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Scholarly culture: how books in adolescence enhance adult literacy, numeracy and technology skills in 31 societies

Abstract

A growing body of evidence supports the contention of scholarly culture theory that immersing children in book-oriented environments benefits their later educational achievement, attainment and occupational standing. These findings have been interpreted as suggesting that book-oriented socialization, indicated by home library size, equips youth with life-long tastes, skills and knowledge. However, to date, this has not been directly assessed. Here, we document advantageous effects of scholarly culture for adult literacy, adult numeracy, and adult technological problem solving. Growing up with home libraries boosts adult skills in these areas beyond the benefits accrued from parental education or own educational or occupational attainment. The effects are loglinear, with greatest returns to the growth in smaller libraries. Our evidence comes from regressions with balanced repeated replicate weights estimated on data from 31 societies which participated in the Programme for the International Assessment of Adult Competencies (PIAAC) between 2011 and 2015.

KEYWORDS: HOME LIBRARIES, BOOKS IN ADOLESCENCE, SCHOLARLY CULTURE, ADULT LITERACY, NUMERACY AND DIGITAL PROBLEM SOLVING, CULTURAL MOBILITY

1. Introduction

How does culture enhance life chances? The most prominent theory of this tradition, Bourdieu's argument about cultural reproduction, builds on Max Weber's insight into the importance of culture in boundary maintenance by elite status groups. It posits that elite families equip their children with "widely shared, high status cultural signals (attitudes, preferences, formal knowledge, behaviours, goods and credentials) used for cultural exclusion" (Lamont and Lareau, 1988: 156) thereby securing educational advantages for their children and reducing opportunities for other children. Critical to this argument are three elements: (1) the signals are arbitrary – they do not actually enhance educational or occupational performance; (2) the signals are difficult and/or time consuming to acquire, so they are difficult to fake; (3) the elite have near-exclusive access to these signals. A host of empirical studies inspired by this argument conclude that cultural capital, misconstrued by teachers as academic excellence, provides elite children with unfair advantages in securing desirable socioeconomic outcomes. Importantly, this tradition assumes that the high-status cultural signals are linked to a monolithic highbrow culture. However, every test of the dimensionality of high culture finds not one, but rather two distinctive groupings: a books and reading-related dimension and a beaux arts/ arts appreciation/ arts spectatorship

dimension. Building on this distinction, a growing body of evidence demonstrates that when book-related forms of cultural resources are distinguished from other forms, the former and not the latter account for much of educational success. This is because book-related resources have a substantive link to academic-related skills such as vocabulary building, counterfactual thinking, and cognitive flexibility, whereas highbrow arts consumption or extracurricular activities have no substantive impact on academic skills. It is only when the books and reading measures are (incorrectly) incorporated into a single "cultural capital" measure with arts spectatorship that the signals as a group have an effect. In short, scholarly culture is separate from arts spectatorship and, moreover, scholarly culture has a major impact on educational performance and attainment, but arts spectatorship has little or no effect. This is important because it undermines the claim that cultural resources are arbitrary signals used by the elite to exclude or disadvantage others: instead, highbrow arts (the arbitrary signals) are of little or no importance to education, while engagement in book-related culture raises educational attainment.

The implication, which we shall examine here, is that scholarly culture endows children with cognitive skills that intrinsically enhance academic performance, rather than scholarly culture being merely an arbitrary signal of elite membership. If that implication is correct, we should be able to detect effects of scholarly culture on cognitive skills – this is consistent with prior research but has not previously been tested due to data limitations.

Another important aspect of the scholarly culture theory is its proposition that involvement in books and reading benefits most disadvantaged children and not the children of the elite. This contrasts with cultural reproduction theory and builds on the cultural mobility model, as detailed below.

Our goals in this paper are to 1) validate the scholarly culture hypothesis in the context of new outcomes that are essential to the claim of intrinsic connection between book-oriented childhoods and educational and occupational success, namely, adult literacy, numeracy, and solving problems using information and communication technologies (ICT); and 2) to illuminate the inter- and intra-generational mechanisms through which scholarly culture operates. We will also consider, more speculatively, if culture conceptualized thus is likely to remain relevant in the era of digital literacy. In service of these goals, we present evidence from 31 societies which participated in Rounds I and II of the Program for International Assessment of Adult Competencies (PIAAC).

2. Cultural reproduction versus scholarly culture

2.1 Cultural reproduction

Cultural reproduction arguments, building on Bourdieu (1984, Bourdieu and Passeron, 1990), suggest that elite parents strategize to equip their children with cultural signals which teachers mistake for academic excellence and hence invest more in educating the elite offspring (Goldthorpe, 2007, Jæger and Breen, 2016). Researchers followed Bourdieu in distinguishing three states of so understood cultural capital, namely *the embodied capital* which involves legitimate preferences and behaviours, *the objectified capital* such as books and other transmittable physical goods and *the institutionalised capital* that involves educational credentials and other indicators of class position (Lamont and Lareau, 1988). It is commonly assumed that embodied capital is necessary for the objectified capital to be mobilised and effectively used for enhancing one's institutionalised capital. Empirical research on cultural reproduction in the last 30 years has been based primarily on the evidence from the United States (for a review of over 40 relevant studies see: Jæger and Breen, 2016) and focused on the extent to which various forms of cultural capital in the family of origin enhanced children's educational achievement, and, in turn, educational attainment. Virtually no research in the cultural reproduction tradition considered the implications of cultural capital for adult outcomes other than educational attainment (but see: Evans, et al., 2015).

