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# The effects of post-compulsory education and training systems on literacy and numeracy skills: A comparative analysis using PISA 2000 and the 2011 survey of adult skills

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## Abstract

This article analyses the contribution of post-compulsory education and training systems to the development of literacy and numeracy skills across OECD countries. While there is extensive cross-country comparative research on the effects of primary and lower secondary education systems on aggregate skills levels, there has been little comparative analysis of system effects after the end of lower secondary education. This article uses a quasi-cohort analysis of the tested literacy and numeracy skills of 15-year-olds in PISA 2000 and 27-year-olds in the 2011 OECD Survey of Adult Skills (SAS) to estimate the gains in different countries in mean levels of competence in literacy and numeracy. We found that Nordic countries (Norway and Sweden) with comprehensive upper secondary education and training systems and German-speaking countries (Austria and Germany) with dual systems of apprenticeship were particular effective, whilst countries with mixed systems (England, Ireland, Northern Ireland and Spain) showed a relative decline in both literacy and numeracy. The education system characteristics that account for these differences are (a) the inclusiveness – as proxied by high rates of participation at 17/18 and low social gradients of level 3 completion; (b) the esteem of vocational programmes; and (c) curriculum standardisation with regard to the study of maths and the national language.

## 1 | INTRODUCTION

This article analyses the contribution of post-compulsory education and training systems[1] to the development of literacy and numeracy skills across OECD countries. There is a considerable body of cross-country comparative research on the effects of primary and lower secondary education systems on aggregate skills levels but little comparative

analysis of system effects following the end of lower secondary education. This can partly be attributed to the lack of comparable international longitudinal data on learning gains after the age of 15 and of international time-series data on adult literacy and numeracy skills. This article uses a quasi-cohort analysis of the tested literacy and numeracy skills of 15-year-olds in PISA 2000 and 27-year-olds in the 2011 OECD Survey of Adult Skills (SAS) to estimate the gains in different countries in mean levels of competence in literacy and numeracy. Because of the different designs of the PISA and SAS tests we were unable to compare skills levels at different ages in absolute terms so the analysis here is based on comparing the relative skills gain across countries. It seeks to explain the variations with reference to the effects of different types and characteristics of post-compulsory education and training systems. Particular attention is paid to the effects of institutional integration and curriculum standardisation across programmes and to the relative esteem of academic and vocational tracks.

## 2 | LITERATURE REVIEW

### 2.1 | Research on the compulsory phase

A large body of literature analyses the effects on performance of education system types and characteristics at the primary and lower secondary levels. It is largely based on quantitative analyses of the international data on literacy and numeracy competence at 15 years, as tested in the OECD PISA surveys and at 14 years by the IEA[2] surveys. The most consistent finding of the IEA studies is that variation across countries in performance in particular subjects is associated with the total time spent on studying those subjects (OECD, 2013). Research based on the PISA data focuses on the effects of different forms of school regulation and governance, for instance policies on school choice and competition between schools (OECD, 2013), school autonomy (Bol & Van de Werfhorst, 2013; OECD, 2013) and school accountability, including centralised exit examinations which are found to have a positive effect on performance (Bol & Van de Werfhorst, 2013; Woessmann, 2005).

A long-standing argument about the effects of school organisation on performance is that tracked systems in which pupils are separated into types of schools by academic ability raise standards of achievement by encouraging more homogeneous classrooms where learning is more effective. However, more recent studies cast doubt on this. Annermueller, Heijke, and Woessmann (2005) found that tracking before age 13 ('early' tracking) was associated with higher average test scores in Central and Eastern Europe, but other studies using performance data for a wider range of countries found no clear relationship between early tracking and mean levels of achievement and educational attainment (Micklewright & Schnepf, 2007; Schutz, Ürsprung, & Woessmann, 2008; Woessmann, 2008). Some even found a negative effect. Hanushek and Woessmann (2006), using a Difference- in- Difference (DID) approach with data from PIRLS, TIMMS and PISA, found that, whilst early tracking tended to increase family background effects on achievement, there was no trade-off with better achievement. Reviewing the literature based on the evidence from international test and attainment data, Van de Werfhorst and Mifs (2010) concluded that, whilst early tracking was generally associated with greater inequality in educational and skills opportunities and outcomes, it led to lower average levels of achievement across a range of subjects.

### 2.2 | Research on the post-compulsory phase

Comparative research on the outcomes of the different types of upper secondary education and training has tended to focus on their relative effectiveness in facilitating youth transitions to the labour market. A series of Anglo-German comparative studies (Bynner & Roberts, 1991; Evans & Heinz, 1994) has suggested that apprenticeship systems provided a smoother transition, with more certainty about entry into employment in skilled and relatively well-paid occupations. The rather mixed and diversified system in England, by contrast, has been associated with less clearly-defined transition pathways with less certain outcomes. Other research has made wider claims for the effects of apprenticeship systems. Research in the comparative political economy tradition has frequently argued that Dual Systems of apprenticeship not only provided smoother transitions and lower rates of youth unemployment (Allmendinger, 1989; Breen,

2005; Gangl, 2003), but also contributed to a reduction of skills inequalities (Green & Pensiero, 2016). Countries with these systems generally retain a higher proportion of adults with intermediate skills and thus reduce the hollowing-out of skills stocks and consequent skills polarisation associated with more liberal economies and other types of education and training (Brown, Green, & Lauder, 2001; Estévez-Abe et al., 2001). Research on adult learning suggests one reason why apprenticeship systems may also have an indirect effect on these basic skills. The use of literacy skills at work has been shown to be associated with higher literacy skills at the individual level (Desjardins & Ederer, 2015; OECD & Statistics Canada, 2000; Rubenson, 1987).

