The evolution of socio-economic disparities in literacy skills from age 15 to age 27 in 20 countries

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This study contributes to the literature by examining the evolution of socio-economic disparities in literacy skills between age 15 and 27. It uses combined cross-sectional data from the Programme for International Student Assessment and the Programme for the International Assessment of Adult Competencies in 20 countries and adopts a synthetic cohort approach. In the article we examine if there are differences in the evolution of socio-economic disparities in literacy between the teenage years and young adulthood among high-achieving students (90th percentile) and among low-achieving students (10th percentile) and compare differences across education systems. We used parental education as an indicator of socio-economic status. Findings indicate that on average, disparities in literacy skills observed at age 15 widen by 15% of a standard deviation by age 27. Such increase is determined by a more pronounced growth in achievement among individuals with tertiary educated parents than among individuals whose parents did not complete tertiary education. The increase in socio-economic gaps between age 15 and 27 is more pronounced among low-achieving students. The group that improves the most between age 15 and 27 is low-achieving individuals with tertiary educated parents. We find that socio-economic differences in educational attainment, NEET status and use of skills at home and in the workplace explain a large part of socio-economic disparities in literacy achievement among young adults. Although countries with above-average disparities at age 15 tend to also display above-average disparities at age 27, we identify differences across countries.

Keywords: cross-national; literacy; PIAAC; PISA; socio-economic disparities in achievement

Introduction

Socio-economic disparities in educational attainment and achievement are generally considered to be both a cause (Card, 1999; Oreopoulos & Salvanes, 2011) and a consequence of broader social and economic disparities (Björklund & Salvanes, 2011; Holmlund *et al.*, 2011; Pokropek *et al.*, 2015). Socio-economic disparities in academic achievement have attracted the attention of researchers and policymakers since the 1960s (see e.g. Coleman *et al.*, 1966; Peaker, 1971; Jencks *et al.*, 1972 and comprehensive reviews such as White, 1982; McLoyd, 1998; Sirin, 2005), although it remains unclear if such disparities have increased globally over the past 50 years, a

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period marked by major educational expansions worldwide (Marks, 2013; Chmielewski, 2019). The observation that the distribution of achievement differs systematically and in predictable ways across students with a different socio-economic background, and that educational attainment and achievement are associated with high economic and social returns (Goldin & Katz, 2008; Brynjolfsson & McAfee, 2014; Castex & Kogan Dechter, 2014), has spurred academic research and policy work aimed at creating conditions that foster equitable educational opportunities (UNESCO, 2015; OECD, 2018; European Commission, 2019).

International large-scale assessments (ILSAs) have played an important role in this context. They have been used to identify between-country differences in socio-economic disparities in academic achievement and to relate such differences to how instruction is organised and resources are allocated (UNESCO, 2015; Mullis et al., 2016; OECD, 2018).

An important shortcoming of current comparative evaluations of socio-economic disparities based on evidence from ILSAs relates to the fact that typically ILSAs target specific grades or age groups and, as such, can only provide evidence on socio-economic disparities at a particular point of students' educational careers or at a specific age. For example, data from the Programme for International Student Assessment (PISA) refer to 15-year-old students, the Progress in International Reading Literacy Study (PIRLS) refers to fourth graders and Trends in International Mathematics and Science Study (TIMSS) refers to fourth and eighth graders.

Attempts have been made to go beyond cross-sectional evidence. Some studies examined cross-country differences in trajectories from childhood into the teenage years in socio-economic disparities in achievement (Ammermueller, 2006; Jerrim & Choi, 2013; Dämmrich & Triventi, 2018). Others have examined cross-country differences in trajectories from childhood into the teenage years in disparities in achievement growth, to identify if widening or shrinking disparities are the result of differential skill accumulation and/or decline in different countries (Jakubowski & Pokropek, 2015). By contrast, although comparative evidence has been developed to examine the evolution of disparities in achievement from the teenage years into young adulthood (Green & Pensiero, 2016; Borgonovi *et al.*, 2017; Dämmrich & Triventi, 2018; Pensiero & Green, 2018), so far there is no cross-national evidence on how achievement growth evolves across different socio-economic groups. This is the gap we fill in this work. We provide the first comprehensive analysis of how socio-economic disparities in achievement evolve between the teenage years and young adulthood in 20 countries, both in the overall population and among high and low achievers.

The aim of this study is fivefold. First, we develop *ex-post* standardised measures of achievement in literacy in the teenage years (age 15) and young adulthood (age 27). Second, we identify if differences in achievement growth depend on socio-economic status (SES). That is, we provide new cross-national evidence on how levels of achievement change over time and among different groups. Third, we examine differences in achievement growth among low-achieving and high-achieving students. Fourth, we examine to what degree access to opportunities for formal, non-formal and informal learning beyond compulsory school differ across SES groups, and if this contributes to achievement differentials in young adulthood. Fifth, we identify the

extent to which institutional arrangements are associated with different trajectories in different countries. Key institutional arrangements that we consider are: the level of curricular standardisation, school-level differentiation and the learning opportunities youngsters can expect to benefit from during the transition from the teenage years into young adulthood.

In the absence of cross-country comparable longitudinal data, we use a synthetic cohort approach applied to data from 20 countries that participated in two ILSAs promoted by the OECD, the 2000/2003 PISA studies and the 2012/2015 OECD Survey of Adult Skills (PIAAC), and new evidence on scale concordance between the two studies (Pokropek & Borgonovi, 2020). We use parental educational attainment as an indicator of SES. Our key indicator of achievement is literacy proficiency. Literacy proficiency is necessary to acquire knowledge, and as such, is a precondition for individuals' success in all domains of life (Cunningham & Stanovich, 1998; Smith *et al.*, 2000). Although PISA and PIAAC contain measures of numeracy as well as literacy, in this work we focus on literacy.

Theory and hypotheses

The literature indicates that socio-economic disparities in academic achievement are the result of disparities in the investments families make in their children's development (Conger & Donnellan, 2007). An advantaged SES allows families to invest more material, cultural and social resources in their children's development. High-SES children often benefit from higher-quality parenting practices (Schaub, 2010), from greater parental involvement in their academic decisions (Domina, 2005), from participation in academic settings of higher quality and from more enriching out-of-school experiences (Lareau, 2002). Recent evidence also suggests that genetic factors could shape SES–achievement differentials (Trzaskowski *et al.*, 2014) and that genes may interact with the environment to shape trajectories in achievement growth (Plomin & Deary, 2015; Rimfeld *et al.*, 2018).

Most existing studies on the evolution of SES differentials in achievement examine changes occurring from the early years until the end of compulsory schooling. They indicate that in countries like Australia, Canada, Germany, the UK and the USA, that is countries with different levels of economic inequalities and organisation of schooling, SES disparities are well-established before schooling starts and do not grow, or grow moderately, during the school years (Duncan & Magnuson, 2013; Skopek & Passaretta, 2020). In other words, schools appear to have an equalising effect.

Much less is known about patterns of achievement growth across individuals with different SES beyond compulsory schooling, when greater differentiation in formal, informal and non-formal learning occurs, since achievement tests are not routinely conducted after the end of schooling. A number of studies have explored the evolution of disparities in achievement in this period (Borgonovi *et al.*, 2017; Rözer & Van de Werfhorst, 2017; Dämmrich & Triventi, 2018; OECD, 2018) but lack of psychometric linkages have prevented the study of disparities in achievement growth. This is an important shortcoming. The years marking the transition into adulthood are attracting growing interest because of their implications for later-life outcomes (Schulenberg *et al.*, 2004; Schulenberg & Schoon, 2012). Furthermore, achievement in

cognitive foundation skills such as literacy have been shown to grow well beyond the end of age 15 and to peak at around age 30 (see Paccagnella, 2016 for a review of ageing and skills).