Theoretically, cultural capital involves a range of elite status signals that is too broad to operationalize (Lamont and Lareau, 1988), hence references to Bourdieu "wild" (Goldthorpe, 2007). In contrast, empirical research usually focuses on the participation in the highbrow culture or Bourdieu's "domesticated" capital (Goldthorpe, 2007), which involves educational resources, cultural involvement, extracurricular activities, and reading climates, with exposure to and possession of books treated merely as one of its many possible indicators (Jæger and Breen, 2016, Kingston, 2001). Importantly, high status culture is seen a monolithic, with all the aspects from reading to attendance at art galleries being interchangeable indicators. Research in this tradition aims to demonstrate that educational inequalities are maintained by elite parents who invest in cultural capital to prime their offspring for socio-economic success regardless of their academic ability (Lareau and Weininger, 2003). By contrast, the cultural mobility tradition, instigated by DiMaggio (1982), rejects the logic of cultural reproduction theory arguing that it is the children from the lowest socio-economic origins, and not the elite, who benefit most from endowment with cultural

resources. This tradition accords with the view that scholarly culture endows children with cognitive skills, intellectual flexibility, and problem-solving capacity that endure throughout their lives. These cognitive skills rather than arbitrary cultural signals of elite status are what translates scholarly cultural endowment into educational and occupational success.

2.2 Scholarly culture

Scholarly culture theory highlights book-oriented socialization, indicated by adolescents' home library size, as a source of cognitive competencies, skills and knowledge that are valued not only in formal education (Evans, et al., 2014, Evans, et al., 2010) but also by employers in different places and historical periods (Mateos-Romero and Salinas-Jiménez, 2016). Scholarly culture does not comprise arbitrary cultural signals that identify elite members and earmark them for privileged positions in society: It enhances performance and as such it is valued in various historical circumstances and by modest families as well as the elite (Duchhardt, et al., 2015, Evans, et al., 2010).

2.2.1 Scholarly culture as social practice and way of life

While the exact processes through scholarly culture accrue may vary, they involve social practices (Evans, et al., 2010, Reckwitz, 2002) in which books co-exist with specific mental activities, the know-how and motivational states. Scholarly culture practice is like a "'block' whose existence necessarily depends on specific interconnectedness "of material and non-material elements and which cannot be reduced to any one of these elements" (Reckwitz 2002: 250). This involves interactions with other household members but also solitary activities with books, storytelling, imaginative play and vocabulary development. Parents who encourage their children to read and enjoy books contribute to their educational success through stimulating children's cognitive skills (Kraaykamp and Notten, 2016, Park, 2008) but, here, their behaviour is routine practice and not concerted cultivation (Lareau, 2011). Books and objects such as e-readers, are not just disposable accessories to scholarly culture practices but constitute their integral part and motive.

2.2.2 Scholarly culture enhances success in school

Both detailed studies of individual countries and studies with a broad international sweep find that children who come from bookish homes get better grades and perform at a higher level on standardized tests than children who are otherwise comparable on stratification and demographic characteristics but come from families with smaller home libraries (Bodovski and Farkas, 2008, Cheung and Andersen, 2003, Comber and Keeves, 1973, Heyneman and Loxley, 1983, Jæger, 2011).

Research which sought to evaluate various aspects of home literacy environments in 25 societies found that household library size predicted school success already among fourth-graders net of the reported literacy activities undertaken with parents and net of parental attitudes to literacy (Park, 2008). Home libraries continue to facilitate students' academic achievement in adolescence (de Graaf, 1988, Evans, et al., 2014, Evans and Kelley, 2002). The results on the standardized tests are particularly important because they are anonymously graded, so there is no teacher to be duped by potentially arbitrary cultural signals.

2.2.3 Scholarly culture enhances educational attainment

With respect to educational gains, both detailed studies of individual countries and research project with a global scope find that net of other influences, children from homes with larger home libraries get more years of education overall and are also more likely to make all the major educational transitions (Crook, 1997, de Graaf, et al., 2000, de Graaf, 1986, de Graaf, 1988, Evans, et al., 2010, Georg, 2004, Teachman, 1987). This has held since at least the 1940s, holds for societies across the whole span of socioeconomic development, held for Communist societies as well as others, and holds for the disadvantaged groups for which it has been assessed (Evans, et al., 2010).

2.2.4 Scholarly culture enhances occupational success

This topic received less attention, but the evidence to date is that, in the 27 societies studied thus far, socialization into scholarly culture is associated with higher occupational attainment, primarily indirectly by raising educational attainment, but also with an extra lift beyond that (Evans, et al., 2015).

2.2.5 The effects are greatest for the most disadvantaged

As anticipated by the cultural mobility thesis, the effects of these cultural resources are strongest for people from the most disadvantaged homes. Assessment of functional forms of the effect of home library size on educational and occupational outcomes repeatedly shows that a log linear form fits better than a linear form (Evans, et al., 2014, Evans, et al., 2015, Evans, et al., 2010). The means that each additional book in a home library has much larger benefits for families that only possess a few books than for families that already possess many. This has been interpreted as the additional skills conferred per book: The first book you read opens a whole new set of operational skills and cognitive possibilities; each subsequent book continues to offer vocabulary expansion, new experiences in cognitive complexity and intellectual flexibility, but at a reduced rate.