## 2.3 | The effect of the post-compulsory phase on skills gain

There has been much less research, however, on the direct effects of different types of upper secondary systems on educational attainment and the acquisition of basic competences, partly because of the difficulties of comparative measurements of learning gain in the absence of international longitudinal data. Some factors considered at the compulsory phase may also explain variations in performance in upper secondary education and training. The prevalence of tracking, for instance, may have a different significance at the upper secondary level during earlier phases (Brunello & Checchi, 2007; Busemeyer, 2014; Green & Pensiero, 2016). Raffe, Brannen, Fairgrieve, and Martin (2001) have argued that, whilst educational programmes are organised hierarchically according to a monotonic scale of academic prestige during the compulsory phase, in the upper secondary phase, the tracks are valued according to more differentiated criteria. Whilst general academic schools and programmes may be valued according to their success in getting students into higher education, vocational schools may derive their prestige from their success in getting graduates into skilled jobs. Where, on differentiated criteria, relative 'parity of esteem' is achieved between academic and vocational programmes, tracking at the upper secondary level may even enhance mean competence levels by raising the skills of lower achievers compared to systems with a hierarchical distinction of esteem between tracks or programmes.

## 2.4 | Typology of upper secondary education and training systems

The literature on upper secondary education and training systems as they were in the early 2000s when our sample from SAS was going through upper secondary education identifies four broad types in OECD countries by classifying systems according to forms of curriculum and assessment, modes of governance and regulation and, importantly, the degree of system integration which relates to both the forms of institutional differentiation and the level of curricula standardisation across programmes (Green, 2002; Lasonen & Young, 1998; OECD, 1985; Raffe, Howieson, Spours, & Young, 1998; Raffe et al., 2001).

### 2.4.1 | Type 1. Differentiated school-based systems

These are predominantly systems with general academic and vocational provision in different types of upper secondary institutions. Programmes last for two or, more usually, three years from the age of 15 and lead to a qualification which gives access to general university education (ISCED 5A) in the case of general education students and vocational tertiary education (at ISCED Level 4 or 5B) in the case of vocational students. The curricula in general and vocational programmes generally share certain common core elements, such as maths and the national language, but are typically organised around a cluster of subjects that is specific to the disciplinary/occupational orientation of the programme. Diplomas are normally based on 'grouped examinations' which require passes in a range of subjects, including language and maths. Most continental European and East Asian OECD countries in our sample have this type of system (e.g., the Czech Republic, Denmark, Estonia, France, Finland, Greece, Italy, Netherlands, Japan, Poland and Russia).[3]

### 2.4.2 | Type 2. Comprehensive school-based systems

These predominantly offer academic and vocational provision in the same institution, either as a standardised, core plus options programme, as in most American high schools, or in programmes with distinctive subject specialisms but with substantial overlapping cores of general education, as in Norway or Sweden. Sweden has 18 three-year programmes,

12 of which are vocational and six are university preparation courses. Norway has nine three-year programmes, three of which are general and six are vocational.[4] Comprehensive upper secondary systems share most of the characteristics of Type 1 systems, but curricula and assessment tend to be more integrated across the range of provision (Raffe et al., 2001). They can be regarded as relatively standardised, since there is only one main type of upper secondary institution. Several countries have a few such institutions (e.g., eniaia lykeio in Greece; lycées polyvalents in France and tertiary colleges in England), but only four OECD countries in our sample have this type of institution as the dominant form (Canada; Norway; Sweden and the United States). Forms of governance and regulation, however, vary considerably between the North American and Scandinavian contexts, with school choice and diversity policies in the former leading to much greater institutional variation than in the more standardised Nordic systems. Hence, we may subdivide this system into Type 2a (North American) and Type 2b (Nordic) comprehensive school-based systems.

#### 2.4.3 | Type 3. Tracked academic and apprenticeship provision

Participation is distributed relatively equally between school-based general education and employment-based Dual Systems of apprenticeship. The provision at upper secondary level may be of similar duration across the different tracks (as with the three-year apprenticeships and final stage Abitur courses in Germany) and the vocational track may contain significant mandatory components of general education, as in all Dual System apprenticeships (Solga, Protsch, Ebner, & Brzinsky-Fay, 2014). However, the general and vocational tracks present sharp differences in forms of regulation based on social partner organisations, curricula and assessment and final qualifications and subsequent progression possibilities in education, training and work. In respect of their Dual Systems, this means that they are closely linked to labour market institutions and the world of work, which has important effects on the labour market value of their qualifications (Busemeyer & Iversen, 2011; Green, 1999) and may have positive feedback effects on participants' motivation (Estévez-Abe et al., 2001). Several countries (Austria, Belgium, Denmark, Germany, Ireland, Luxembourg, Netherlands and Switzerland) have traditional Dual Systems of apprenticeship where provision is regulated by the social partners, with apprentices recruited by firms and placed in employment contracts. However, it is only in Austria, Germany and Switzerland that a third or more of young people participate in them (OECD, 2008; Steedman, 2001, 2010). Only Austria and Germany are represented in our sample, so only these two countries are allocated to Type 3 in this analysis.

#### 2.4.4 | Type 4. Mixed systems

These include many school- and employment-based programmes of variable length and quality, but with predominantly academic tracks. They are often organised on a modular basis to promote flexible combinations of options. There is usually no compulsory core curriculum across all programmes and the learning of maths and the national language is not necessarily mandated in all programmes (Hodgen, Pepper, Sturman, & Ruddock, 2010). Assessment can be by elective single subject examinations (as with the English A levels) or by examination in a range of specified subjects for grouped awards (as in the Bachillerato in Spain). Reaching a specified standard in maths and the national language, however, is not necessarily a condition to obtain the diploma. In vocational courses, students are assessed on the basis of their ability to demonstrate competences rather than on their knowledge of a syllabus and programmes often do not have a prescribed duration so that rates of early school leaving are relatively high. Regulation and governance in mixed systems are generally more liberal and market-oriented, with great diversity in programmes and types of providers, including private training organisations. Australia, England, Northern Ireland, Ireland, Scotland, Spain and New Zealand broadly belong to this type of education.

## 3 | HYPOTHESES

In light of the previous discussion, we expect that systems with greater life-course gains in skills are those with:

- More inclusive systems, with high rates of post-compulsory participation and completion and greater equality of opportunity;

- Greater 'parity of esteem' between academic and vocational tracks;
- Greater standardisation across pathways with regard to the mandatory inclusion of maths and the national language and the length of programmes.