SES disparities in achievement growth could arise between the end of compulsory schooling and early adulthood because of initial SES disparities in achievement and the cumulative nature of advantage. If growth in achievement is positively related to previous achievement levels, then SES disparities are bound to grow over time in a cumulative fashion (DiPrete & Eirich, 2006). Access to post-secondary educational opportunities is especially conditional on success in secondary education and, contrary to earlier levels of schooling, it is not compulsory. Therefore not all individuals take part and instructional quality is likely to be more variable (Breen & Jonsson, 2005). As a result, disparities in achievement growth could be pronounced between the teenage years and early adulthood.

Prior learning is not the only factor potentially shaping access to formal and informal learning opportunities and leading to divergent trajectories in achievement. The teenage years and young adulthood mark a period of major neurological changes which lead to increased impulsivity, difficulty in evaluating long-term benefits vis à vis short-term costs and proneness to engage in risky behaviours (Sapolsky, 2017). All these changes occur at a time when individuals make important educational, training, and labour-market decisions that require them to evaluate the costs and benefits arising from alternative courses of action yielding markedly different payoffs, including differences in achievement growth. High-SES individuals can generally count on their families to receive high levels of support in terms of resources and advice on how to navigate the increased differentiation of educational and training pathways (Schulenberg *et al.*, 1993; Johnson, 2001; Hartung *et al.*, 2005).

The theory of relative risk aversion maintains that avoiding downward social mobility is a key driver of the educational choices individuals and their families make (Breen & Goldthorpe, 1997). According to the theory, high-SES families will be willing to invest considerable resources to avoid downward mobility for their children, irrespective of their academic potential (Holm *et al.*, 2019). Moreover, according to effectively and maximally maintained inequality theories, high-SES families will secure any quantitative or qualitative advantage for their children, leading them to participate in more and better post-secondary education or in other learning opportunities that maximise their learning potential (Raftery & Hout, 1993; Lucas, 2001). Given prior evidence and theories of social stratification, we expect that between age 15 and 27, literacy achievement will grow among both high and low-SES groups but, crucially, that achievement growth will be more pronounced among high-SES individuals. Consequently, our first hypothesis is:

> *H 1.* Socio-economic gaps in literacy achievement are more pronounced at age 27 than at age 15 because the growth in literacy achievement between age 15 and 27 is more pronounced among high-SES individuals.

Theories of cumulative advantage predict that achievement growth differs across the achievement distribution and that high achievers will experience a markedly higher growth than low achievers due to path dependency. However, according to the

theory of compensatory advantage, the life-course trajectories of high-SES individuals will be less dependent on prior negative outcomes than those of socio-economically disadvantaged individuals (Bernardi, 2014). Initial negative outcomes are more likely to endure over time or become more pronounced among low-SES groups than among high-SES groups.

Relative risk-aversion theory suggests that low levels of educational achievement play a less prominent role in the educational continuation decisions of socio-economically advantaged children, even when they have low levels of ability (Lucas, 2009; Bernardi, 2014; Holm *et al.*, 2019). Achieving high levels of educational attainment and obtaining high skills is generally more valued by high rather than low-SES groups because, on average, avoiding downward social mobility is a greater motivational driver than achieving upward social mobility (Lucas, 2009). The negative state associated with enduring a loss is in fact larger than the positive state associated with experiencing a similarly sized gain (Kahneman & Tversky, 1979). As a result, high-SES parents will be more likely to hold ambitious educational expectations for their children, even when they have low levels of ability (Ganzach, 2000), and will be more likely to invest resources to compensate for low ability or low motivation in their children to realise their educational expectations. High-SES families are also more likely to distribute resources across their children in order to avoid demotion of those with the lowest ability, while lower-class families are more likely to focus their more limited resources on more endowed children and invest less in others (Hsin, 2012; Restrepo, 2016).

Maximally and effectively maintained inequality theories predict a compensatory model of the interaction between ability and SES, and therefore that privileged individuals will try to maintain their advantage by accessing the highest possible quality learning opportunities given their ability (Lucas, 2009). Among privileged low achievers this would entail, for example, accessing tertiary education paying full fees, acquiring the support needed to be able to pass courses, persist despite initial failure, and cover the upfront costs this may entail in terms of additional fees and a delayed income. Upon entrance into the labour market, it could also entail participating in unpaid internships, working in jobs that have low initial monetary benefits (involving a low salary and high housing and/or transportation costs) but high learning value, and enrolling in additional training programmes (Friedman & Laurison, 2020). By contrast, low-ability and socio-economically disadvantaged individuals are unlikely to be able to access any of these opportunities.

Consequently, we expect that the growth in SES differentials will be especially pronounced among low achievers. Among low achievers, learning opportunities enjoyed by high and low-SES individuals are likely to differ along both a quantitative and a qualitative dimension. By contrast, among high achievers we expect that differences in the learning opportunities enjoyed by high and low-SES individuals might differ but only along the qualitative dimension, given evidence on stratification in tertiary education opportunities, since high achieving low-SES individuals may still be able to access learning opportunities given their talent (Altbach *et al.*, 2009). We therefore expect that the growth in achievement of privileged low-ability individuals will be greater (relative to that of low-ability low-SES individuals) than the growth in achievement of privileged high-ability individuals (relative to that of high-ability low-

SES individuals). Our second and third hypotheses on differences across groups and factors that explain trajectories are:

H 2. Increases in socio-economic gaps in literacy achievement between age 15 and 27 are especially pronounced among the lowest achievers because of a marked growth in achievement among low-ability, high-SES individuals.

H 3. Differences across socio-economic groups in literacy achievement at age 27 can be explained by SES differences in formal and informal learning opportunities they participate in beyond the end of compulsory schooling.

Countries vary with respect to the organisation of and access to learning opportunities beyond the end of compulsory schooling, which could lead to cross-country differences in patterns of achievement growth among different SES groups. These include, for example, the availability of learning opportunities beyond secondary education at university level, in other educational and training settings or in the workplace (Fialho *et al.*, 2019; OECD, 2020). The negative consequences of poor school-to-after-school transitions are well established: being not in education, employment or training (NEET) has negative consequences for skill formation, while participation in adult education and training has positive effects on skill acquisition (Paccagnella, 2016).

Prior work examined how education system characteristics are associated with differences across countries in changes in SES differentials between the teenage years and early adulthood (Green & Pensiero, 2016; Pensiero & Green, 2018). Although the small sample size in our study means that we have enough power only to identify very large effects, we try to identify factors that could contribute to shape patterns of achievement growth among different SES groups in different countries.

Researchers often characterise education systems on the basis of the approaches they use to manage student heterogeneity and the level of autonomy they give to teachers and schools. In particular, tracking, stratification policies and curricular autonomy have been shown to influence socio-economic disparities in achievement at age 15 (see Hanushek & Wössmann, 2006; Montt, 2011 as examples). Similarly, greater curricular standardisation and lower differentiation are associated with smaller than expected socio-economic disparities in academic achievement among secondary school students (Hanushek & Wössmann, 2006; Brunello & Checchi, 2007; Pfeffer, 2008). However, little is known about the extent to which these factors influence the evolution of socio-economic disparities beyond compulsory schooling (Kerckhoff, 2001). Systems that reduce differentiation in the school years may not necessarily compress SES disparities but simply change the timing when widening occurs and, once different learning paths are established after the end of compulsory schooling, SES disparities may increase.

Moreover, there is evidence that in systems with undifferentiated educational programmes, school-to-work and school-to-further-education transitions are generally less smooth (Shavit & Müller, 2000). By contrast, systems with greater educational differentiation appear to perform better on school-to-work and school-to-training transitions (see Bol & Van de Werfhorst, 2013a for a review). Prior research considered education-system characteristics referring to upper secondary education, such as the specificity of

vocational programmes—that is, the extent to which upper secondary vocational education includes a dual system of apprenticeship—and the extent to which mathematics courses are mandatory in upper secondary educational programmes (Green & Pensiero, 2016; Pensiero & Green, 2018). However, lack of between-country variation in the extent to which language of instruction courses differ across countries (since our focus is literacy achievement) and lack of indicators on the specificity of vocational programme for almost half of the countries in our sample, prevented us from exploiting these in the empirical analysis. Our fourth and final hypothesis is:

> *H 4.* The growth in socio-economic gaps in literacy achievement differs across countries and depends on the timing of differentiation in educational pathways and the quality of school-to-work transitions.