2.2.6 This paper's contribution: Scholarly culture confers cognitive skills that last into adulthood

It has long been argued that cognitive assets are closely entwined with life chances (Kohn and Schooler, 1978, Spaeth, 1976). The specific contribution of scholarly culture theory is that cognitive skills are the "missing link" heretofore unmeasured directly in studies of the effects of book-oriented socialization on educational and occupational success. We cannot here assess the specific mechanisms whereby book-oriented socialization instils cognitive skills and intellectual flexibility, although we argue that it is through social practices in the family which make up a bookish way of life (Reckwitz, 2002), rather than the more instrumental concerted cultivation proposed in the cultural reproduction model (Lareau, 2011).

That model relegates the role of books to merely one of many possible indicators of parental cultural capital in its objectified form, which is often individually owned and purchase-related. However, book-oriented culture is a shared rather than individual resource. Thus, in a twin study aimed at measuring individual capital, individual book ownership within twin pairs correlated at 0.994 (Jæger and Møllegaard, 2017) which fits the concept of bookishness as a shared family practice. Moreover, bookishness is more culturally acquired than purchase-oriented (Lamont and Lareau, 1988). Books cost money but family bookshelves might be filled with regular loans from libraries or bookish friends.

Building on this evidence, the current paper extends scholarly culture theory by demonstrating that bookishness as social practice, to which youth are acculturated, creates cognitive benefits which are not only immediate but also last into adulthood and are independent of educational and occupational standing (although bookishness also significantly enhances both forms of attainment).

It might be argued that the rapid rise of digital literacy calls into question the relevance of bookish cultures for future generations, but we find no sign of a diminishing effect in more recent cohorts of PIAAC participants. We take up this question more deeply in the conclusion.

2.3 Hypotheses

Our hypotheses stem from an argument about broad benefits of bookish socialization. Hence, we expect similar outcomes for literacy, numeracy and ICT skills:

Hypothesis 1: Diminishing returns with greatest gains at the bottom: Adult literacy, numeracy and ICT problem solving skills develop more when home libraries grow from tiny to medium than from large to enormous.

Hypothesis 2: Direct literacy benefits of growing up in scholarly culture: Exposure to larger home libraries in adolescence enhances adult educational and occupational attainment, but it also boosts literacy, numeracy and ICT skills net of parental education or respondents' attainment in adulthood. The impact on skill is contrary to the cultural reproduction claim that cultural resources confer arbitrary signals.

Hypothesis 3: Life-long cumulative benefits of scholarly culture: larger home libraries in adolescence benefit adult cognitive skills through stimulating more engagement in out-of-work routine adulthood practices that maintain literacy, numeracy and ICT skills but also irrespective of these activities.

3. Data, measurement and method

3.1 Data

The Programme for the International Assessment of Adult Competencies (PIAAC) measures adult literacy, numeracy and information technology competencies (OECD, 2016). Data in Rounds 1 and 2, used here, were collected between 2011 and 2015 (OECD, 2016) in person or by telephone from representative samples of adults aged 16 through 65, regardless of citizenship, nationality or language status. The survey was primarily a computer-based assessment and only respondents with insufficient basic computer skills were given pen-and-pencil tests. We use data from adults aged between 25 and 65 years from 31 societies: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, England and Northern Ireland (here referred to as the United Kingdom), Greece, Ireland, Israel, Italy, Japan, Korea, Lithuania, Netherlands, Norway, New Zealand, Poland, Russian Federation (with the exception of Moscow), Singapore, Slovak Republic, Slovenia, Sweden, Turkey, and the United States. Response rates varied from 45 % in Sweden to 81% in Turkey (for details see: OECD, 2016: Table 16.4). We had to exclude Cyprus entirely, because it did not have variables related to everyday adult activities that enhance literacy, numeracy or ICT skills. However, reduced models for Cyprus (available upon request) align with the results we report here. Italy, France and Spain had no data on digital problem-solving skills so, for this outcome, we had to limit our estimations to 28 societies.

3.2 Dependent variables

We consider all three domains of PIAAC assessment, namely 1) literacy, 2) numeracy and 3) ICT problem solving. In PIAAC literacy is the ability to read effectively to participate in society and achieve personal goals (OECD, 2016). Special emphasis was given to the comprehension of digital texts displayed on screens that require navigation skills not needed to read traditional print. Example items include interpreting preschool rules or user guides for gym equipment. The literacy assessment did not include respondents' writing skills. Rather, test scores captured a range of basic through advanced comprehension skills, from reading brief texts for a single piece of information to synthesising information from complex texts, while making high-level inferences.

Numeracy in PIAAC is an ability to use mathematical concepts in everyday life. PIAAC respondents answered questions gauging numeracy at different proficiency levels ranging from simple sorting, arithmetic operations and recognising spatial representations in familiar contexts to understanding abstract mathematical and statistical ideas presented in complex contexts. Examples included interpreting graphical representations of trend data or science problems involving measurement.

