausible value, a mathematical distribution around a reported value is first calculated and then each observation is assigned a set of random values drawn from this distribution.

Theory analysis, latent regression, and computation of plausible values (OECD, 2013b, Ch. 17, p. 1). For the analyses to properly estimate the standard errors, all 10 plausible values must be employed, together with both sample weights and the replicate weights, which handle sample uncertainties. A correct estimate is given by averaging the results over these 10 plausible proficiency scores, as has been done in this study.

The Swedish Case

Participants.

In total, the Swedish PIAAC sample included a little over 4467 participants but in the present study we are considering a sub-sample of 2581 consisting of those who have completed upper-secondary education. There is register information missing for 1722 respondents due to, for example, lack of an upper-secondary education or whether the respondent has recently become a Swedish citizen. These respondents are omitted. The mean literacy score for this sample is 285.3 score points and the standard deviation is 39.2 points. The average in the total Swedish sample is 279 score points and thus, the sub-sample in the present study perform better than the total sample, as expected considering the groups omitted. Four age groups (Table 1) were defined according to differences in the number of subjects related to cognitive foundation skills in the Swedish VET curriculum (see Table 2).

Variables and analysis.

As mentioned previously, the Swedish data from PIAAC has been extended with Swedish register data. The register data consists of information about type of upper-secondary educational track (VET or general)[2] and GPA from the last year of compulsory school. Grades are only available from 1989 (i.e., for the two youngest age groups with participants born 1973 [16 years old in 1989]) or later. For those with upper-secondary education as their highest attained education, the information from registers is in general the same as the information found in PIAAC. However, for those who have attained higher educational qualifications, their upper-secondary track is not registered in the PIAAC survey. For these participant's we have used register data from the time when upper-secondary education was still their highest attained education to determine which track they completed.

The older respondents, for whom no register information about GPA exists, have been assigned imputed grades. The method used is in line with Reuterberg's (2001) recommendations for handling missing data. Using respondents in the age groups who experienced a norm-related grading system (the same as the group with missing information on grades), the following model, separately for VET and general students, is used for predicting grades:

$$\begin{aligned}\text{GPA (standardized)} = {} & \text{pvnum1} + \text{female} + \text{immi} + \text{child_immi} + \text{mom_upsec} \\ & + \textit{mom_tert} + \textit{dad_upsec} + \text{dad_tert} + \varepsilon\end{aligned}$$

Table 1. The Swedish sub-sample by the four age cohorts and type of education.

Age	Born	General *n*	VET *n*	Total *n*	Total with weights[a] *n*
19–32	1980–93	475	506	981	1,331,735
33–40	1972–79	260	232	492	671,193
41–57	1955–71	249	544	793	1,096,362
58–65	1947–54	122	193	315	397,848
Total		1106	1475	2581	3,497,138

[a]The weighted figures are estimated with IEA IDB Analyzer using the PIAAC sample weight (SPFWT0).

[2]Information about highest attained education is coded according to the Swedish SUN2000-classification system, which builds on the ISCED97-classification system (see Table 3).

Table 2. Overview of upper-secondary VET systems in Sweden and Denmark, 1960–2012.

Age group	Sweden	Denmark
VET before 1970 PIAAC respondents born 1947–1954, ages 58–65	Very little of general subjects. No organizational relationship between VET and Grammar school	Traditional apprenticeships, no school-based parts, governed by labour market regulations
VET 1971–1988 PIAAC respondents born 1955–1971, ages 41–57	Comprehensive curriculum, two year school based, vocational subjects tuned down in favour of general subjects	EFG (erhvervsfaglige grunduddannelser) with an introductory school year for all, with ambitions to introduce a comprehensive system (not fulfilled, though). The traditional apprentice system kept as a parallel system.
VET 1989–1996 PIAAC respondents born 1972–1980, ages 33–40	Same as above, but with 3-year programmes instead of 2 years. Options to choose general subjects for eligibility for higher education	New legislation common to all forms of VET incl. HHX and HTX. A 20/40-week introductory school-based period followed by interchangeably school- and workplace-based periods including problem-based learning-based general subjects. 13 weeks elective course with options to include formal courses in general subjects. Examination covers vocational as well as general subjects.
VET 1997 – PIAAC respondents born 1981–1993, ages 19–32	All programmes give eligibility for higher education, 25% general subjects in the syllabus.	Same as above