Data, measures and methods

Data

Our research combines two sources of data: PISA and PIAAC. PISA data allow us to identify socio-economic disparities at age 15, while PIAAC data allow us to identify socio-economic disparities at age 27. Both studies are led by the Organisation for Economic Co-operation and Development (OECD). Because the key aim of our study is to map the evolution of disparities in literacy between age 15 and 27, we create a synthetic cohort by matching data from PISA 2000 for 17 countries that administered PIAAC in 2012. To increase the international coverage, we augment these data with data from PISA 2003 for three countries that administered PIAAC in 2015.

PISA is a triennial large-scale international survey that measures the knowledge and skills of representative samples of 15-year-old students attending lower secondary or upper secondary schools in more than 60 education systems worldwide since 2000. PISA assesses proficiency in reading, mathematics and science literacy. PIAAC is a large-scale international assessment covering the non-institutionalised adult population, between the ages of 16 and 65, residing in the country at the time of data collection, irrespective of nationality, citizenship or language status. It was conducted in 2012 in the large majority of countries, but was administered in 2015 in Greece, New Zealand and Turkey.

PISA and PIAAC have been widely used in cross-national research because they are designed to ensure comparability. Moreover, technical standards are high, and the representative nature of the samples allows inferring population-level estimates. Comprehensive documentation regarding the sampling design, response rates, questionnaire items, quality assurance, scale construction and appropriate weighting procedures, which we follow, are provided in the PISA 2000 Technical Report (OECD, 2002) and the PIAAC Technical Report (OECD, 2016).

Instruments

The PISA and PIAAC studies have two main components: a background questionnaire and a direct assessment. We use data from the background questionnaires to

derive a comparable measure of parental educational attainment, our indicator of SES, and to restrict samples to make sure that target populations are common across the two studies. We use parental educational attainment as an indicator of SES because it is one of the few indicators of SES present in both surveys and studies have criticised analyses of socio-economic disparities observed in ILSAs based on aggregate indicators due to issues of validity, reliability and comparability of such measures (Rutkowski & Rutkowski, 2013; Pokropek *et al.*, 2017). We use data from the direct assessments to calculate the literacy proficiency of individuals participating in PISA and PIAAC. An extensive discussion of the PISA and PIAAC questionnaires, assessment frameworks, instruments and implementation, as well as key differences across the two studies, can be found in Borgonovi *et al.* (2017).

Parental educational attainment.   Parental educational attainment is used as a proxy for SES. Parental educational attainment was asked of respondents in the background questionnaire for both the PISA and PIAAC studies. Respondents in both studies were asked to indicate the highest educational attainment obtained by their mother and father, using national qualifications which were then converted into the internationally comparable International Standard Classification of Education (ISCED)-level metric. We create a dichotomous variable that classifies individuals according to whether they have at least one parent who obtained tertiary level qualifications (ISCED level 5 or above), or if none of the respondent's parents completed tertiary level qualifications.

Literacy.   Literacy in this article is used to refer to both *reading literacy*, which is the common term used in the context of PISA, and *literacy*, the common term used in the context of PIAAC. Literacy is defined in very similar ways in the assessment frameworks of PISA and PIAAC. It is conceived as a continuum of ability involving the mastering of tasks of increasing difficulty (OECD, 2016). In PISA 2000, literacy was defined as 'understanding, using, and reflecting on written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society' (OECD, 1999) and in PIAAC it was defined as 'understanding, evaluating, using and engaging with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential' (PIAAC Literacy Expert Group, 2009).

Both PISA and PIAAC reflect a strong influence of previous adult literacy assessments, such as the International Adult Literacy Survey (IALS) and the Adult Literacy and Lifeskills Survey (ALL), and combine multiple assessment items to derive the underlying unobservable ability of individuals. As a result, although in PISA and PIAAC the relative importance assigned to different cognitive process and context areas differs, the two literacy assessments are very close and, in fact, both PISA 2000 and PIAAC 2012 contain a set of literacy questions that were originally administered in IALS (Borgonovi *et al.*, 2017).

Contextual features.   We use information derived from the PISA system-level data collection to identify the level of standardisation and the level of differentiation of educational systems and data from *Education at a Glance* to identify the rate of 15–29-year-olds who are NEET and tertiary education attainment rates (OECD, 2015b).

The level of standardisation of the educational system is determined by the degree to which school curricula are nationally or regionally standardised. We operationalised this indicator as the percentage of principals of secondary schools attended by PISA-participating students who reported that local/regional or national education authorities were responsible for deciding which courses would be offered in schools. A higher percentage corresponds to a higher level of standardisation (van Hek *et al.*, 2019). We use Bol & Van de Werfhorst's (2013b) proposed measure of differentiation: the age at which students in an education system are first selected into different tracks or different programmes. The higher the level of differentiation, the lower the age at first selection.

We use the share of NEETs (15–29-year-olds who were not in education, employment or training) in the year 2015 to identify lack of skill development opportunities and tertiary attainment rates among 25–34-year-olds also in 2015 to identify availability for the development of high levels of proficiency (OECD, 2015b). Table S1 in the online Supporting Information illustrates country-specific contextual variables for each country in the sample.

Study population and the construction of a pseudo-cohort

To study the evolution of gaps in literacy skills between the teenage years and young adulthood, one would ideally use panel data, tracking the same people over time. In the absence of such data for a large number of countries, it is possible to use a synthetic cohort approach. The synthetic cohort approach consists of dividing an initial sample (in our case the sample of 15-year-old students who sat the PISA test in 2000) into groups whose membership is assumed to be fixed over time. The average behaviour of these groups is then tracked over time (in the PIAAC study) and as long as the sample is continually representative of an underlying population that has a fixed composition, estimates from the synthetic panel should be consistent with estimates from an actual panel based on individual-level data.

The 1984/1985 birth cohort represents the primary population of focus in the study. People born in that period, in fact, were eligible to take part in the PISA study in 2000 and were approximately 27 years old at the time PIAAC was administered. The representative nature of the PISA and PIAAC studies, and the broad stability over time of the highest parental educational attainment measure, guarantees the adequacy of the synthetic cohort approach. However, in order to increase the precision of estimates and widen the international coverage, three adjustments were made.

Sample sizes used to construct our synthetic cohort vary markedly across the two studies. The minimum target sample in PISA is around 4,500 students per country. Unfortunately, as the target PIAAC sample size in each country was about 5,000 for the entire adult population aged 16–65, the age-specific sample is typically around 150 individuals. For this reason, the PIAAC age band was widened to cover 26–28-year-olds, thus allowing the inclusion of people born a year before and a year after the 2000 PISA cohort. Country-specific sample sizes in PISA and PIAAC used to construct measures of socio-economic disparities are reported in Table S2 in the online Supporting Information.

In order to widen the international coverage, individuals in countries that administered PIAAC in 2015 are also presented, and for these, information collected in the PISA 2003 survey administration is used to match the PIAAC 26–28 age range. Analyses exclude adults sampled in PIAAC who report having been born outside the country of the assessment, with no information on age at migration or who reported having migrated after the age of 10. Analyses include foreign-born individuals who reported having migrated prior to age 10. The threshold was chosen to ensure that individuals would have been part of PISA samples at age 15 and had adequate language proficiency. Previous analyses of PISA data reveal large late-arrival penalties (OECD, 2015a).