## 4 | METHODS

To address these questions empirically, we analysed the cross-country variation in competence levels between the ages of 15 and 27 in relation to the differences in post-lower secondary provision. The use of data on competences at different points in time enabled us to define country profiles of competence development over the life course. This has the advantage of controlling the initial level of competences at age 15, which means that our results regarding the effect of upper secondary education characteristics are not confounded by the fact that countries have low or high levels of competences to begin with. Some countries improve (or deteriorate) more than others in terms of relative competence levels between the ages of 15 and 27. Hence, the aim of the analysis was to quantify the effect of the post-compulsory education and training systems and characteristics in accounting for this country variation in competence development over the life-course.

Theoretical limitations and data availability mean that some relevant factors are omitted in our analysis. Given these limitations, an OLS estimator or a simple mean comparison of proficiency at age 27 are likely to be biased, as they do not take into account differences between countries at the beginning of the upper secondary phase. The advantage of the Difference in Differences (DID) estimator (Hanushek & Woessmann, 2006) is that it controls for omitted systematic (time-constant) factors that are likely to affect the outcome over and above the impact of the independent variable. For example, if two countries differ in youth labour market opportunities, these differences may encourage young people to acquire job-relevant skills in the two countries in diverse ways. This is likely to lead to a lower achievement by early adulthood in the country, with worse youth labour market opportunities. By removing country-specific effects, the DID estimator generates estimates which are 'net' of macro systemic factors, such as youth labour market opportunities. The DID estimator is defined as the difference in average outcome in the treatment group before and after treatment minus the difference in average outcome in the control group before and after treatment. In other words, it compares the over-time changes in mean scores across countries with a dual apprenticeship system (treated group) and those with a comprehensive system (control group). In formal terms, the effect of the treatment $\gamma$ can be expressed as:

$$\gamma = (\bar{}\text{itreat, after} - \bar{}\text{itreat, before}) - (\bar{}\text{icontrol, after} - \bar{}\text{icontrol, before})$$

We implemented the DID technique using the equation below which pools the skill measures at age 15 and 27 in a regression framework.

$$\textit{Proficiency index}_{\textit{pooled}} = \beta_0 + \gamma_0 \textit{age27} + \beta_1 Y + \gamma_1 Y.\textit{age27} + \textit{residual}$$

Age27 is an indicator set to 0 for the 15-year-old observations and 1 for the 27-year-old observations and $\gamma_0$ is the expected mean change in outcome from before to after the treatment within the control group. It reflects the change in achievement over time in the absence of the actual intervention. $\beta_1$ is the estimated difference between the treated and the control group in the achievement at age 15 before the treatment started, yet the focus is $\gamma_1$ which is the expected difference between treated and untreated in the change in achievement from 15 to 27. In other words, it is the effect of the characteristics of a given education system on the change of position in the ranking of countries over the interval. $\beta_0$ is the constant term and the *residual* is what is left unexplained by the model. Standard errors are clustered by country in order to account for their correlation within a group over time. As the change in proficiency in relation to other countries is the focus, the interpretation of the effect of each independent factor also assumes a relative connotation. Hence, any estimated impact represents the change that would occur in a given country had it introduced a given change in the upper secondary system (along one of the relevant indicators), provided that the other countries did not improve their aggregate proficiency.

## 5 | DATA

The Survey of Adult Skills (SAS) was conducted in 2011 and 2012 in 25 countries and regions under the supervision of the OECD and tested adults aged 16–64 years for their competences in literacy, numeracy and problem-solving skills (OECD, 2013). Sample sizes for the 25–29-year-old age group which we used varied between 327 and 1,715 across countries. In addition, the survey also contains data on the highest qualification levels of respondents and their parents. Twenty one of the 24 nations that took part in SAS also participated in PISA 2000. This sub-group of countries constituted our sample. The outcome of interest is the change in mean achievement at the country level between ages 15 and 25–29. Australia was not included since its data were not publicly available.

SAS and PISA draw on similar underlying constructs of literacy and numeracy competence and both assess the ability to apply these skills in real world contexts. The tests adjust the questions to reflect the life experiences of those aged 15 and adults. However, there is still a considerable overlap in the contexts of the question across the two surveys (Gal & Tout, 2014). Both are large surveys that use nationally-representative samples derived from standardised stratified sampling. Both use questions of different levels of complexity and compute scores based on the principles of item response theory in order to take into account the number of correct answers and the difficulty of the items. The proportion of less complex questions tends to be higher in SAS than in PISA (Gal & Tout, 2014). Moreover, SAS relies somewhat less than PISA on the use of the terminology and procedures of formal mathematics, but both test the ability to solve similar real world problems.

Given these underlying similarities in the tests, how far can their results be compared across countries? One view is that international surveys of achievement often test similar underlying competences and are thus comparable even when they have different design features (Hanushek & Woessmann, 2006, 2010; Rindermann, 2007). As Hanushek and Woessmann note (2010, p. 9), the correlation coefficients between the results of TIMSS 2003 tests of 8th graders and the PISA 2003 tests of 15-year-olds across 19 countries participating in both are 0.97 in maths/numeracy and 0.97 in science. There is also a high correlation at the country level between the TIMMS curriculum-based student tests and the practical literacy adult examinations of IALS (Hanushek & Zhang, 2009). Some studies use a variety of international surveys of different age groups (such as PIRLS and TIMSS) to analyse cross-country variation in skills levels and inequality between primary and secondary education (Annermueller, 2005; Hanushek & Woessmann, 2006; Van de Werfhorst & Mifs, 2010). On this basis, it should also be possible to make meaningful comparisons across countries between the PISA and SAS results. However, there are great differences between the assessment and reporting methods in SAS and PISA tests which need to be taken into account. PISA is a school- and classroom-based assessment which uses pencil and paper responses, whereas SAS is a household survey where responses are predominantly computer-based. Normally lasting for two hours, the PISA tests include many more questions than the SAS tests which normally last for no more than an hour. The mode of reporting results is also different. PISA uses six levels and scores are on a scale of 200 to 800. SAS uses five levels and is scored on a scale from 0 to 500. According to Gal and Tout's study of the comparability of the two tests, these differences mean that '. . .a comparison of reported results from PISA and PIAAC has to be done with much caution. . .' (Gal & Tout, 2014, p. 26). They also note that the sample size for a single year group in SAS would be too small for a reliable analysis of the distribution of scores.[5]