PIAAC also assessed the ability to use digital technology to communicate with others as well as to gather, analyse and synthesise information. This domain involves a combination of broadly understood computer literacy and ICT problem-solving skills. Three types of problems were presented to respondents. The first involved evaluating the information available on the Internet for quality and credibility, the second called for the application of new technological tools such as spreadsheets for managing records, while the third involved technical knowledge related to the operation of computer or navigating the Internet. These skills are seen as "solving problems in technology-rich environments" (Desjardins, et al., 2013, Kankaraš, et al., 2016). France, Italy and Spain did not provide any data on adult skills in this domain and other societies had data for some respondents only. Hence our analysis of this domain involves only 106,585 respondents in contrast to 162,955 respondents who have data on literacy and numeracy (Supplementary materials Appendix Table 2 has descriptive statistics).

PIAAC has been criticised for overemphasising generic skills used out of the meaningful context of everyday lives as they may differ from the skills utilised in concrete social situations (Tsatsaroni and Evans, 2014). Nevertheless, the survey provides the best up-to-date

comparative data on adult literacy, numeracy and technological problem-solving and as such is optimal for our purposes. We use ten plausible values (OECD, 2016), standardized in the pooled file in a manner that preserves their original variation.

3.3 Independent variables

Following prior studies of scholarly culture, we focus on the question about the number of books respondents had at home in adolescence. All PIAAC respondents older than 16 were asked: *About how many books were there in your home when you were 16 years old? Do not include magazines, newspapers or schoolbooks. To give an estimation, one metre of shelving is about 40 books*. Answer categories were: *10 books or less; between 11 and 25 books; between 26 and 100 books; between 101 and 200 books; between 201 and 500; more than 500 books*. We control for gender, age, parental education in years obtained by averaging maternal and paternal education and respondent's education in years (OECD, 2016). Educational variables have been constructed based on PIAAC documentation for particular societies. We also control for respondents' occupational status in ISEI scores (Ganzeboom, et al., 1992, Ganzeboom and Treiman, 2010). To ensure that the measure of home library in adolescence does not reflect the variation in the intensity of adult activities, undertaken daily, which maintain literacy, numeracy and technology skills, we use as control variables three OECD indices (OECD, 2016). The first is an eight-item index of reading skills used at home, that reflects reading basic and complex materials e.g. instructions, emails and professional publications. The second is a six-item index of numeracy skills used at home that gauges the frequency of calculating prices, budgets, using formulas, algebra or calculus. The third is a six-item index of ICT skills used at home, which indicates how often respondents used email, made purchases online, used spreadsheet software or participated in real-time discussions on the Internet. Answer categories for all index items were: *Never, Less than once a month, Less than once a week but at least once a month, At least once a week but not every day* and *Every day*. Higher values of each index denote higher frequency (OECD, 2016). Prior to imputing some missing values (Appendix Table 1), we standardised all independent variables except for the number of books and respondents' education as these are our key predictors for which standardization obscures interpretability. Additionally, gender was left as a dummy variable. Standardisation makes no difference to the substance of our results. In additional analyses, we considered models which control for work-related activities (i.e. reading, numeracy and ICT used at work) but their results are comparable to what we present here so we have opted

for more parsimonious models. Moreover, work-related variables are available only for sub-samples of respondents.

3.4 Omitted variables and measurement error

We have no data on the types of books held in home libraries, although these matter, and people in bookish households are more likely than others to read poetry, science, mathematics or technology texts (de Graaf, 1986). Instead, we must focus on the boundaries between people who surround themselves with many books and those who do not.

Cross-sectional data with retrospective indicators of scholarly culture are affected by measurement error and indicators could reflect unmeasured influence of other confounding variables which may lead to over-optimistic estimates (de Vries and de Graaf, 2008). However, prior research using longitudinal data from Australia with corrections for measurement error showed that a substantial impact of home library size on adult education existed net of the effects of academic ability (IQ) of adults or their father's scholarly habitus (i.e. employment in occupations where use of books is common) as well as family income or wealth (Evans, et al., 2010). Although we have no means of correcting for these potential biases in ways available in longitudinal data, we argue that even somewhat optimistic estimates are of value as an initial step in proposing and assessing hypotheses for future, more stringent tests. To limit the potential for confounding adolescent and adult literacy-enhancing activities, we control for adult daily out-of-work activities related to literacy, numeracy and ICT skills that might correlate with scholarly culture experienced in adolescence but are indicators of adult scholarly culture.

3.5 Method

We use ordinary least squares regressions with balanced repeated replicate (BRR) weights that correct for the complex designs of PIAAC samples which vary from society to society (Avvisati and Keslair, 2017, OECD, 2016). In pooled analysis we rely on senate weights which adjust for complex sample design and ensure that each society contributes equally to the analysis. To maximise the use of available information we imputed the missing data on independent variables separately in each society (see Supplementary materials Appendix Table 1), utilising chained equations and generating 10 imputed datasets to match the number of plausible values (Royston, 2004). Most analyses, we present, comprised fitting ten models, one for each plausible value, and combining the coefficients using the Rubin rule

(Little and Rubin, 1987). The substantive results are the same regardless of whether we use the imputed data or listwise deletion of missing values.

For reporting purposes, we convert the number of books into mid-category values of 5, 18, 63, 151, 351 and 650 and use a natural log to capture the effect of books in one coefficient. The value of 650 books was an arbitrary choice but other reasonable values make no difference to our results. Sensitivity analyses showed that using natural logs is as effective as using dummy variables in each country (see Supplementary materials Appendix Tables 3 through 5). Our full model for literacy is as follows:

Eq.1

Literacy = f(ln_Books_in_adolescence,
Parents'_education,
Respondent_education,
Respondent_occupation, Age, Female,
Reading_at_home)

Our models predicting numeracy and ICT problem solving skills are as above, except that we use the indices of numeracy activities at home and ICT activities at home, respectively, in lieu of the reading at home index.