Although England, Northern Ireland, the Netherlands and the Russian Federation took part in both PISA and PIAAC, they are excluded. The response rate for the UK and the Netherlands in PISA 2000 and PISA 2003 was below the minimum required by the PISA technical standards. The sample for the Russian Federation in PIAAC does not include the population of the Moscow municipal area and therefore does not represent the entire resident population. Only Flanders in Belgium took part in PIAAC, while PISA data refer to results for the Flemish community.

Analytic plan

In order to combine multiple assessment items to derive the underlying unobservable ability of individuals, both PISA and PIAAC make use of item response theory (IRT). The measurement scales differ across the two assessments (the literacy scale in PISA is standardised to have a mean of 500 and a standard deviation of 100 across OECD countries, while in PIAAC it is standardised to have a mean of 268 and a standard deviation of 47 across OECD countries).

In both PISA and PIAAC, individuals' responses to individual test questions were combined with background information to estimate, for each respondent, a distribution of proficiency, from which a set of plausible values is drawn (Jacob & Rothstein, 2016). Until 2012, PISA used a one-parameter Rasch model and five plausible values for each proficiency domain and for each participant were drawn. PIAAC used a two-parameter IRT model and a set of 10 plausible values were drawn for each proficiency domain and for each individual. Although each plausible value represents an unbiased estimate of respondents' underlying ability distribution, only by combining plausible values is it possible to correctly account for the underlying level of measurement uncertainty that is inherent in any cognitive test, and reflect such uncertainty in the standard errors associated with any estimate.

A second complication when developing estimates using PISA and PIAAC data is that participants are not selected using simple random sampling but, rather, complex sampling designs were employed. We consider PISA and PIAAC plausible values and estimate each model five times for PISA and for PIAAC. We also account for the clustering and representativeness of individuals participating in PISA and PIAAC by estimating each model with replicate weights as well as individual final weights in the two assessments. All models were estimated using Stata software version 15, with the user-written commands *piaactools* (Jakubowski & Pokropek, 2019) and *pisatools* (Jakubowski & Pokropek, 2013). Results were combined using Rubin's rule (Rubin, 1987).

In order to identify how achievement growth differs across the two groups, we use new evidence on scale concordance provided by Pokropek & Borgonovi (2020). No attempts were made to link PIAAC and PISA at the international level during the design of the two studies. However, in PISA 2012, countries had the opportunity to extend the PISA target population through national options. Pokropek & Borgonovi (2020) make use of the Polish PISA grade extension and use a pseudo-equivalent group approach to achieve pseudo-equivalency between PISA and PIAAC using propensity score reweighting techniques. They establish scale concordance between two assessments, which we use in our analyses to establish disparities in achievement growth. In this work, all estimates are presented on the PISA scale. A detailed discussion of the linking procedure is presented in Pokropek & Borgonovi (2020).

We examine if there are differences in the evolution of socio-economic disparities in literacy achievement between the teenage years and young adulthood among high-achieving students (90th percentile) and among low-achieving students (10th percentile), and compare differences in socio-economic gaps between high and low achievers across education systems.

Finally, to examine potential mechanisms leading to SES differentials in achievement growth, we use data from PIAAC for 16–28-year-old participants and estimate differences in the educational attainment and NEET rates of youngsters with at least one parent who obtained tertiary level qualifications and those without. We also consider SES differences in informal and non-formal learning opportunities at work among youngsters surveyed in PIAAC, as well as SES differentials in the extent to which youngsters in PIAAC report using their literacy skills at home and in the workplace. These indicators are described in detail in the online Supporting Information. We fitted two regression models on the pooled sample of participants with literacy achievement as the dependent variable to test H3 to examine the contribution of educational attainment, participation in training and the labour market, and the use of skills at home and in the workplace to shape SES differentials in young adulthood. The first model include only parental education and country fixed effects. The second further included controls for being NEET, educational attainment and use of skills at home and in the workplace. We use the two models to compare the observed and predicted literacy achievement of individuals with and without tertiary educated parents among individuals with similar observed characteristics. Indicators of individuals' educational attainment and NEET status are dichotomous variables taking value 1 if the participant obtained a tertiary level degree for educational attainment and if the participant reports not being in education, paid employment or training at the time of the assessment for NEET status. Indicators of skills use are continuous variables standardised to have a mean of 0 and a standard deviation of 1 across the entire PIAAC sample. A detailed description of the items used to derive these indicators is available in the online Supporting Information.

Results

Between-country differences in achievement growth

Data presented in Figure 1 illustrate literacy proficiency among 15-year-olds tested in PISA in 2000 and the same birth cohort tested in PIAAC in 2012. Results indicate
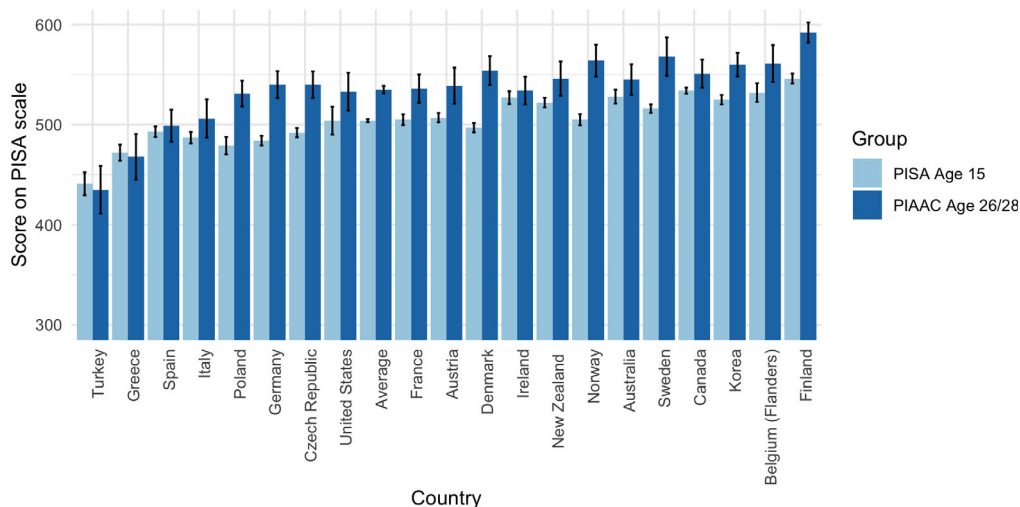
Figure 1.   Mean literacy achievement growth between age 15 and age 26–28, by country. *Source*: PISA 2000 and PIAAC 2012/2015 databases. Linking constants to transform PIAAC scores into PIAAC scores can be found in Table S1 in the online Supporting Information. Full results are available in Table S3. [Colour figure can be viewed at wileyonlinelibrary.com]

that on average, individuals' literacy achievement grew between age 15 and 27 by 31 points on the PISA literacy scale: it was 504 among 15-year-olds and 535 among 27-year-olds, an increase of around 30% of a standard deviation. However, Figure 1 also identifies a large heterogeneity across the 20 countries in our sample in achievement growth.

Some of the countries with the lowest levels of literacy achievement among 15-year-olds in 2000 experienced no statistically significant changes in mean achievement. In particular, in Turkey, Greece and Spain, the estimated growth in achievement was close to zero (although imprecisely estimated). However, achievement growth was small (and not statistically different from zero) also in Australia and Canada, two of the countries with the highest levels of mean literacy achievement among 15-year-olds in 2000. Similarly, some of the countries with the largest improvements were countries with low mean achievement at age 15—Poland and Germany.

The variability in patterns of achievement growth across countries with different levels of mean achievement suggests that observed associations are not the result of regression to the mean effects or ceiling effects. Moreover, the large heterogeneity in patterns of achievement growth means that rankings of education and skills systems depend greatly on when individuals are evaluated. At the two extremes, Finland and Turkey keep their respective score as the highest and lowest-performing country, irrespective of whether they are evaluated at age 15 or 27. However, as many as eight countries have a change in rank corresponding to at least five places (out of a possible 20). Germany moves from 17th place to 11th place, Denmark from 13th place to 6th place and Norway from 10th place to 3rd place, while Ireland moves from 4th place to 14th place and Australia from 3rd place to 9th place.