The dependent variable in our imputation model is standardized using the cohort mean and standard deviation, there are two reasons for this: (1) due to possible grade inflation we do not want to use the grades as they are, we want the individuals' relative grade position in their cohort. Usually this is done by percentile ranking of the grades, which requires information on the entire cohort, whereas we only have a random sample of each cohort. For all cohorts with register information on grades we also have information on the cohort mean and standard deviation, which we use to express the grades as relative to the cohort mean (in terms of standard deviations); (2) the standardization is also needed to enable comparisons over the different grading systems. As we only have information on cohort mean and dispersion for a few of the cohorts who we assign imputed grades (graduation years 1977–1980), we cannot impute the grades (1–5) directly. The reason for this is that in the analyses we use standardized grades for better comparison over years and grading systems and, as we lack cohort means and standard deviations for these older cohorts, we could not calculate standardized grades if we had imputed on the 1–5 non-standardized scale. We performed a backwards transformation on grades 1–5 for the few cohorts where we have means and dispersion statistics. This gives us a benchmark for the quality and plausibility of the imputed standardized grades. According to the benchmarks, the imputation model underestimates the grades of VET students and overestimates the grades of general students. Adding 0.35 to all imputed VET grades and subtracting 0.15 from all imputed grades for general students brings the means of the imputed grades to the levels of the benchmarks.

The correlation of predicted and actual standardized GPA, after the adjustment mentioned above, is 0.56 within-sample and 0.5 out-of-sample. The main predictor in the model is the first of the plausible values in numeracy (pvnum1)[3] and compared to the actual standardized GPA, the predicted standardized GPA and pvnum1 are too strongly correlated (0.8 compared to 0.5) and show a highly linear relationship due to the linear imputation model. Adding a normally distributed random error (~N[0,1]) reduces the correlation to 0.36 and gives us a relationship pattern between the predicted standardized GPA and pvnum1, which resembles that of the actual standardized GPA and pvnum1. Thus, all grades were predicted on a standardized scale for the two grading systems

[3]As previously mentioned, to correctly handle the measurement uncertainty, due to PIAAC's use of IRT, an analysis using each of the 10 plausible values, should be made and the results should be averaged over these 10 analyses. In this case, however, we only need an indicator of skill to increase the fit of the imputation model. Any of the 10 could have been used, we chose the first.

Table 3. The chosen codes in the Swedish register variable SUN2000niva.

VET		General	
313	Upper-secondary education, shorter than 2 years, initial vocational training, no final grades	312	Upper-secondary education, shorter than 2 years, theoretical/academic, no final grades
317	Upper-secondary education, shorter than 2 years, initial vocational training	316	Upper-secondary education shorter than 2 years, theoretical/academic,
323	Upper-secondary education, 2 years, initial vocational training, no final grades	322	Upper-secondary education, 2 years, theoretical/ academic, no final grades
327	Upper-secondary education, 2 years, initial vocational training	326	Upper-secondary education, 2 years, theoretical/ academic.
333	Upper-secondary education, 3 years, initial vocational training, no final grades	332	Upper-secondary education, 3 years, theoretical/ academic, no final grades
337	Upper-secondary education, 3 years, initial vocational training,	336	Upper-secondary education, 3 years, theoretical/ academic

used in Sweden in 1988–2013 to enable comparisons with the two actual grade types.[4] The standardized grades ranged from −5 to 5.

In order to assure a tolerable proportion of unique variance among the independent variables and, thus, a low level of correlation, an estimate of multicollinearity has been calculated. The variation inflation factors were in the range of 1.02 to 1.70 and thus below the often reported acceptable level of 10 (e.g., Hair, Anderson, Tatham, & Black, 1995; Kennedy, 1992; Marquardt, 1970; Neter, Wasserman, & Kutner, 1989). An important factor to consider is that of endogeneity (see, e.g., Heckman, 1978; Heckman, Stixrud, & Urzua, 2006). In correspondence with the study on labour market outcomes and social behaviour by Heckman et al. (2006), we have controlled for as many of the variables that have a direct or indirect effect on cognitive skills as possible in the present study. However, we are aware that, as in many other studies, endogeneity problems could still remain and, unfortunately, there is no empirical data available to estimate this risk nor any available instruments to perform an instrumental variable analysis. Moreover, a cautious interpretation is called for as numeracy scores are used in the imputation of missing grades and there is a strong association between numeracy and our dependent variable, literacy. However, as mentioned above, a normally distributed random error is added to the imputation model and when examining the correlations between the standardized grades (including the imputed grades) and the literacy scores in each age cohort (ranging from .32 to .39) the risk of bias seems to be on an acceptable level.