4. Results

4.1 Home libraries vary in size from society to society

The reported adolescent exposure to books at home varies considerably from society to society (Table 1). Adults in Scandinavia and in some post-communist societies recall growing up with large home libraries. The average library size in Norway was 212 and in Sweden it was 210, in contrast to 192 in Denmark and 162 in Finland. Estonians grew up with 218 books on average and the Czechs with 204. On the other end of the spectrum, the average home library size in Turkey was 27 books, in Chile or Singapore 52 books, with the average across the 31 societies at 115 books.

[Table 1]

Evidently, what counts as a large home library, varies considerably depending on societal context. Nevertheless, these reports broadly correspond with reports in other data collections in different time periods, where the residents of post-Soviet and Scandinavian societies also reported larger home libraries than the denizens of English speaking parts of the world

(Evans, et al., 2015, Evans, et al., 2010). Local standards of bookishness matter for local practices and success at school, therefore our key conclusions are based on society-specific analyses with the pooled analyses serving merely as a convenient summary of what we establish, society-by-society, as nearly universal effects.

4.2 Greatest gains at the bottom: exposure to books in adolescence enhances adult literacy, numeracy and ICT skills

We begin from comparisons of unadjusted literacy, numeracy and problem-solving scores obtained by respondents who grew up in households with relatively few as opposed to many books (Figure 1a).

[Figure 1]

Growing up with almost no books is associated with literacy levels at about half a standard deviation below the mean in the pooled sample. Having had approximately 80 books in adolescent home library raises literacy levels to the average while from about 350 books onwards further growth in the library size is not associated with significant literacy gains.

The relationship is remarkably similar for numeracy and ICT skills (Figure 1b and 1c) but gains in ICT skills, associated with larger library sizes, are not as steep. While it may appear that bookishness matters less for digital competencies, the important caveat of the data about ICT skills, however, is that they are available only from a PIAAC subsample, which, on average, was two years younger than the entire sample, had more educated parents and more books in their adolescent libraries (152 versus 127). Thus, it is only to be expected that for this group of respondents, given the general pattern of smaller returns in the upper end of the distribution, the benefits will be more moderate. Notwithstanding that, the log-linear relationship between the number of books and the dependent variables holds for all three cognitive domains and the natural log of the average number of books represents well these relationships, when compared to a dummy variable specification, which we also considered (see Supplementary materials Appendix Tables 3 through 5). Therefore, we settled on using the natural log of books as our key independent variable.

4.3 Books in adolescence enhance adult literacy, numeracy and digital problem-solving: total and direct effects

In the pooled data the exposure to home libraries in adolescence explains about 17% of variance in adult literacy, 17% of variance in numeracy and about 8% of variance the ICT skills in the younger and better educated subsample (Model 1: Total effects in Table 2). The

books coefficient suggests that adult literacy raises by 0.274 of a standard deviation which means that when a library grows from 18 to 63 books, the literacy gain is about 0.34 of a standard deviation but when it grows from 350 to 650 books, the associated gain is only 0.17. The corresponding coefficients for numeracy and ICT skills are also sizeable, at 0.277 and 0.207, respectively, and imply the diminishing returns pattern stipulated by our first hypothesis, while contradicting the expectation that the elite benefit most from books as signals of cultural capital.

[Table 2]

Model 2 in Table 2 summarizes the direct effects and shows that home library size remains a significant predictor of adult literacy even after we control for adult education (each year of which raises adult literacy by 0.079 of a standard deviation), occupation, parental education, sex, age and routine reading that adults undertake outside of work. The effects of predictors other than books and respondents' education can be compared as they have been standardized to a common metric. While education is the strongest predictor (as shown later in path analyses), high occupational status and frequent home reading also enhance literacy. Women fall marginally behind men's literacy test scores; net of their socio-demographic characteristics. The literacy skills of older people are also somewhat weaker. The key conclusion here is that exposure to larger home libraries in adolescence has a positive direct effect on literacy, numeracy and ICT skills even when educational and occupational attainment of adults are controlled for. While much of the benefit is via attainment some of it is attainment-independent, in line with Hypothesis 2.

Auxiliary analyses, not shown in Table 2, demonstrate that in one third of PIAAC societies a negative interaction exists between respondents' education and the number of books in adolescence when literacy and numeracy are modelled as outcomes. This suggests that, in some locations, growing up with large libraries makes a particularly large contribution to adult competencies of people with lower educational credentials which further supports the logic of cultural mobility arguments when they are applied to intra-generational mobility.

The analysis presented here is, to our knowledge, the first to consider how home libraries matter for numeracy and the impact shown is no less than for literacy (but see: Braun, 2018), and it shows the net boost at 0.132 of a standard deviation. Other effects resemble the effects

of independent variables in the literacy model except for sex, as women lag behind men more in numeracy than literacy.

Books in adolescence enhance also adult ICT skills, which are generally stronger amongst the better educated and those in higher status occupations. The younger respondents who frequently undertake ICT activities outside of work, have the strongest ICT skills. A one-standard deviation growth in the index of ICT activity at home rises technological problem-solving skills by 0.170 of a standard deviation.