In this analysis, in order to increase our SAS sample size to an acceptable level, we take the 25–29 age range in SAS to proxy for the 27-year-olds in our quasi cohort. Second, we avoid comparisons based on absolute differences in mean scores between the two tests. Instead, we rank the countries by average competence levels for each test and then compare the changes in ranking for each country between the two tests representing achievements at 15 and 27 years, respectively. Third, score distributions are divided into five quintiles so as not to overstate the significance of small differences in average scores. The changes in ranking are measured in terms of quintile positions, so, if country A scores in the lowest quintile of country scores in literacy (position 1) in PISA and in the top quintile (position 5) in SAS, we say that the change between the two in relation to other countries is + 5. Whilst we cannot say for sure that the average score in literacy for country A is higher amongst 27-year-olds in 2011 than amongst 15-year-olds in 2000, we can say that country A improved its ranking in relation to Country B as the 15-year-old cohort in 2000 reached 27

years in 2011. Since the tests measure similar things, we can say that Country A is doing better than country B in increasing or maintaining literacy competence during this phase of the life course. Using the data we have on the system types and characteristics in the different countries, we can then use a DID approach to explore their impact on relative changes in ranking for literacy and numeracy during the life course.

## 5.1 | Indicators

Here, we introduce a range of independent variables which the empirical literature and theoretical models suggest may be relevant to explain cross-country variations in the contributions of post-compulsory education and training to literacy and numeracy skills. Several variables represent characteristics which are specific to particular system types and may therefore help to explain any effects of different system types on changes in skills levels during the upper secondary phase.

*Entry rates into higher education* for the relevant cohort (www.oecd-library.org/content/table/20755120-table2) are measured in increments of 10%, so that the coefficient in the DID table represents the change in ranking that is associated with an increase of 10% in the enrolment rate.

*Rates of secondary and tertiary participation at 17/18* are the ratio of 17- and 18-year-old students who are enrolled in secondary, post-secondary and tertiary education to the corresponding population in that age range (OECD, 2001). This interval variable is measured in increments of 10%.

*Social gradient of level 3 completion*. We computed the social gradient of ISCED level 3 completers using the SAS data on parents' educational levels to represent how the achievement of full upper secondary qualifications was influenced by family background. The odds ratio measure represents the chances of respondents with graduate parents of completing a level 3 qualification compared with those with non-graduate parents (Green & Pensiero, 2016). This is an interval variable.

*Vocational prevalence*. We calculated this indicator according to the ratio of those in SAS reporting highest qualifications at ISCED 4 or ISCED 3A, B or C (designated in SAS as vocational) to those reporting highest qualifications at ISCED 4 or above or ISCED 3 A, B (designated as non-vocational). This interval variable is measured in increments of 10%.

*Specificity of vocational programmes*. This measures the proportion of upper secondary vocational education in a Dual System of apprenticeship. Bol and van de Werfhorst (2013) argue that the job-specificity of skills taught in vocational programmes is key to understanding the strength of the Dual System in upper secondary education. The data are taken from the 2007 volume of *OECD Education at a Glance*. This interval variable is measured in increments of 10%.

*Standardisation of outputs*. This refers to how educational achievement (the output) is tested against external standards using centralised exit examinations. Bol and van de Werfhorst (2013, p. 6) argue that: 'Central examination leads to a standardization of the educational system as it obliges schools to teach their students what is examined in the central exams'. Standardisation of output is a dummy variable: when there are central exams in the secondary education system a country scores 1.

*Percentage enrolled in private secondary schools*. This refers to the proportion of students in upper secondary education who are enrolled in private institutions that receive less than 50% of their core funding from government agencies and whose teaching personnel is not paid by a government agency (OECD, 2000). This interval variable is measured in increments of 10%.

*Mandatory maths and language learning*. This indicator measures whether the learning of maths and the national language is compulsory in upper secondary programmes. The data are obtained from a survey conducted by the Nuffield Foundation (Hodgen et al., 2010) using country experts, with missing values supplemented by the authors' searches in the country- specific reports and official documents. We give a value of 2 to a country where both subjects are compulsory in all programmes; 1 where one or the other is compulsory in all programmes and 0 where neither are compulsory in all programmes. This is a categorical variable.

**TABLE 1** Relative position of countries on average scores in PISA and SAS, by quintiles

| | Reading age 15 (quint) | Literacy age 27 (quint) | Change over pseudo-cohorts | Math age 15 (quint) | Numeracy age 27 (quint) | Change over pseudo-cohorts |
|---|---|---|---|---|---|---|
| AT | 3 | 3 | 0 | 3 | 4 | 1 |
| BE (Flanders) | 5 | 4 | −1 | 5 | 5 | 0 |
| CA | 5 | 4 | −1 | 4 | 3 | −1 |
| CZ | 2 | 3 | 1 | 2 | 3 | 1 |
| DE | 1 | 3 | 2 | 1 | 3 | 2 |
| DK | 2 | 3 | 1 | 3 | 4 | 1 |
| EN | 4 | 2 | −2 | 4 | 2 | −2 |
| ES | 1 | 1 | 0 | 1 | 1 | 0 |
| FI | 5 | 5 | 0 | 4 | 5 | 1 |
| FR | 3 | 2 | −1 | 3 | 2 | −1 |
| IR | 4 | 1 | −3 | 2 | 1 | −1 |
| IT | 1 | 1 | 0 | 1 | 2 | 1 |
| JP | 4 | 5 | 1 | 5 | 5 | 0 |
| KR | 4 | 4 | 0 | 5 | 3 | −2 |
| N IR | 3 | 1 | −2 | 4 | 1 | −3 |
| NL | 5 | 5 | 0 | 5 | 4 | −1 |
| NO | 2 | 4 | 2 | 2 | 4 | 2 |
| PL | 1 | 1 | 0 | 1 | 2 | 1 |
| SE | 3 | 5 | 2 | 3 | 5 | 2 |
| US | 2 | 2 | 0 | 2 | 1 | −1 |