Using multiple regression analysis, an estimate of the contribution of VET versus general upper-secondary education to the proficiency in literacy is calculated for each age group separately. In the models, a number of variables are taken into account: grades from compulsory school, participation in adult education, social background (parents' educational level), gender, and further studies at the tertiary level (Table 4). The corresponding procedure was performed for general upper-secondary education. The sub-sample in the present study had at least upper-secondary education and some of the participants also had tertiary education.

As mentioned above, some of the variables were selected from the PIAAC questionnaire. These are parental educational background, if the respondent is currently studying, the variable for higher education, and the gender dummy. The variable for parental educational background is a combined variable constructed from the educational background variables for the mother and the father. The educational background variables for the mother and the father take three values: high, middle, and low education. Our dummy variable for high parental education takes value 1 if one of the parents has a high education and 0 elsewise. Our dummy variable for low parental education takes value 1 if *both* of the parents have low education and 0 elsewise. The reference group in the regressions is the group of the remaining parents who do not have either high or low parental education (see Table 4).

[4]1988–1997 norm-related grades year 9, 1998–2013 criteria-related grades year 9, 1963–1987 imputed grades.

Table 4. The independent variables used in the Swedish analyses.

Variable	Source	Coding
Type of secondary education	Register data, own aggregation	General = 1, Vocational = 0
Current education	PIAAC BQ02a	Yes = 1, No = 0
Grades, end of compulsory school	Register data	Range -5–5
Parents education 1	PIAAC PARED	Level 2 and 3 = 0, Level 1 = 1
Parents education 2	PIAAC PARED	Level 1 and 3 = 0 Level 3 = 1
Gender	PIAAC	Male = 0, Female= 1
Higher education	PIAAC ISCED 5-6	Yes = 1, No = 0

The variable "Currently studying" is a yes or no response to the question "Are you currently studying for any kind of formal qualification?" in the PIAAC questionnaire.

Comparisons between age cohorts in the Swedish case.

Literacy skills are expected to grow during adolescence and young adulthood (Paccagnella, 2016). This holds true in our analysis for those who have attended theoretical tracks at the upper-secondary level (Table 5). For those who have followed a VET track is the effect positive but non-significant. For the older cohorts the effect is, as expected, negative. This is especially obvious for those who attended a VET track at the upper-secondary level. For those who followed a theoretical track, the negative effect is significant only for the oldest cohort, while for those with a VET exam the effect is significant for the two oldest cohorts (from age 40 and onwards).

It should be noted that the effect of age on literacy skills is very limited. Age explains less than 5% of the total variance in all cohorts. The low explanatory power in the above model gives room for an influence of a number of uncontrolled variables. Among these we find grades from compulsory school as well as social background. Nearly 50% of the cohorts who followed a theoretical track at the upper-secondary level have continued studying with an exam at the tertiary level, while somewhat below 20% of those from a VET track have achieved a tertiary exam. This most likely has an effect on adult literacy. Gender is also included in the analysis to see whether there are gender differences in literacy between the age cohorts (Table 6).

A multivariate regression model including the abovementioned variables increases the explanatory power substantially. Between 22 (the oldest cohort) and 33% (33–40 year olds) of the total literacy variance is explained by the model. Looking at the coefficients for the different variables you can see a monotonous increase for the VET/General track-variable from the youngest ($B = 5.85$, $\beta = 0.15$) to the oldest ($B = 12.80$ $\beta = 0.31$) cohort. The cmoefficient for grades from compulsory school stays at the same high level for all cohorts. The additional value of an exam at the tertiary level is obvious for all cohorts (somewhat lower for 41–57-year-olds, $B = 7.64$, $\beta = 0.12$, compared to $B =$ 13–16 [$\beta = 0.11$–0.35] for the other cohorts). Interesting, but not expected from the PISA studies, is the advantage for males in all age cohorts. To sum up, the significant difference in literacy outcome between former VET and general students is twice as strong for the oldest cohort compared to the youngest. For the oldest cohort the coefficient for additional tertiary level qualifications is similar in size to the coefficient on the General Studies dummy.

There are, however, issues remaining before conclusive answers to the research questions can be achieved. For one thing, collinearity between the variables included in the analysis might distort the

Table 5. Swedish results from a regression analysis with literacy as the dependent variable and age as the independent variable for the vocational and general samples, respectively.