Overall, the direct effects in Table 2 are consistent with Hypothesis 3 which expected cumulative benefits of exposure to scholarly culture. Adolescent engagement with books at home enhances adult competencies not only via attainments and regular reading habits in adulthood (as shown later in our path analyses which estimate not only effects on literacy, but also adult education, occupation and reading at home) but also directly, as a lifelong propensity to routinely include books into one's cultural and material environment. Table 2 suggests that about 40% of the effect of books is not explained by socio-economic attainment or demographic factors, and even if this estimate is optimistic, its direction and nearly universal relevance (seen later in our society-specific results) supports the view that when bookishness becomes an integral part of early socialisation, it later enhances a specific suite of cognitive skills, through fostering the practice of surrounding oneself with books. This practice pays off in formal education in adolescence and it continues to benefit adults later in life in ways inherent to but also entirely independent of attainment-related returns.

4.4 Bookish adolescents with lower secondary education credentials become as literate, numerate and technologically apt in adulthood as university graduates who grew up with only a few books

Predicted values, or average partial estimates (Williams, 2012) based on Table 2, are in Figure 2 and illustrate the relative importance of scholarly culture and formal education for the cognitive outcomes. In the PIAAC cohort, people who were between 25 and 65 years of age between 2011 and 2015, grew up without any books, and managed to finish only lower secondary school (9 years) typically performed in the literacy test at about -0.55 of a standard deviation below the mean (Figure 2a). Their counterparts with university degrees had roughly average literacy levels (0.00). The same level of literacy was achieved by people who were surrounded by many books in adolescence but whose schooling ended in Year 9 (0.02). So, literacy-wise, bookish adolescence makes up for a good deal of educational advantage. Adults in their early forties (the average age in our PIAAC sample is nearly 45 years) from

bookish homes who completed university had, unsurprisingly, highest levels of literacy, at, roughly, half a standard deviation above the mean (0.57) with all other predictors kept at mean values. For gender we used the average proportion of women which was 51%, other means are in Appendix Table 2 in Supplementary materials.

[Figure 2]

The relative advantages of home libraries for adult numeracy mirror those for literacy (Figure 2b). Respondents with 9 years of education who grew up without books had numeracy levels less than half a standard deviation below the mean (-0.59). Their bookish counterparts had average numeracy skills (0.03) which is close to the expected value for university-educated respondents who grew up with very few books (-0.01). Thus, adolescent exposure to books compensates for shortcomings not only in adult literacy but also numeracy, which are equivalent to additional years of education.

The same pattern, albeit with less variation due to the restricted sample, holds also for the ICT skills (Figure 2c). Exposure to books in adolescence boosts technological competencies by over 0.4 of a standard deviation. This gain is similar for respondents with lower secondary and university education. What varies is the typical level of these skills in different respondent groups. Lower secondary education and no books in adolescence are associated with below average (-0.48) technology skills (this prediction is for people around 43 years of age, the values would be even lower for an older cohort). Lower secondary graduates who had plenty of books in their home, sport ICT skills comparable to those of their bookless but university-educated peers (-0.06 versus -0.14 in Figure 2c).

Overall, the impact of book-oriented socialisation is substantial. The details for each of the 31 societies are in Tables 3, 4 and 5 and these society-specific analyses are our main evidence. While some variation in society-specific predictors of literacy occurs (Table 3), the results on pooled data in Table 2 approximate well society-specific patterns. The total effects of home library size on literacy are large everywhere and the direct effect is insignificant only in Lithuania, where it is explained by occupational attainment (not shown in Table 3). As expected, respondents' education, occupational status and reading activities at home are strong predictors of superior literacy nearly everywhere, but respondents clearly benefit from adolescent exposure to books above and beyond these effects.

[Table 3] [Table 4] [Table 5]

Table 4, which shows society-by-society estimates for numeracy, also lends credence to the message in the pooled model: both total and direct effects of home library sizes are sizeable in each society without exception. Finally, bookishness directly enhances ICT skills in many societies even in the younger and more socially select sub-sample (Model 2 in Table 5), although the impact is not as steep as for literacy and numeracy. This holds for all societies except Greece and Israel where the ICT benefits of growing up with books are explained entirely by respondents' occupational attainment.

4.5 How do adolescent libraries matter? Path analyses: Literacy as an example

Adolescent bookishness influences adult outcomes in many ways. The fully standardized coefficients from path analyses, estimated in Mplus 7 (Muthén and Muthén, 2013), show that adolescent home library size significantly enhances not only literacy, but also adult education, occupation and non-work routine reading activities (Figure 3). Because the patterns are similar for all three cognitive domains, the results for numeracy and ICT skills are in Supplementary materials (Appendix Figures 1 and 2).

Indirectly, books benefit literacy mostly through educational, but also through occupational attainment as well as a boost from routine reading practices undertaken by adults. Yet, the direct effect of books on literacy remains non-trivial at 0.171. The coefficient depicting the enhancement of adult reading habits by adolescent exposure to books is 0.158, with the greatest benefit occurring for educational attainment 0.323 in contrast to 0.068 for occupational status. Here, the reading habits indicator is a predictor of literacy because it gauges the frequency of activities that precede literacy tests taken by PIAAC respondents. In sum, the benefits of bookishness for attainment are beyond question. The direct effects of books on adult literacy and reading habits fit in with the scholarly culture argument but not with theories of elite closure that are central to traditional cultural capital arguments. Early exposure to books in parental home matters because books are an integral part of routines and practices which enhance life-long cognitive competencies.