*Proportion studying maths in upper secondary education and training*. This indicator uses the data from the Nuffield Foundation survey (Hodgen et al., 2010) which asks country experts what proportion of young people study maths in upper secondary education and training. The database contains country values based on a five-point scale where 1 = 0%-5%; 2 = 6%-20%; 3 = 21%-50%; 4 = 51%- 80% and 5 = 81%-94%.

## 6 | RESULTS

### 6.1 | Cross-country differences

Table 1 shows the changes between PISA and SAS in country ranking (on the five-point scale) for literacy and numeracy. The first observation is that most countries (14 out of 20) do not change position by more than one place up or down in either literacy or numeracy rankings. In only four instances across literacy and numeracy do countries change positions by three or more places. So there would appear to be a fair degree of continuity in most countries' relative position in skills for 15- and 27-year-olds. Most countries with relatively high average scores in literacy and numeracy amongst 15-year-olds in PISA still have relatively high scores for 27-year-olds in SAS, and vice versa.

Amongst the 12 instances (out of 40) with a country change by two or more positions in the ranking for either literacy or numeracy, there is considerable consistency in the direction of change and, to a lesser extent, the degree of change across the two domains. Germany goes up two places in both scales; Ireland goes down three places in literacy

**TABLE 2** DID estimates of effects of system types

| | | Numeracy (quintiles) DID estimate ($\gamma_1 Y.age27$) | Literacy (quintiles) DID estimate ($\gamma_1 Y.age27$) |
|---|---|---|---|
| Model 1 (N: 20) | Education system (Ref.: Differentiated. CZ, DK, FI, BE, FR, IT, JP, KR, NL, PL) | | |
| Type 2a | Comprehensive (North America. CA, US) | −1.1**** (0.39) | −0.6* (0.49) |
| Type 2b | Comprehensive (Nordic. NO, SE) | 1.9***** (0.39) | 1.9***** (0.26) |
| Type 3 | Dual (AT, DE) | 1.4**** (0.57) | 0.9 (0.87) |
| Type 4 | Mixed (EN, ES, IR, N IR) | −1.6**** (0.76) | −1.85**** (0.69) |
| | R-squared | 0.62 | 0.52 |

*****$p < 0.01$, ****$p < 0.05$, ***$p < 0.1$, **$p < 0.2$, *$p < 0.3$.

and one place in numeracy; Korea stays put in literacy and goes down two places in numeracy; Norway and Sweden go up two places in both; and England goes down two places in both. Countries showing relative improvement or relative declines tend to do so in the same direction in both domains. The major exception is Flanders which improves by four places in literacy but stays the same in numeracy. The other notable pattern is the uni-directional change across domains in two groups of countries. Almost all the Anglophone countries (including Canada, Ireland, England and Northern Ireland) show relative declines in both domains. The only English-speaking exception is the United States which shows a relative decline in numeracy but no change in literacy. The Nordic countries all show relative improvements in either literacy or numeracy and all except Finland show relative improvement in both domains.

## 6.2 | Effects of system types

Table 2 presents the DID estimates of the effects of different types of system on the relative position of countries in the ranking of mean numeracy and literacy competence. The reference group is countries with Type 1 systems. The system types associated with the greatest positive improvement in literacy and numeracy rankings in relation to the reference group are the Type 2b (Nordic) comprehensive systems and the Type 3 systems with Dual Systems of apprenticeship.

Countries with Type 3 systems significantly ($p < 0.05$) improve their ranking for numeracy by 1.4 units on the five-point scale in relation to the reference group. However, for literacy, whilst there is a positive effect, it is not significant. Countries with Type 2b (Nordic) systems improve their ranking in both numeracy and literacy by almost two positions on the five-point scale ($p < 0.01$ in both cases) in relation to the reference group. In contrast, two system types have significant negative effects on changes in ranking in numeracy and literacy. Type 2a (North American) systems show a decline of 0.6 units in numeracy and 1.1 units in literacy (significant at the $p < 0.3$ and $p < 0.05$ levels, respectively). Type 4 mixed systems show a decline of 1.6 units in numeracy and 1.85 units in literacy (significant in both cases at the $p < 0.05$ level). The type of education system not only has a significant effect on skills level, but describes quite accurately the cross-country variation, as suggested by the R-squared value. Between 52% (literacy) and 62% (maths) of the variation in skills levels are accounted for by the type of education system.

## 6.3 | Effects of system characteristics

Why do some types of upper secondary education and training system improve their scores in literacy and numeracy more than others? The following part of our analysis looks at the effects of different individual system characteristics. Many of these vary significantly between system types and may therefore provide some clues as to why some improve their performance more than others.