Age group	Vocational	R^2	General	R^2
19–32 (born 1980–1993)	0.43 (0.05)	0.00	1.85 (0.21)*	0.04
33–40 (born 1972–1979)	0.77 (0.04)	0.00	−0.31 (−0.02)	0.00
41–57 (born 1955–1971)	−1.67 (−0.18)*	0.03	−0.70 (−0.08)	0.01
58–65 (born 1947–1954)	−3.11 (−0.18)*	0.03	−3.21 (−0.19)*	0.04

Note. *$p < .05$.

Table 6. Swedish results from the regression analyses with literacy as the dependent variable, four age groups.

	19–32	33–40	41–57	58–65
Variable	B (β)	B (β)	B (β)	B (β)
Constant	302.70	294.42	285.50	249.47
General studies	5.85*	6.65*	9.94*	12.80*
	(0.15)	(0.15)	(0.22)	(0.31)
Grades	8.04*	9.79*	12.88*	10.84*
	(0.23)	(0.24)	(0.36)	(0.30)
Parents higher education	0.28	3.39	−1.28	−2.01
	(0.01)	(0.08)	(−0.03)	(−0.03)
Parents lower education	−3.23	−0.98	−3.72	−1.30
	(−0.05)	(−0.02)	(−0.09)	(−0.03)
Woman	−4.07*	−7.04*	−3.39*	−4.59*
	(−0.11)	(−0.16)	(−0.08)	(−0.11)
Exam from higher education	13.67*	15.54*	7.64*	15.70*
	(0.31)	(0.35)	(0.12)	(0.11)
Currently studying	3.50*	−10.05	−2.19	–
	(0.09)	(−0.13)	(−0.02)	
R^2	0.24	0.33	0.24	0.22

Note. $N = 2581$. Range for the mean and standard deviation for literacy is 258.1–301.8 and 38.4–43.6, respectively.
*$p < .05$

picture. Effects of social background (fathers/mothers level of education in the analysis) might for example be confounded with the effect of grades from compulsory school. A closer look does not, however, give rise to concerns (see above). An additional factor to take into account is the relative impact of the variables included in the analysis. To ascertain each variables contribution to the explanatory power of the model, stepwise regressions were performed for each of the age cohorts (Table 7).

The VET/general variable contributes with 8% of the total explained variance for the youngest cohort ($B = 11.12$, $\beta = 0.29$). Gender and parents educational level do not contribute significantly to the explanatory power of the model. When grades from compulsory school are entered, an additional 7% variance is explained. A tertiary-level exam adds another 8%. Apparently, the stepwise model points in the same direction as the original model. Vet/general, marks, and tertiary-level education have a significant impact on literacy for the 19–32-year-olds (Table 8).

For the cohort of 33–40 years, the structure is basically the same as for the youngest. VET/general contributes marginally more than for the youngest, while grades from compulsory school contribute much the same as for the youngest. Exams at the tertiary level contribute marginally more than for the youngest. It is worth observing that the sign for "currently studying" is negative, which indicates that participation in adult education does not increase the literacy level (Table 9).

Grades from compulsory school contribute substantially more in the age group 41–57 compared to the two younger groups, while the VET/general variable has less impact (5% compared to 8 and

Table 7. Swedish results from the regression analyses with literacy as the dependent variable, age group 19–32.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variable	B (β)	B (β)	B (β)	B (β)	B (β)	B (β)
Constant	299.34	299.32	296.82	294.92	301.13	302.70
General studies	11.12* (0.29)	11.15* (0.29)	9.93* (0.26)	9.55* (0.25)	6.46* (0.17)	5.85* (0.15)
Woman		−0.73 (0.02)	−0.98 (−0.03)	−3.71* (−0.10)	−3.91* (−0.10)	−4.07* (−0.11)
Parents higher education			2.80 (0.07)	1.47 (0.04)	0.55 (0.01)	0.28 (0.01)
Parents lower education			−3.28 (−0.05)	−2.54 (−0.04)	−3.47 (−0.05)	−3.23 (−0.05)
Grades				9.44* (0.27)	8.15* (0.23)	8.04* (0.23)
Exam from higher education					13.20* (0.30)	13.67* (0.31)
Currently studying						3.50* (0.09)
R^2	0.08	0.08	0.09	0.15	0.23	0.24

Note. $N = 981$.
*$p < .05$.