How socio-economic disparities grow over time

Data presented in Figure 2 illustrate the difference in literacy proficiency of 15-year-olds in PISA and 27-year-olds in PIAAC for individuals whose parents did not obtain a tertiary degree and individuals with at least one parent who obtained a tertiary degree. In line with H1, Figure 2 indicates that the gap associated with parental education is generally large at the age of 15 and that it increases slightly as individuals transition from the teenage years into young adulthood.

On average, across the 20 countries in our sample, the gap in literacy between individuals with at least one tertiary educated parent and individuals whose parents did not complete a tertiary degree was 40 score points at age 15 (corresponding to 40% standard deviation) and 55 score points at age 27 (corresponding to over half of a standard deviation). This corresponds to a difference of 15 score points, an increase of 15% of a standard deviation. In line with H1, results indicate that the increase in disparities in literacy achievement is due to the fact that, on average, literacy achievement grew more between age 15 and 27 among individuals with tertiary educated parents than among individuals with parents who did not complete tertiary education. For example, among individuals with parents who did not complete tertiary education, literacy achievement grew from an average of 491 score points at age 15 to an average of 518 points, a difference of 27 points. In the same timeframe, the growth in achievement experienced by individuals with tertiary educated parents corresponded to 42 points, from 531 to 573. Although on average the gap in achievement between individuals with and without tertiary educated parents grew by 15 points between age 15 and 27, Figure 3 suggests a large degree of variability across countries (we examine potential sources of this variation below).
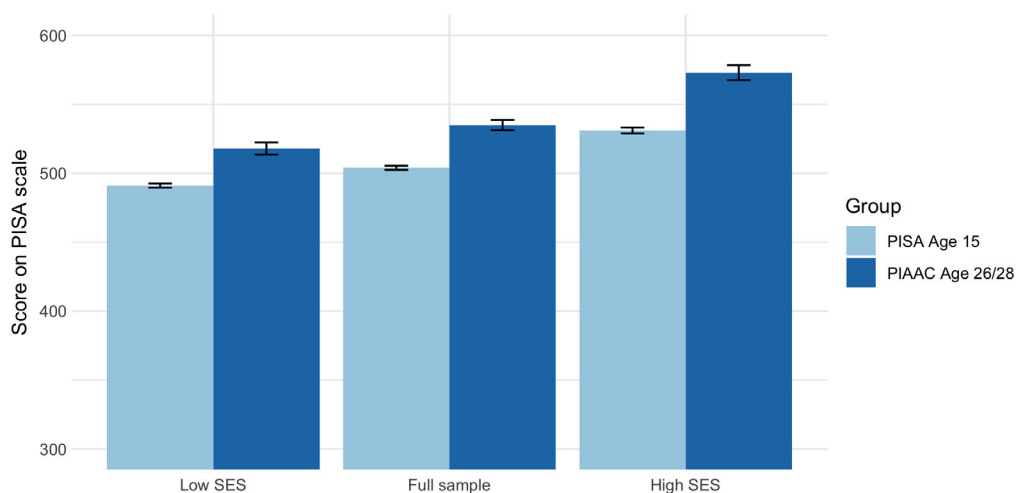

Figure 2.   Disparities in literacy achievement growth, by parental education. *Source*: PISA 2000/2003 and PIAAC 2012/2015 databases. Low parental education refers to individuals with no parent who obtained a tertiary degree. High parental education refers to individuals with at least one parent with a tertiary degree. Detailed results are available in Table S4 in the online Supporting Information. [Colour figure can be viewed at wileyonlinelibrary.com]
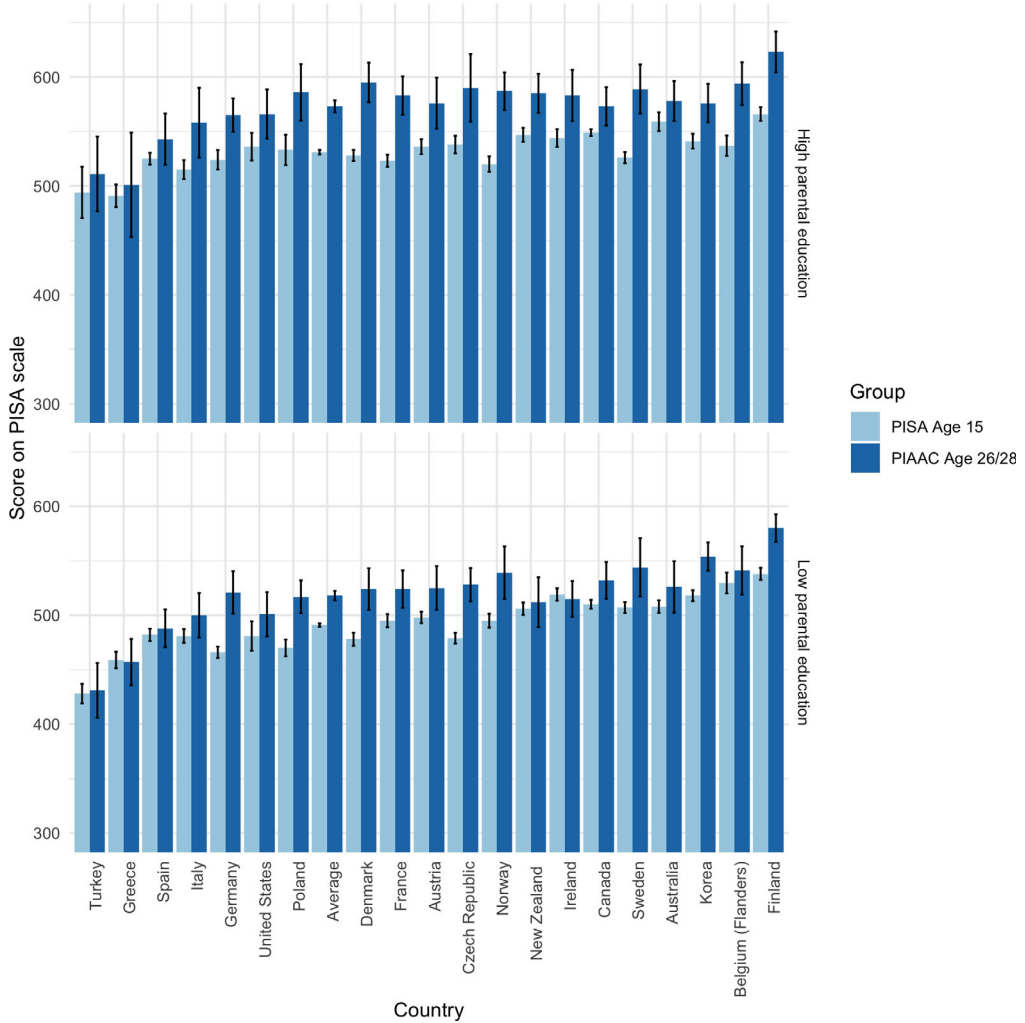
Figure 3.   Disparities in literacy achievement growth, by parental education and by country.
Source: PISA 2000/2003 and PIAAC 2012/2015 databases. Low parental education refers to individuals with no parent who obtained a tertiary degree. High parental education refers to individuals with at least one parent with a tertiary degree. Detailed results available in Table S4 in the online Supporting Information. [Colour figure can be viewed at wileyonlinelibrary.com]

At the country level, the size of the socio-economic gap in literacy at age 27 is positively associated with the size of the socio-economic gap in literacy at age 15. However, the association is moderate in size (Pearson's $r = 0.523$). The gap at age 15 was 50 score points or larger in Australia, the Czech Republic, Denmark, Germany, Poland, Turkey and the USA. However, among these countries, by age 27 the gap had become smaller than 50 score points in Germany, while in some of the countries with comparatively small gaps at age 15, such as France, Ireland and Italy, the gap observed at age 27 was larger than 50 points.