**TABLE 3** DID estimates of effects of system characteristics

| | | Numeracy (quintiles) | | Literacy (quintiles) | |
|---|---|---|---|---|---|
| | | DID estimate ($\gamma_1 Y.age27$) | R-squared | DID estimate ($\gamma_1 Y.age27$) | R-squared |
| Model 1 (N: 19) | Enrolment age 17–18 | 1.03***** (0.25) | 0.24 | 0.83***** (0.23) | 0.16 |
| Model 2 (N: 18) | ISCED3 social gradient | −0.56***** (0.13) | 0.24 | −0.54***** (0.13) | 0.28 |
| Model 3 (N: 19) | HE entry rates | 0.31** (0.19) | 0.03 | 0.32** (0.20) | 0.03 |
| Model 4 (N: 20) | % secondary private schools | −0.39* (0.34) | 0.01 | 0.06 (0.35) | 0.01 |
| Model 5 (N: 17) | Vocational prevalence | 0.65***** (0.19) | 0.03 | 0.34* (0.26) | 0.07 |
| Model 6 (N: 20) | Vocational specificity | 0.45***** (0.14) | 0.06 | 0.39***** (0.13) | 0.05 |
| Model 7 (N: 20) | Standardised outputs | −0.94** (0.63) | 0.02 | −0.75* (0.61) | 0.02 |
| Model 8 (N: 17) | Compulsory Language and Maths (Ref.: Maths and language are not compulsory in all programmes | | 0.15 | | 0.16 |
| | Math or language are compulsory in all programmes | 1.5**** (0.59) | | 1.8***** (0.41) | |
| | Maths and language are compulsory in all programmes | 2.6***** (0.64) | | 2.9***** (0.41) | |
| Model 9 (N: 19) | % Students Maths | 0.69***** (0.17) | 0.13 | 0.64***** (0.15) | 0.11 |

*****$p < 0.01$, ****$p < 0.05$, ***$p < 0.1$, **$p < 0.2$, *$p < 0.3$.
In models 1, 3, 4, 5, and 6 the unit of measurement is a 10% increase.

Table 3 shows the results of the DID regressions, including the coefficients for the effect sizes and the significance levels. The different models-rows report the unconditional effect of each of the independent factors whose effect is significant in at least one domain.

## 6.4 | Inclusiveness: Participation and opportunity in attainment

The first four models analyse the extent to which an inclusive system with high rates of post-compulsory participation and completion and greater equality of opportunity is associated with greater skills gain (H1). Participation in education and training at 17–18 and HE entry rates are both closely associated with competence gain in literacy and numeracy (see Figures 1 and 2). The effect of participation at age 17–18 is roughly 1 for numeracy and 0.8 for literacy (significant in both cases at the $p < 0.01$ level). Relatively high rates of enrolment in German-speaking, CEE and Nordic countries and relatively low rates in Anglophone countries seem to drive this association. Focusing on tertiary education, the results show that this phase has a distinctive effect which amounts to 0.3 positions in both domains. However, the effect of HE drops in the model that includes age 17–18 participation as a control. The results, which are not presented in the table, show that the effect of HE on literacy becomes non-significant, whilst the effect on numeracy decreases (.26). By contrast, the effect of age 17–18 enrolment is not altered by controlling for HE entry rates. The social gradient of ISCED 3 completion has a consistently negative effect on both literacy and numeracy, significant in both cases at the $p < 0.01$ level (see Figure 3). If the odds of ISCED 3 completion for students with graduate parents compared with those of non-graduate parents are increased by 1, the expected change in ranking for literacy and numeracy is about half a position. In this case, the higher social gradients of ISCED 3 completion in most

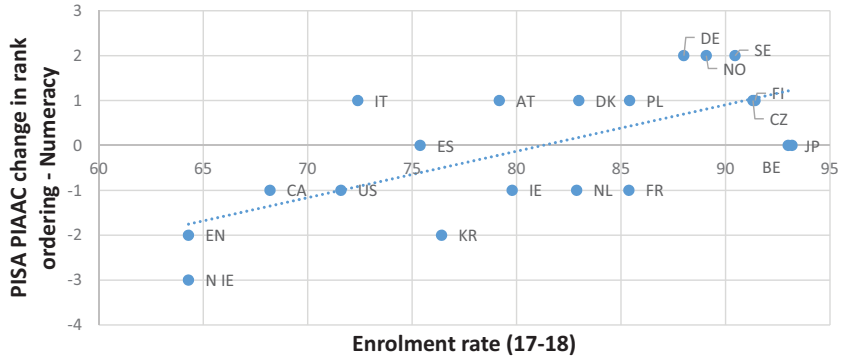


**FIGURE 1** The effects of enrolment rates at 17/18 on numeracy [Colour figure can be viewed at wileyonlinelibrary.com]

English-speaking countries and Spain (mostly with Type 4 systems) are likely to drive the negative association with skills position improvement because of the negative effects of inequality of skills opportunity on skills gain amongst lower achievers. Conversely, all the Nordic countries have relatively equal educational opportunity and high relative improvement in skills, which also re-enforces this negative relationship. A high proportion of upper secondary students in private schools has no significant relation with literacy, but is negatively associated with relative improvements in numeracy.

The models regarding the effectiveness of the system characteristics do not show large R-squared values, varying from 28% to 1% of total variance explained. These findings are not surprising if we consider that the models shed light on the effect of a specific aspect of the education system. Other factors which are not included can affect the skills levels. Nonetheless, the R-squared values can be used to evaluate the goodness of fit of the presented models. Among these, those that look at the enrolment rate at age 17–18 and the ISCED 3 social gradient explain a relatively large proportion of the variance, whilst the one looking at higher education explains relatively little. The 17–18 enrolment rate explains 24% of the variance of numeracy and 16% of the variance of literacy, whilst HE explains 3% of the variance in both domains.

## 6.5 | Esteem of vocational programmes

The two factors relating to prevalence and esteem of vocational education (H2) seem to have significant positive effects on changes in literacy and numeracy ranking positions. An increase in *vocational prevalence* of 10% is associated with an improvement of roughly one third of a position in literacy and of more than half a position in numeracy, significant at the $p< 0.01$ and $p< 0.3$ levels, respectively (see Figure 4 for numeracy). The variable accounts for 3% of the variance of numeracy and 7% of the variance of literacy. *Vocational specificity* has a significant ($p < 0.01$) positive effect on both literacy and numeracy, increasing the ranking position by 0.39 in the first (R-squared = 0.5) and 0.45 in the second (R-squared = 0.6) (see Figure 5 for literacy).