5 Conclusion

5.1 Summary

Our results show that adolescent exposure to books is an integral part of social practices that foster long term cognitive competencies spanning literacy, numeracy and ICT skills, as anticipated by Hypothesis 2. These competencies facilitate educational and occupational

attainment, but they also lay a foundation for life-long routine activities that enhance literacy and numeracy, irrespective of attainment, as anticipated by Hypothesis 3. Our findings from 31 societies surveyed between 2011 and 2015 support the scholarly culture argument and stand in opposition to the theory of cultural closure/ cultural reproduction in which cultural capital has no relationship to concrete skills and, instead, functions as a signal that legitimises the social exclusion of non-elite persons. These results are robust to sensitivity tests and they also corroborate the expectation from scholarly culture theory that the first few books make the greatest contribution to cognitive skills of all three kinds, as Hypothesis 1 predicted. In other words, home library size has a loglinear effect on cognitive, numerical, and problem-solving skills that endure throughout life.

Of course, our data are not perfect: they have only a single indicator (rather than multiple indicators) of scholarly culture; retrospective data are not perfectly reliable, and our key indicator could incorporate unmeasured heterogeneity in family backgrounds. These issues all call for replication of this analysis with data that address these deficiencies.

5.2 Discussion: The future of scholarly culture

We must consider the possibility that as knowledge societies move towards digital literacy and numeracy, the consumption of printed materials and books will become obsolete as an indicator of scholarly culture. For now, however, the beneficial effects of home libraries in adolescence are large and hold in many different societies with no sign of diminution over time. Moreover, home library size is positively related to higher levels of digital literacy so, the evidence suggests that for some time to come, engagement with material objects of scholarly culture in parental homes, i.e. books, will continue to confer significant benefits for adult ICT competencies. In the US, over 80% of readers who used e-books 2011 already read many print books which they supplemented with digital reading (Zhang and Kudva, 2014). Indeed, recent research indicates that reading printed rather than digital texts enhances comprehension and retention of information (Mangen, et al., 2013). Specifically, metanalyses of studies, that compare reading of print and digital material, point to the advantages of reading books for deeper comprehension of complex content (Singer and Alexander, 2017), retrieving specific information (Mangen, et al., 2013), and facilitating shared family reading time (Kucirkova and Littleton, 2016).

Therefore, future surveys should include not only questions about the possession of printed books and e-readers, as was done in Programme for International Student Assessment 2015,

but also collect information about the use of audio books, e-books, and printed books, distinguishing also their type of content. For the time being, however, the perception that social practice of print book consumption is passé is premature.

5.3 Discussion: How does scholarly culture confer cognitive skills?

Now that we have established that scholarly culture as indicated by the size of home libraries, confers enduring cognitive skills in literacy, numeracy, and technology, the next burning question becomes: "How does this come about?"

We will propose some possibilities for future research on engagement with digital and printed books. Role modelling: Children emulate parents who read (de Graaf, 1986, de Graaf, 1988). Acquisition of specific strategies proposed by significant others or discovered in books themselves: children build "toolkits" of strategies that they apply in multiple situations (Swidler, 1986). Stimulation of cognitive skills through family social practices: books are interwoven with positive affect, specific mental activities, know-how, and motivational states (Reckwitz, 2002). Storytelling, imaginative play, charades, and vocabulary development come to mind (Evans, et al., 2010). We suggest that scholarly culture is a way of life rather than concerted cultivation (Lareau, 2011).