The gap shrank by 14% of a standard deviation in Germany. However, in France (a 31 score-point increase), in Ireland (a 43 score-point increase), in Italy (a 25 score-

point increase) and in New Zealand (a 33 score-point increase). Most of the countries with large increases in disparities between the age of 15 and 27 experienced more pronounced growth in achievement among individuals with tertiary educated parents, thus supporting H1.

Differences in achievement growth across the literacy performance distribution

Figure 4 reports the mean level of achievement on the PISA literacy scale among 15-year-olds tested in PISA in 2000 and individuals from the same birth cohort tested in PIAAC in 2012 at age 27. Results indicate that the literacy achievement of the 10% lowest-performing 15-year-olds was 375, but the literacy achievement of the 10% lowest-performing 27-year-olds was 416, an increase of 41 score points, equivalent to around 40% of a standard deviation. By contrast, the literacy achievement of the 10% highest-achieving 15-year-olds was 622 and the literacy achievement of the 10% highest-achieving 27-year-olds was 644, an increase of 22 points, equivalent to around 20% of a standard deviation. These results suggest that, on average, the gap in performance between the highest and lowest achievers narrowed by around 20% of a standard deviation.

Just as Figure 1 illustrates a large variability across countries in mean levels of achievement growth, Table S4 in the online Supporting Information identifies a large variability across countries in the achievement growth of different groups, although in most countries performance disparities declined because performance increased especially among the lowest achievers. The fact that the performance of the best 10% of achievers increased markedly in countries like Finland, where it was already comparatively high at age 15, suggests that results are not driven by ceiling effects. Moreover, the fact that the between-country variation in size of improvements among the lowest achievers was not related to the size of the achievement gap between high and low
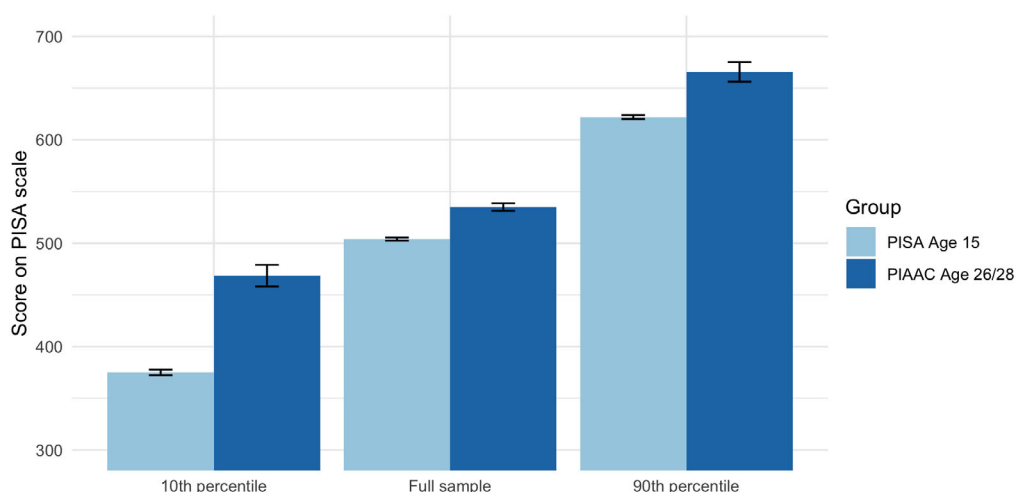

Figure 4.   Achievement growth between age 15 and 26–28, by percentile. *Source*: PISA 2000/2003 and PIAAC 2012/2015 databases. Country-specific results available in Table S5 in the online Supporting Information. [Colour figure can be viewed at wileyonlinelibrary.com]

achievers at age 15, or overall levels of achievement at age 15, suggests that results are not driven by regression to the mean effects. In general, it is important to note that given the small sample size at the country level for comparisons at the 10th and 90th percentile of achievement, especially for some countries, country-level results are generally imprecisely estimated.

How socio-economic disparities in achievement growth evolve among high and low achievers

Figure 4 indicates that at age 15, the literacy proficiency gap between those with and those without tertiary educated parents was similar across the performance distributions: the gap was around 45 score points both among the 10th and the 90th percentile (44 and 47 score points, respectively). The gap remained very similar at the 90th percentile at age 27 (44 score points). However, in support of H2 we find that the gap grew larger at the 10th percentile and that by age 27 it stood at 67 score points. Also, in line with predictions made in H2, Figure 5 indicates that the change in the gap was due to the fact that at the top of the performance distribution, achievement growth between age 15 and 27 was similar among individuals with and without tertiary educated parents (30 and 33 points, respectively). At the bottom of the performance distribution, achievement growth was especially pronounced among individuals with tertiary educated parents (the growth in achievement was 70 score points among individuals with tertiary educated parents and 47 score points among those whose parents had not completed tertiary education, a difference of 24 score points).

Table S5 in the online Supporting Information illustrate cross-country differences. In Ireland, Norway, France and Turkey, the trend of growing disparities at the bottom of the performance distribution was particularly pronounced. In these countries,
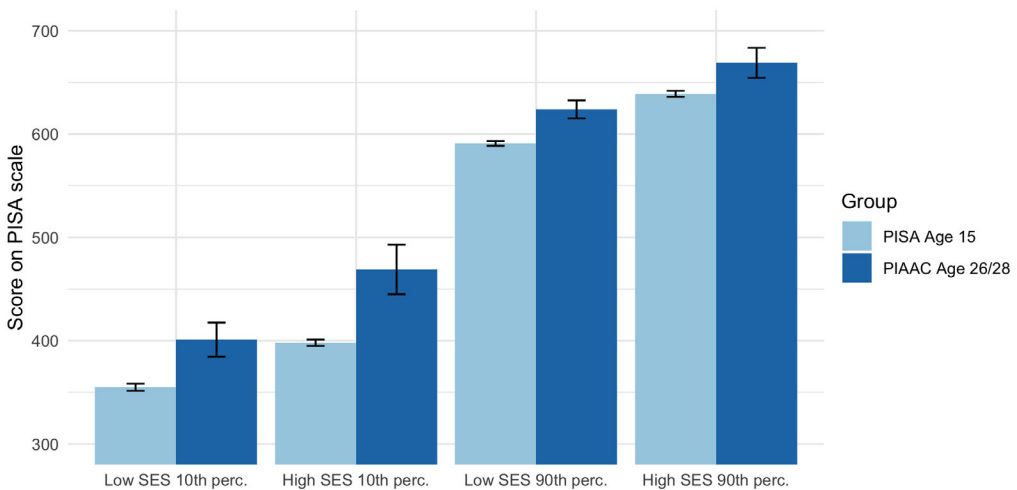

Figure 5.   Disparities in achievement growth between age 15 and 26–28, by parental educational attainment and percentile. *Source*: PISA 2000/2003 and PIAAC 2012/2015 databases. Low parental education refers to individuals with no parent who obtained a tertiary degree. High parental education refers to individuals with at least one parent with a tertiary degree. [Colour figure can be viewed at wileyonlinelibrary.com]

disparities among individuals with the lowest 10% of literacy scores grew by as many as 68, 69, 71 and 84 score points, respectively, while disparities among the highest achievers increased by only 6 points in Ireland and Norway, decreased by 3 points in France and by as many as 59 points in Turkey. In all these countries, disparities at the bottom grew because achievement growth between age 15 and 27 was especially pronounced among individuals with tertiary educated parents, while it was considerably smaller among individuals with parents who had not completed tertiary education.