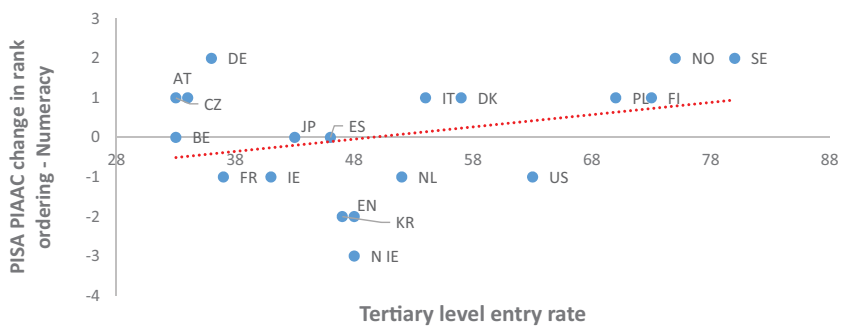


**FIGURE 2** The effects of HE participation on numeracy [Colour figure can be viewed at wileyonlinelibrary.com]

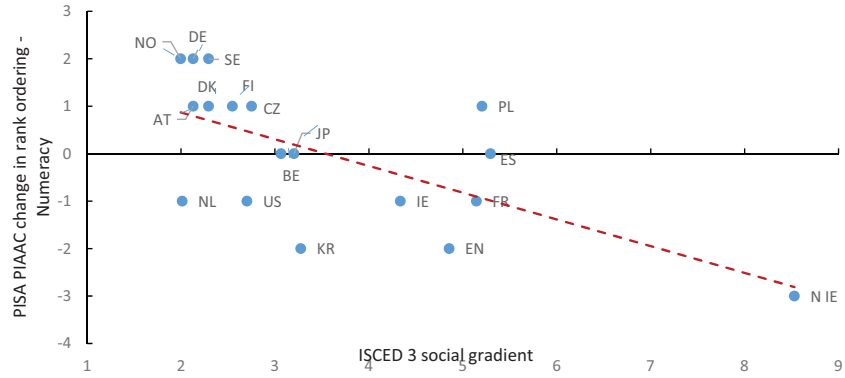


**FIGURE 3** The effects of the social gradient of ISCED Level three completion on numeracy [Colour figure can be viewed at wileyonlinelibrary.com]

The relationship between vocational prevalence and relative improvements in numeracy appears to be driven by the relatively high rates of vocational enrolment in German-speaking and Nordic countries and the relatively low rates in Anglophone countries. The association between vocational specificity and relative improvements in literacy seems to be driven by the relatively high levels of apprenticeship training in Denmark and the German-speaking countries and the relatively low rates in Anglophone countries and Spain.

## 6.6 | Curriculum standardisation

We have seen that high rates of enrolment in upper secondary education and training are associated across countries with relative gain in literacy and numeracy levels. Where a large proportion of students is studying maths and the national language one would expect that the relative improvement in literacy and numeracy skills is even greater. This is what we find. The measure for the proportion of students in upper secondary education and training studying maths has a significant positive effect (at the $p < 0.01$ level) on both literacy and numeracy, increasing ranking position by 0.64 and 0.69, respectively (see Figure 6) and fits the data relatively well (R-squared values are 0.11 and 0.13, respectively). The measure for mandatory maths and national language learning has a significant, monotonic and positive impact on literacy and numeracy. Moreover, the variable fits the data relatively well (R-squared values are 0.15 for numeracy and 0.16 for literacy).

The compulsory provision of maths or national language in all programme is associated with an improvement of 1.5 ($p < 0.05$) and 1.8 ($p < 0.01$) positions in numeracy and literacy, respectively, compared to a situation where neither subject is compulsory in all programmes. When the provision is compulsory for both maths and language in all programmes, the improvement represents 2.6 ($p < 0.01$) in numeracy and 2.9 ($p < 0.01$) in literacy, compared to a situation

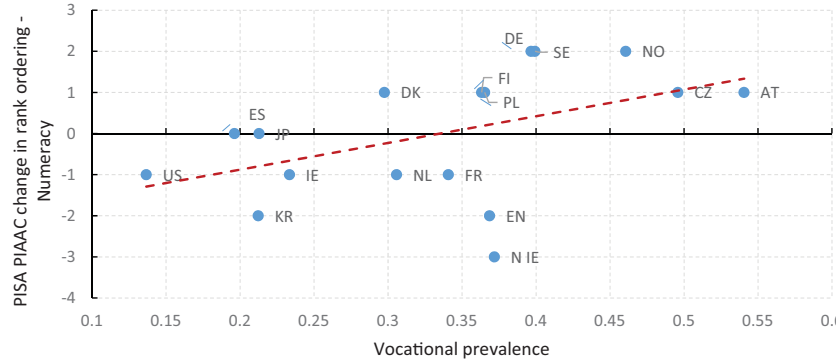


**FIGURE 4** The effects of vocational prevalence on numeracy [Colour figure can be viewed at wileyonlinelibrary.com]

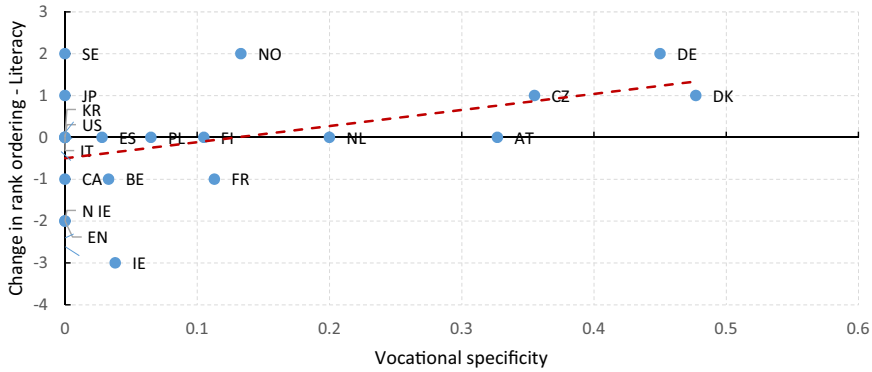


**FIGURE 5** The effects of Dual System apprenticeship enrolments (vocational specificity) on literacy [Colour figure can be viewed at wileyonlinelibrary.com]

where neither maths nor language is compulsory. The similar effect on both literacy and numeracy can be related to the fact that countries which have mandatory maths tuition in all upper secondary programmes also tend to have mandatory study of the national language (Hodgen et al., 2010).