Table 8. Swedish results from the regression analyses with literacy as the dependent variable, age group 33–40.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variable	B (β)	B (β)	B (β)	B (β)	B (β)	B (β)
Constant	300.67	300.77	301.18	299.74	302.97	294.42
General studies	15.18* (0.35)	15.40* (0.35)	14.05* (0.32)	12.82* (0.29)	7.27* (0.17)	6.65* (0.15)
Woman		−3.24 (−0.07)	−2.72 (−0.06)	−5.34* (−0.12)	−7.62* (−0.17)	−7.04* (−0.16)
Parents higher education			6.05* (0.14)	4.25 (0.10)	3.43 (0.08)	3.39 (0.08)
Parents lower education			−3.39 (−0.07)	−2.94 (−0.06)	−0.62 (−0.01)	−0.98 (−0.02)
Grades				10.80* (0.27)	9.58* (0.24)	9.79* (0.24)
Exam from higher education					15.16* (0.34)	15.54* (0.35)
Currently studying						−10.05 (−0.13)
R^2	0.12	0.13	0.16	0.23	0.32	0.33

Note. $N = 492$.
*$p < .05$.

Table 9. Swedish results from the regression analyses with literacy as the dependent variable, age group 41–57.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variable	B (β)	B (β)	B (β)	B (β)	B (β)	B (β)
Constant	280.78	280.81	283.68	282.39	287.35	285.50
General studies	10.61* (0.23)	10.70* (0.23)	10.74* (0.24)	10.77* (0.24)	9.96* (0.22)	9.94* (0.22)
Woman		−0.84 (−0.02)	0.14 (0.00)	−2.98 (−0.07)	−3.47* (−0.08)	−3.39* (−0.08)
Parents higher education			2.30 (0.05)	−1.04 (−0.02)	−1.23 (−0.02)	−1.28 (−0.03)
Parents lower education			−6.08* (−0.14)	−4.33* (−0.10)	−3.70 (−0.09)	−3.72 (−0.09)
Grades				13.30* (0.38)	12.90* (0.36)	12.88* (0.36)
Exam from higher education					7.35* (0.12)	7.64* (0.12)
Currently studying						−2.19 (−0.02)
R^2	0.05	0.05	0.10	0.22	0.24	0.24

Note. $N = 793$.
*$p < .05$.

12%, respectively, for the youngest and next youngest group). The same is true also for the variable Exam from tertiary level (2% compared to 8 and 11%). In contrast to the two younger groups, the negative impact of having a parent with only basic schooling is significant and contributies 5% to the explanatory power of the model.

For the oldest cohort (aged 58-65) VET/general and grades from compulsory school represent the major share of explanatory power (11 and 9%, respectively) (Table 10).

Table 10. Swedish results from the regression analyses with literacy as the dependent variable, age group 58–65.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variable	B (β)	B (β)	B (β)	B (β)	B (β)	B (β)
Constant	260.52	260.79	263.50	263.97	275.60	249.47
General studies	13.74* (0.33)	13.72* (0.33)	13.45* (0.33)	12.77* (0.31)	12.65* (0.31)	12.80* (0.31)
Woman		−3.69 (−0.09)	−3.10 (−0.80)	−4.79* (−0.12)	−4.72* (−0.12)	−4.59* (−0.11)
Parents higher education			1.31 (0.02)	−1.12 (−0.02)	−1.80 (−0.03)	−2.01 (−0.03)
Parents lower education			−2.09 (−0.04)	−1.46 (−0.03)	−1.41 (−0.03)	−1.30 (−0.03)
Grades				10.96* (0.30)	10.81* (0.30)	10.84* (0.30)
Exam from higher education					12.82* (0.09)	15.70* (0.11)
Currently studying						–
R^2	0.11	0.12	0.12	0.21	0.22	0.22

Note. $N = 315$.
*$p < .05$.

The Danish Case

Participants.

The number of the respondents in the estimation sample is obtained as follows. The PIAAC data set for Denmark contains 7328 respondents, but 42 do not have literacy scores and are thus omitted. There is no register information on education for 426 respondents, 1434 only obtained compulsory school and both of these groups are also omitted. Finally we dropped 43 respondents who have age 18 or below. The mean of the literacy score for this sample 280.8 score points and the standard deviation is 42.2 points.

Table 11 contains the respondents in the estimation sample distributed on the different cohorts corresponding to the cohorts used in the estimations on the Swedish sample. The respondents in each cohort are distributed into the "general studies" category and the "VET" category.

Variables and analysis.

The Danish data are the PIAAC data for Denmark supplemented with data from administrative registers. The supplementary data are data on education and data on grades from primary school. Both types of data are provided by Statistics Denmark.