By contrast, in Germany, socio-economic disparities were greatly reduced between age 15 and 27 among the lowest achievers (a 36 score-point reduction) and were somewhat reduced among the highest achievers (a 9 score-point reduction). In Germany, the reduction of disparities was due to a generalised growth in achievement that was especially pronounced among individuals without tertiary educated parents. Moreover, while such increase was similarly large at different levels of performance among individuals without tertiary educated parents, it was especially small among individuals with tertiary educated parents at the bottom of the literacy performance distribution. Greece also experienced a reduction in socio-economic disparities at the bottom of the performance distribution and an increase at the top. At the bottom, the decline in disparities resulted from growth in achievement among individuals without tertiary educated parents (a 25 score-point increase) and declining performance among those with tertiary educated parents (a 23 score-point decrease). At the top it was caused by especially marked improvements in achievement among individuals with tertiary educated parents (61 points vs. 33 points among those without tertiary educated parents).

Factors that contribute to the evolution of achievement differentials

Results presented in Table 1 indicate that individuals with tertiary educated parents differed from individuals without tertiary educated parents in key dimensions that are associated with growth in achievement. Country-specific results are available in Table S6 in the online Supporting Information. They were less likely to be classified as NEET, more likely to have obtained a tertiary education degree, more likely to use reading, writing and ICT skills at home and in the workplace, and more likely to engage in learning activities at work. For example, across countries in our study, 14% of 16–28-year-olds without a tertiary educated parent were NEET. The comparable figure among 16–28-year-olds with a tertiary educated parent was 6%. By contrast, only 20% obtained a tertiary degree, against an average of 39% among 16–28-year-olds with a tertiary educated parent. Differences in the use of skills at home and at work, and in self-reported readiness to learn and participation in learning activities at work, are also large and are as high as around 40% of a standard deviation for use of ICT and reading skills at home.

Figure 6 and Table S7 in the online Supporting Information present results in which we formally test H3 by examining the extent to which SES differentials in literacy achievement in young adulthood can be explained by differences in formal learning opportunities that occur in education or training, and differences in informal and non-formal learning opportunities that occur through the practice of skills at home and in the workplace. Results indicate that the SES gap in literacy achievement

Table 1.   Socio-economic differences in access to formal and informal learning opportunities

Variable		Low parental education	High parental education	Mean difference	pval
		SES difference			
NEET status	Mean	0.14	0.06	−0.08*	0.00
	SE	(0.00)	(0.01)	(0.01)	
Tertiary education degree	Mean	0.20	0.39	0.19*	0.00
	SE	(0.00)	(0.01)	(0.01)	
Use of ICT skills at home	Mean	−0.12	0.28	0.40*	0.00
	SE	(0.01)	(0.02)	(0.02)	
Use of ICT at work	Mean	−0.11	0.08	0.19*	0.00
	SE	(0.02)	(0.02)	(0.03)	
Learning at work index	Mean	−0.03	0.04	0.07*	0.00
	SE	(0.01)	(0.02)	(0.02)	
Use of reading skills at home	Mean	−0.16	0.23	0.39*	0.00
	SE	(0.01)	(0.02)	(0.02)	
Use of reading skills at work	Mean	−0.11	0.16	0.26*	0.00
	SE	(0.01)	(0.02)	(0.02)	
Readiness to learn index	Mean	−0.16	0.12	0.29*	0.00
	SE	(0.01)	(0.02)	(0.02)	
Use of writing skills at work	Mean	−0.12	0.04	0.16*	0.00
	SE	(0.01)	(0.02)	(0.02)	
Use of writing skills at home	Mean	−0.12	0.16	0.28*	0.00
	SE	(0.01)	(0.02)	(0.02)	

Source: PIAAC 2012 and 2015 database. The sample includes 16–28-year-olds in PIAAC. Country-specific results are available in Table S6 in the online Supporting Information.
*Mean difference significant at the 1% level.

among 16–28-year-olds was large and equalled 51 score points. However, once individuals from different SES backgrounds but similar characteristics in terms of educational attainment, NEET status and use of skills were compared, SES disparities in literacy achievement remained but were greatly reduced and stood at 28 score points.

Correlates of between-country differences in the evolution of disparities between age 15 and 27

The number of countries in our sample is small, so it is not possible to draw firm conclusions on factors that drive between-country differences in observed patterns of achievement growth between age 15 and 27 because we have only the power necessary to identify very large differences. We find weak support for H4: Table 2 illustrates correlation coefficients between measures of achievement growth and country-level characteristics that could determine the quality of school-to-after-school transitions. Across countries in our sample, overall increases in achievement growth were more marked in countries where the share of youngsters in a country who are NEET was lower ($r = -0.75$), a difference observed in similar terms both at the 10th and 90th percentiles of achievement. By contrast, we do not identify a strong association between educational attainment, early selection, curricular differentiation and
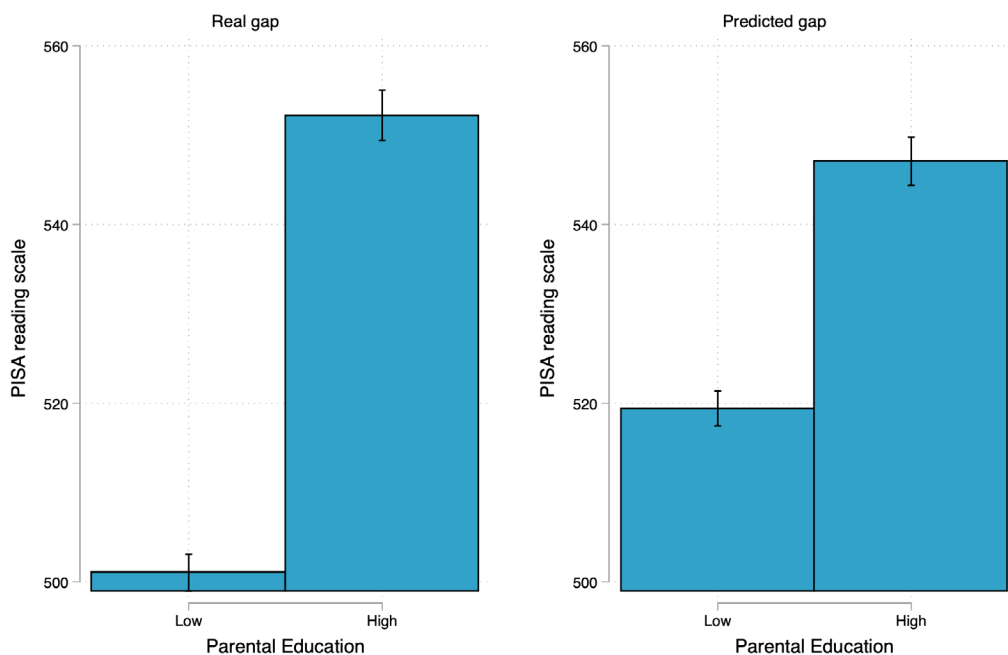
Figure 6. Observed and predicted levels of literacy achievement after considering differences between socio-economic status groups in learning opportunities. *Source*: PIAAC 2012/2015 database. Detailed data from the underlying regression models are available in Table S8 in the online Supporting Information. Low parental education refers to individuals with no parent who obtained a tertiary degree. High parental education refers to individuals with at least one parent with a tertiary degree. The regression includes PIAAC participants between the ages of 16 and 28. Observed gap refers to the difference in literacy achievement associated with being in the low rather than the high parental education group. Estimates are based on a regression run on a pooled sample of 16–28-year-old PIAAC participants with parental education and country fixed effects as the only controls. Predicted gap refers to the difference in literacy achievement associated with being in the low rather than the high parental education group when further controlling for educational attainment, NEET status, use of skills at home and learning in the workplace (use of skills in the workplace was dropped by the model because of multicollinearity with NEET status). [Colour figure can be viewed at wileyonlinelibrary.com]

average growth in achievement in the overall population and different population subgroups.

Discussion

Since 2000, the PISA study has revealed that 15-year-old students with a disadvantaged socio-economic background are less likely than their more advantaged peers to develop strong literacy skills. However, so far little was known on how disparities in literacy evolve after the end of compulsory schooling, whether disparities in learning opportunities after compulsory schooling magnify or reduce disparities observed at the age of 15, and if there are variations across countries.