The relationship between studying maths and the relative improvements in numeracy seems to be driven by the relatively high proportion studying maths in the Nordic and German-speaking countries compared with the low rates in countries with mixed systems like England, Northern Ireland, Ireland and Spain. On the other hand, curriculum standardisation through the use of centralised external exit exams is negatively associated across countries with relative improvement in literacy and numeracy (see Table 3), unlike the research findings for lower secondary education. However, since these exams do not always mandate reaching particular standards in maths and the national language (e.g., in England), there is no reason why their effects should be in the same direction as for the indicators for studying these subjects.

## 7 | CONCLUSIONS

Our analysis suggests that the type of post-compulsory education and training systems in different countries does have an effect on the improvement in the mean literacy and numeracy competence of young people between 15 and 27 years of age. This does not seem to be an indirect result of some systems being more effective at getting young people into skilled jobs where they use their literacy and numeracy skills, since our measures for these were only weakly associated with relative skills improvement across countries.[6] The nature of the education and training system,

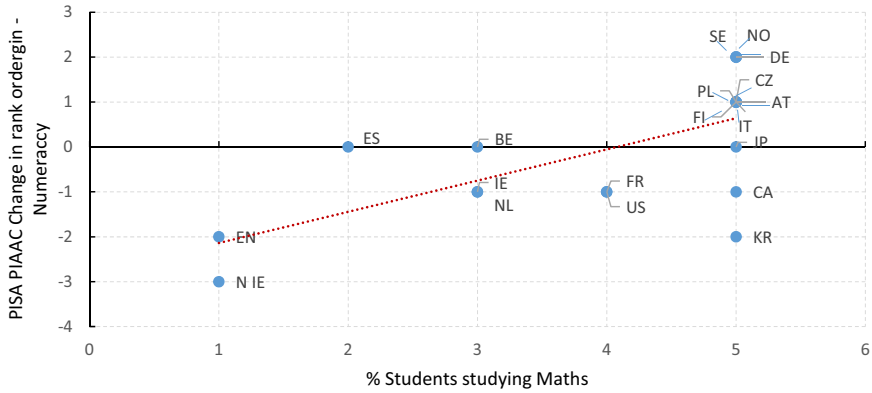


**FIGURE 6** The effects of studying Maths in upper secondary programmes [Colour figure can be viewed at wileyonline library.com]

particularly at the upper secondary level, seems to matter most. Countries with Type 2b comprehensive upper secondary education and training systems with little between-school variation (Sweden and Norway) or with Type 3 Dual systems (Austria and Germany) seem to be particularly effective. On the other hand, countries with Type 4 mixed systems (England, Ireland, Northern Ireland and Spain) all show a relative decline in both literacy and numeracy.

Which characteristics of these systems seem to explain this? Those associated with relative skills improvement relate to inclusiveness, the esteem of vocational programmes and curriculum standardisation with regard to the study of maths and the national language. These findings would seem to support the arguments in the literature that Dual Systems with relative parity of esteem between tracks (Raffe et al., 1998, 2001) and qualifications with high labour market value (Estévez-Abe et al., 2001) enhance skills acquisition, whilst more integrated school-based systems promote learning gain by reducing inequality of opportunity and greater standardisation of curricula (Boudon, 1974; Raffe et al., 1998). The benefits of inclusive participation on learning (in this case in basic skills) is, of course, upheld by most education research.

Countries which fare badly in relative literacy and numeracy gain, like England, Ireland, Northern Ireland and Spain, have 'mixed systems' with little inclusiveness, including low rates of participation at 17/18, high social gradients of level 3 completion and, in most cases, higher rates of enrolment in private schools. They also tend to show low esteem for vocational learning, with lower rates of enrolment, particularly in apprenticeships. They are also least likely to require that students study maths and the national language at the upper secondary level.

On the other hand, countries which do well, such as the Nordic countries and German-speaking countries, rate higher across all these dimensions. They are all relatively inclusive at the upper secondary level, with high participation at 17/18, lower social gradients of level 3 completion and lower proportions in private schools. They tend to show greater esteem for vocational programmes, with a high proportion of upper secondary students in vocational programmes or apprenticeships. All require the study of maths and the national language as part of the upper secondary curriculum.

Unlike the findings of much research on lower secondary education (Hanushek & Woessmann, 2006; Van de Werfhorst & Mifs, 2010), in upper secondary education and training tracking *per se* does not explain why some systems fare better than others. Provided that participation rates are high, that vocational education is prevalent and relatively highly esteemed and that the study of maths and the national language form a mandatory part of the curriculum, improvements in literacy and numeracy skills are possible in systems with strong tracking, such as Austria and Germany, and in systems with low levels of tracking, such as Sweden and Norway.

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## ENDNOTES

[1] We use the term lower secondary education for the phase that typically starts after 6 years of primary education and lasts for 3 years and 'post-compulsory' for education and training following lower secondary education.

[2] Programme for International Student Assessment (PISA) and International Evaluation of Educational Achievement in Math and Science (TIMSS) and Literacy (PIRLS).

[3] Denmark could be considered a borderline case because up to 30% of young people follow some form of apprenticeship, but many are not on traditional apprentice contracts as in Dual System apprenticeships.

[4] For Sweden: 'Overview of the Swedish upper secondary school' at www.gotland.se/71846. For Norway: L. Frilseth, 'The Norwegian Model for Education for All in Upper Secondary School,' Norwegian Directorate for Education and Training at www.european-agency.org/sites/default/files/Norway-L-Frilseth.pdf

[5] In several countries, the sample size for a single year group is less than 70 individuals in SAS.

[6] We explored this using data from SAS on the proportion of skilled employment and skills use at work. The results in each indicator were significant for only one domain, which was different across the two indicators.

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