The variable used to distinguish between general and vocational education is a variable for the highest completed education (named *hfaudd* – "*højeste fuldførte uddannelse*"). This variable contains a detailed registration of the type of education (cook, carpenter, mechanic, etc.). Following a procedure provided by Statistics Denmark, we aggregate the educations into nine main categories. One of the nine main categories is a category that indicates that the respondents have completed an education that contains a substantial amount of vocational training (the full name of the category is "*Erhvervsfaglige praktik- og hovedforløb*").[5] Tabulation of education at the detailed level in this main category shows that almost all of the included education belong to the traditional Danish vocational education system, including an apprenticeship contract and education on vocational oriented secondary educational schools.[6] All of the education at the disaggregate level seems to include considerable vocational elements.

Among the other eight main educational categories is a category that indicates that the respondent has not completed an education beyond the compulsory level ("*grundskole*") and we omit these respondents from the analysis. The other seven categories are included in the estimation sample as having completed general education. Two main categories indicate that the respondents have completed high school ("gymnasium") but not any education beyond this level. Five main categories indicate that respondents have completed higher education,[7] which is included as a dummy variable in the analysis.

The rest of the variables in the analysis across cohorts are obtained from the PIAAC questionnaire as for the Swedish case, see description above. These variables are parental educational background,

Table 11. The Danish sub-sample by the four cohorts and type of education.

Age	Born	General *n*	VET *n*	Total *n*
19–32	1980–93	768	291	1,059
33–40	1972–79	479	330	809
41–57	1955–71	1,161	1,001	2,162
58–65	1947–54	661	692	1,353
Total		3,069	2,314	5,383

[5]"*Erhvervsfaglig*" does not have a direct translation in English but corresponds closely to "*Berufsbilding*" in German.

[6]An exception is that education to become a bank assistant is included in the category – this education actually contains a substantial vocational element but is private education and not a part of the state regulated apprenticeship system, in contrast to, for example, Germany and Switzerland.

[7]The Danish dummy variable for higher education differs from the corresponding variable in the Swedish analyses. In the Danish analyses there is no information about VET respondents who have higher education.

whether the respondent is currently studying, and the gender dummy. These variables correspond to the variables applied in the analysis of the Swedish data except for the variable higher education. In the Danish analyses this variable is instead derived from the Danish register variable "*hfaudd*" (the highest completed education).

Comparisons between age cohorts in the Danish case.

Sweden and Denmark apply different principles for organizing upper-secondary education, as shown above. This presents us with something resembling a quasi-natural experiment. Table 12 shows the result of regression analysis for the same age cohorts in Denmark as is reported above for Sweden. Due to different availability of register data, grades from compulsory school ae not included in the Danish analysis. Data on grades were only available for 548 respondents aged 19–27 and imputation would result in estimates suffering from a large degree of uncertainty, so was thus ruled out. The Danish as well as the Swedish analyses without grades are both included in Table 12.

It can be seen that the pattern of coefficients demonstrating different literacy outcomes for those with a VET exam versus a General exam at the upper-secondary level are very different when comparing the two country analyses. While the coefficient in the Swedish case is much lower for the younger cohorts, the reverse is true in the Danish case. While the shrinking coefficient size for Sweden runs parallel to a steady increase in the share of general subjects in the Swedish VET system, no such pattern is apparent for Denmark.

The first column of Table 12 contains the results for the youngest cohort of age 19–32. The reference person is a man with completed vocational education who is not currently studying and where the parents have a middle-level education. The coefficient in the first column shows that respondents who have attended general studies have 23.7 higher literacy score points in PIAAC than persons who have attended vocational education, conditional on the other explanatory variables in the regression, corresponding to 56% of a standard deviation in the literacy score. It can be noted that in the Swedish regression, the choice of a general upper-secondary education corresponds to only 15% of a standard deviation in the literacy score. The conditioning variables show that respondents where at least one parent has a higher education have higher scores, while respondents where both parents have a lower education have lower scores. Furthermore, the first column of Table 12 shows that women have lower scores than men, an examination from a higher education is associated with a higher score, and respondents who are currently studying have higher scores than those who are not studying.

The remaining three columns of Table 12 show the results for the older cohorts of respondents. The coefficients on the dummy for general study are high and not far for each other, the lowest is the 17.5 score points for the cohort aged 33–40. All the coefficients to the general study dummy are significantly different from zero and the coefficients for the different cohorts are not significantly different from the ones in the other cohorts. For Denmark, Table 12 thus shows that attending general studies in contrast to vocational education is associated with higher literacy scores and that this advantage is large and not different across cohorts.