The analyses presented in this article indicate that, in most countries, disparities in literacy skills between individuals of high and low SES observed at age 15 not only

Table 2.　Associations between achievement growth between age 15 and 26–28 and country-level characteristics

	NEET rate (2015)	Educational attainment (2015)	Standardisation	Age at selection
NEET rate (2015)	1			
Educational attainment (2015)	−0.42	1		
Standardisation	0.19	−0.42*	1	
Age at selection	−0.03	0.55**	−0.19	
Average achievement growth	−0.75**	0.05	−0.14	−0.06
Achievement growth (10th percentile)	−0.67**	0.03	0.03	−0.09
Achievement growth (90th percentile)	−0.73**	0.28	−0.32	0.20
Average achievement growth—low parental education group	−0.65**	0.01	−0.20	−0.18
Average achievement growth—high parental education group	−0.53**	−0.01	−0.21	−0.01
Achievement growth (10th percentile)—low parental education group	−0.53**	−0.09	0.13	−0.31
Achievement growth (90th percentile)—low parental education group	−0.52**	0.17	−0.41*	0.03
Achievement growth (10th percentile)—high parental education group	−0.25	−0.11	−0.22	−0.16
Achievement growth (90th percentile)—high parental education group	−0.61**	0.33	−0.35	0.38

The table illustrates Pearson's correlation coefficients. The NEET rate refers to the percentage of 15–29-year-olds in a country who were not in education, employment or training in the year 2015. The tertiary attainment rate represents the share of 25–34-year-olds in 2000 who obtained a tertiary education qualification in 2015. Curricular standardisation represents the percentage of school principals surveyed in PISA who reported that courses offered are decided at the national/local/regional level rather than by the school. Age at first selection is based on the PISA data system-level data collection and represents the age at which students in education are first streamed into different educational tracks or programmes. Detailed country-level characteristics can be found in Table S1 in the online Supporting Information.
*$p \leq 0.1$.
**$p \leq 0.05$.

persist in young adulthood, but tend to widen by age 27. Moreover, in support of predictions made by proponents of cumulative advantage theory, we find that there is a positive medium-sized association between disparities in skills at age 15 and at age 27: countries with larger literacy gaps in the teenage years tend to be those where literacy gaps at age 27 are larger. However, there are a number of countries where gaps are similar at age 27 and at age 15 and in Germany, a country where large disparities at age 15 can be observed, disparities by age 27 became smaller. These results indicate that those countries in which the education system is able to create more equal opportunities for skill development during the school years are not necessarily able to create effective school-to-after-school transition pathways later on.

Our work suggests that the increase in disparities in literacy skills is particularly pronounced at the bottom tail of the proficiency distribution: while achievement tends to grow between age 15 and 27 among all groups, such growth is especially pronounced among individuals with tertiary educated parents. Further education and

participation in the labour market appear to be the crucial mechanisms that are associated with skill acquisition beyond compulsory schooling. Socio-economically disadvantaged youngsters are considerably less likely than their more advantaged counterparts to attend post-secondary education and training, and are more likely to drop out of education without a secondary degree. They are also more likely to be unemployed or out of the labour force and to work in jobs that require little advanced on-the-job training or the practice of higher-order thinking skills. By contrast, individuals with tertiary educated parents are not only more likely to obtain tertiary level qualifications, in line with predictions made by the effectively maintained inequality thesis, but are also less likely to be NEET and more likely to develop their skills through use, both in the workplace and in everyday settings. Our results indicate that the divergence in the opportunities for skill development between socio-economically advantaged and disadvantaged youngsters upon completion of compulsory schooling is associated with an overall increase in socio-economic gaps in proficiency.

Our results indicate that SES disparities in literacy achievement among young adults are related, to a large degree, to differences across SES groups in formal and informal learning opportunities. Once differences across SES groups in educational attainment, NEET status and use of skills at home and in the workplace are accounted for, the difference in literacy achievement in young adulthood between individuals with and without a tertiary degree is considerably smaller. A clear limitation of our study, is that it is not possible to establish causality in the association between skill development and participation in education, employment or training given the nature of the data examined. It is therefore possible that skill development is promoted by the learning opportunities individuals are given in education, employment or training, but also that individuals with greater potential for skill development are given learning opportunities while those with little potential become NEET. To the extent that such unobserved potential is associated with parental education, reverse causality determines observed socio-economic disparities as well as overall patterns of achievement growth.

The fact that disparities between adolescence and young adulthood tend to grow should be of concern to policymakers, especially because these trends stand in sharp contrast to the trends we identify when considering the growth in achievement of high and low-ability individuals. The difference in the 90th–10th percentile gap at age 27 was in fact smaller compared to the 90th–10th percentile gap observed at age 15. The divergent trend can be explained by the fact that the group that appears to benefit most during the school-to-after-school transition is that composed by low ability but socio-economically advantaged individuals, who experience a marked increase in literacy achievement between age 15 and 27. Such result could be due to the greater variety of learning experiences that occur outside of school settings, a variety that can appeal to the preferences and learning styles of low-ability individuals and the fact that extensive access to such opportunities is only available to those coming from socio-economically advantaged households.

In the absence of comparable longitudinal data, our analysis relies on a synthetic cohort approach and concordance scores that allow us to derive comparable measures of literacy achievement across the PISA and PIAAC tests. Lack of longitudinal data means that our inferences only apply at the population level, and we cannot study in

depth the mechanisms that shape differentials in achievement growth in different groups. Furthermore, although our study provides the widest comparison to date on SES differences in achievement growth between the age of 15 and 27, the limited number of countries that we could examine means that our analysis of cross-country differences can only identify large effects because we lack power to identify small and medium-size effects. Although we are not aware of other large cross-country comparable assessment data with a longitudinal component, future research could attempt to use *ex-post* harmonised data and exploit psychometric studies designed to establish links across assessments in order to consider disparities in achievement growth.

Our findings support prior research based on growth in achievement disparities in the early years and the schooling years, suggesting that schools and education systems play an important equalising role with respect to the development of literacy skills. Such research indicates that disparities grow before schooling starts and remain relatively stable during the school years (see Skopek & Passaretta, 2020 for a review). Our research indicates that disparities widen once schooling ends. Our work indicates that the availability of opportunities for further education can influence how socioeconomic gaps established at the end of compulsory schooling evolve in the crucial transition years between adolescence and young adulthood. In most countries, whatever their social background, students follow a broadly similar programme of study, at least until the completion of lower secondary level education. Even if participation in a common educational experience does not eliminate socio-economic disparities in learning outcomes, it moderates the effects of differences in social background and the differences in access to resources, as well as in the associated dispositions and attitudes to learning proficiency. While further research is needed, when taken together, these results suggest that when the schooling and educational pathways available to individuals differ, social stratification occurs and, as a consequence, the experiences and opportunities of young people from different backgrounds begin to diverge. Unsurprisingly, inequalities in literacy skills widen, in particular among low-achieving individuals.

Acknowledgements

Ethical Review Approval

The research conducted was reviewed and approved by the Institute of Education Ethics Review Board.

Conflict of Interest

Francesca Borgonovi: I am a British Academy Global Professor at University College London but I am also employed by the Organisation for Economic Cooperation

Data Availability Statement

The data that support the findings of this study are available at www.oecd.org/pisa/data and www.oecd.org/skills/piaac/data/.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Table S1. Country-specific contextual variables.
Table S2. Sample size for PISA 2000 and PIAAC.

Table S3. Mean literacy achievement growth between age 15 and age 26–28, by country.

Table S4. Disparities in literacy achievement growth, by parental education and by country.

Table S5. Achievement growth between age 15 and 26–28, by percentile and by country.

Table S6. Disparities in achievement growth between age 15 and 26–28, by parental educational attainment and percentile, by country.

Table S7. Socio-economic differences in access to formal and informal learning opportunities, by country.

Table S8. Raw and adjusted gap for literacy achievement (OLS regression) with marginal effects.