The coefficients on the conditioning variable are also stable across cohorts in most cases. The coefficients to the dummy for parents with higher education ranges from 7.0–10.3 score points, which is significantly different from zero in three cases. The dummy for having parents with a low level of education is smaller and ranges from 3.4–9.5 points, which is significantly different from zero in one case and on the borderline in the other case. The gender dummy shows that women score 1.3 –5.2 points lower than men, conditional on the other explanatory variables, and this difference is significantly different from zero in two cases. An exam from higher education is associated with a higher score at 2.6–8.0 points, which is significantly different from zero in one case. The only covariate, which varies substantially over cohorts, is the dummy for currently studying, which ranges from −6.0 points for respondents aged 33–40 to 18.7 points for respondents aged 58–65 (only 1% of the respondents in the oldest age category are currently studying and the majority

Table 12. Results from the regression analyses with literacy as the dependent variable and without grades, in the four age groups.

	Denmark				Sweden			
	19–32	33–40	41–57	58–65	19–32	33–40	41–57	58–65
Variable	B (*β*)	B (*β*)	B (*β*)	B (*β*)	B (*β*)	B (*β*)	B (*β*)	B (*β*)
Constant	271.35	280.09	267.56	249.30	305.03	296.58	286.89	252.23
General studies	23.65* (0.27)	17.51* (0.22)	18.69* (0.23)	21.44* (0.26)	5.81* (0.15)	7.38* (0.17)	9.67* (0.21)	13.44* (0.32)
Parents higher education	8.92* (0.11)	7.06 (0.09)	9.51* (0.10)	10.30* (0.09)	1.28 (0.03)	4.94 (0.11)	1.83 (0.04)	0.31 (0.00)
Parents lower education	−6.34 (−0.05)	−9.53* (−0.09)	−4.46* (−0.05)	−3.37 (−0.04)	−3.92 (−0.06)	−1.18 (−0.02)	−5.22* (−0.12)	−1.92 (−0.04)
Woman	−5.23* (−0.07)	−4.75 (−0.06)	−4.41* (−0.05)	−1.30 (−0.02)	−1.82 (−0.05)	−4.90* (−0.11)	−0.49* (−0.01)	−2.92 (−0.07)
Exam from higher education	7.47* (0.09)	8.04 (0.10)	5.50 (0.07)	2.59 (0.03)	14.98* (0.34)	16.63* (0.38)	10.01* (0.38)	17.27* (0.13)
Currently studying	2.31 (0.03)	−5.99 (−0.05)	1.74 (0.01)	18.71* (0.05)	3.82* (0.09)	−9.31 (−0.12)	−3.73 (−0.03)	–
R^2	0.15	0.14	0.12	0.12	0.19	0.28	0.12	0.14

Note. Denmark: $n = 5{,}383$. Standard deviation for literacy is 42.2 points. Sweden: $n = 2{,}581$. Range for the mean and standard deviation for literacy is 258.1–301.8 and 38.4–43.6, respectively. The reference person is a man with completed vocational education who is not currently studying and where the parents have a middle level education.

*$p < .05$.

have an exam from a higher education, which makes this group very different from the respondents in the younger age categories who are currently studying).

The main result obtained from Table 12 is that following General Studies as opposed to vocational education is associated with substantially higher levels of literacy. Moreover the higher level of literacy associated with General Studies is about the same across different cohorts, which is consistent with the observation that the share of general subjects in the vocational educational system was not subject to major changes at the time when most respondents were educated.

The exception is the oldest cohort, as a major increase in the amount of general subjects in the vocational educational system took place in the beginning of the 1970s. Most of the vocational-trained respondents in the oldest Danish cohort are thus expected to have received training during the system before the reform, while the respondents in the cohort aged 41–57 is expected to have received training after the increase in the amount of General Studies in the vocational training system. If a higher nuber of general subjects in the vocational educational system increases literacy, the expectation is that the coefficient on the general study dummy for the oldest cohort is larger than the coefficients for the younger cohorts.

The general study dummy for the oldest cohort takes the value 21.4, which actually is larger than the coefficients on the General Studies dummy for the cohorts aged 33–40 and 41–57, which takes values 17.5 and 18.7, respectively. However, according to the associated standard errors to the coefficients, there is no significant difference between the coefficients for the different cohorts.

Conclusion and Caveats

The study aims at answering the research questions:

> How does choice of VET versus General Studies at the upper-secondary level affect long-term literacy trajectories?
>
> Does an increase of cognitively demanding content in VET affect this development?

The results show clear indications of a higher performance in literacy in those Swedish age groups who attended more academically oriented VET programmes compared to the older Swedish age groups and to all the Danish age groups. For the youngest Swedish age group (19–32), the differences in literacy proficiency related to type of upper-secondary programme was much smaller than for the oldest Swedish group and also compared to the Danish sample. This indicates that the choice of VET versus general programmes at the upper-secondary level is associated with proficiency in literacy. A reasonable interpretation is that the number of general subjects challenging CFS at the upper-secondary level give a lasting imprint on literacy proficiency later in life. In the Swedish results, two of the control variables account for a comparable share of explained variance, namely "Grades from compulsory school" and "Exam from higher education." The abilities represented by each of these variables have a lasting impact on lifetime literacy trajectories for all four cohorts (ages 19–65). The results appear in all the regression models applied in the Swedish case.

The model on Danish data, without grades, confirms the assumption that literacy skills follow vocational versus general upper-secondary education. Contrary to the decrease in B estimates for the "General/VET studies" variable from the oldest to the youngest cohort in the Swedish case, there is no such decrease in coefficient size in the Danish data (Table 12). This might mirror the comprehensive effort with more of general subjects in the Swedish VET system from the 1960s to the 1990s. Moreover, having parents with a higher education is associated to a better literacy performance in Danish sample in the age groups 19–32, and 41–65 whereas none of the Swedish age groups have a statistically significant association to parent's higher education in the model in Table 12. This is in line with the OECD (2013a) report stating that Sweden has the lowest socioeconomic status influence on literacy proficiency and Denmark the highest among the Nordic countries, although all Nordic countries are below the OECD average.

A follow-up analysis on the Danish sub-sample of 548 participants aged 19–27, that included grades showed that grades in primary school are strongly associated with the literacy score in PIAAC for this group. An increase in grades by one standard deviation is associated with an increase in the literacy score at 18.2 points. For this sub-sample, grades in primary school are more strongly associated with performance in literacy than the variables for educational choice and parental education background. It is of interest to note that the choice of General Studies in contrast to vocational programmes is associated with a modestly higher literacy score at 5.16 score points. This difference is, however, not statistical significantly separated from zero, possibly due to the relatively small sample size. The point estimate is very close to the corresponding point estimate at 5.85 in the Swedish results for the cohort aged 19 to 32 (Table 6). Caution in the interpretation of these follow-up analyses is, of course, needed due to the small sample size and the limited age range.

The steady increase in the share of general subject in VET, from a negligible part for the oldest age group to 30% of the curriculum in the youngest, goes together with a steady decease in the coefficient size related to choice of VET versus general tracks in upper-secondary school. Still, the design does not permit causal inferences and there are remaining concerns about selection and aging effects. For one, we have controlled for literacy-related abilities before the choice of track in upper-secondary school via grades from compulsory school for the three younger cohorts, but not for the oldest. Systematic bias might result from age related non-response. In our case this might mislead our conclusions if the less proficient older are more likely to participate in PIAAC than the younger less proficient.

There might be selection effects related to specific cohort characteristics like changes in the attractiveness of vocational education from the 1960s. Is it that vocational education 60 years ago was more of a scrap or inferior alternative for young people leaving compulsory school? This does not seem likely considering the steady increase in popularity of VET during the 1960s and 1970s, as opposed to today's concerns about lacking interest for VET among young people in Denmark as well as Sweden. Thus, we should not understate the similarities between the roles played by VET in the two countries. Both the Danish and the Swedish VET system seem to offer a way for students who have failed at the compulsory stage to opt out from further theoretical studies (Fouganthine, 2012, Grogarn, 1979). Both countries have also met severe drop-out problems among VET students (Cedefop, 2012b; Olofsson & Wadensjö, 2007).

There is an ongoing discussion about flexibility in working life and the importance of life-long learning. Literacy, as well as numeracy, are crucial competences for adult education. Choosing VET at upper-secondary school will probably increase the opportunities for employment in the short run, but in the long run the demand for that specific education could decrease and thus render a need for re-training. The present study would be an important contribution for policy makers regarding the type of VET education most beneficial in today's and tomorrow's society.

Widening the study to include more PIAAC countries adhering to the classical apprentice model for vocational education would cast further light on the critical issue here – is there a prize to pay in long-term diminished literacy returns to education for the labour market benefits of apprentice VET systems?

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ORCID

Maria Rasmusson http://orcid.org/0000-0002-3241-967X

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