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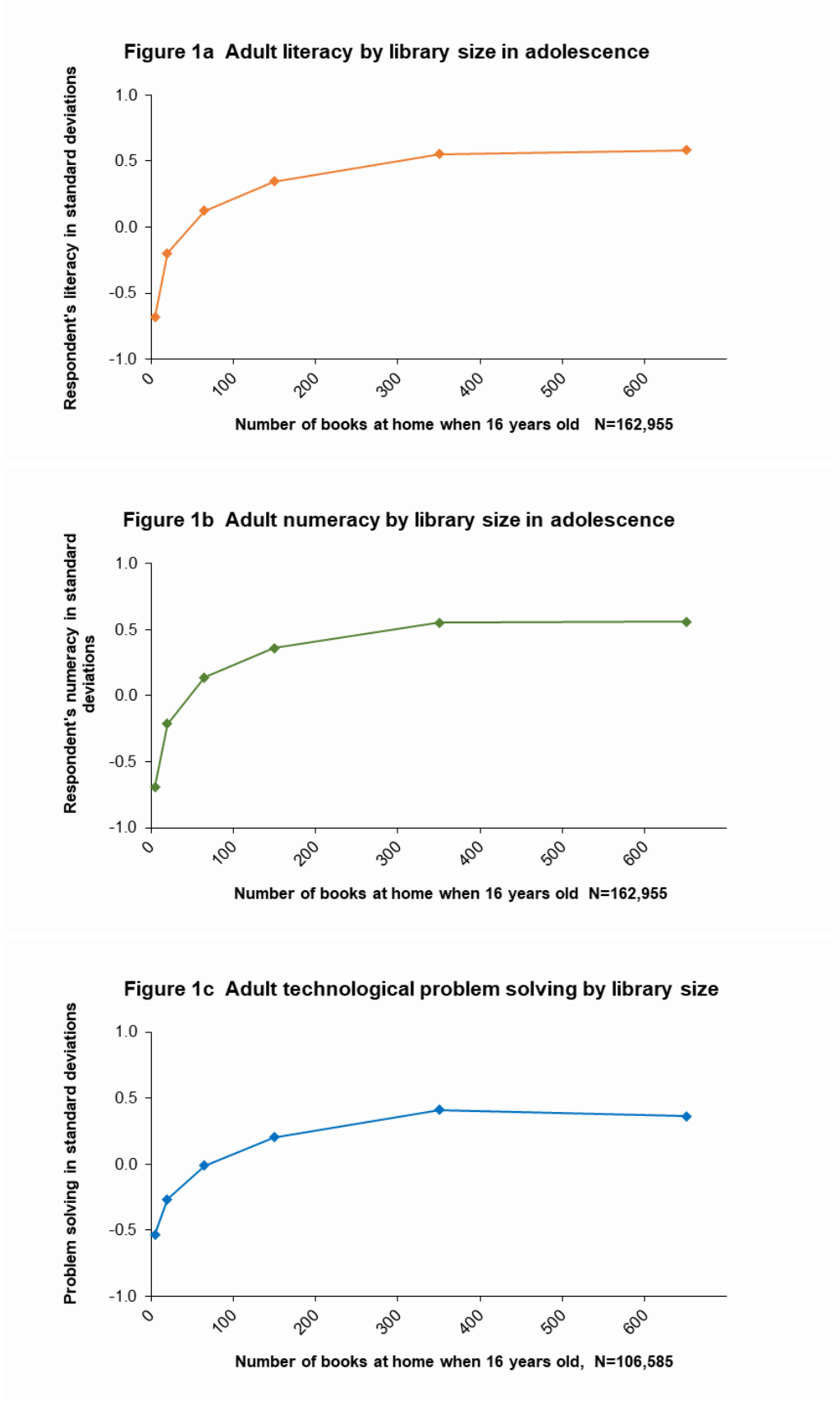
Table 1. Home library size in adolescence: percentages and means for 31 societies, PIAAC 2011-2015

Number of books	Around 5	Around 20	Around 65	Around 150	Around 350	500 +	Mean	Std. Dev.	N
	%	%	%	%	%	%			
Australia	13	13	35	18	13	7	148	178	6465
Austria	15	18	33	15	11	7	131	173	4133
Belgium	26	21	30	11	9	4	95	145	4051
Canada	18	16	33	16	12	5	125	163	22059
Chile	46	23	21	6	3	2	52	110	4136
Czech Republic	2	6	33	27	22	10	204	186	4602
Denmark	9	12	29	21	19	11	192	201	6221
Estonia	4	9	28	23	22	13	218	205	6240
Finland	9	14	34	18	16	8	162	183	4569
France	22	17	31	14	9	6	117	167	5811
Germany	12	15	34	17	14	8	151	180	4316
Greece	37	23	26	7	5	2	62	114	4235
Ireland	23	18	31	13	10	4	107	154	5210
Israel	17	14	29	18	14	9	153	187	4009
Italy	32	23	26	11	5	3	75	127	4064
Japan	18	20	36	12	9	4	102	146	4403
Korea	23	19	35	13	7	3	91	134	5584
Lithuania	15	23	35	14	9	5	109	151	4369
Netherlands	16	15	29	16	15	8	154	188	4196
New Zealand	12	12	33	18	16	9	166	190	4804
Norway	6	9	30	22	20	14	212	208	3982
Poland	16	20	35	15	10	4	111	149	4892
Russian Federation	7	15	35	22	14	7	154	174	2653
Singapore	40	23	27	6	3	1	52	98	4319
Slovak Republic	11	18	38	19	10	4	117	143	4566
Slovenia	24	21	33	13	7	4	92	139	4457
Spain	22	21	33	12	9	4	102	152	4979
Sweden	8	9	29	21	21	13	210	207	3627
Turkey	60	21	13	4	1	0	27	62	4335
United Kingdom	15	16	33	16	13	7	143	179	7585
United States	20	18	32	15	9	5	114	159	4083
Pooled data	21	18	32	15	10	5	115	160	162955

Figure 1. Adult numeracy, literacy and ICT problem solving skills by home library size in adolescence: pooled data



Data: PIAAC 2011-2015

Table 2. OLS models with BRR weights predicting adult literacy, numeracy, and ICT problem-solving. Pooled data for 31 societies, PIAAC 2011-2015

	Literacy		Numeracy		ICT skills	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Model 1: Total effects						
Books ln	0.274**	0.005	0.277**	0.004	0.207**	0.009
Constant	-1.046**	0.021	-1.059**	0.019	-0.859**	0.037
R-squared	0.17		0.17		0.08	
Model 2: Direct effects						
Books ln	0.116**	0.007	0.129**	0.005	0.091**	0.009
Education years	0.079**	0.003	0.083**	0.003	0.052**	0.005
Parental education	0.060**	0.008	0.025**	0.008	0.060**	0.009
Occupation ISEI	0.100**	0.009	0.119**	0.008	0.148**	0.011
Female	-0.042**	0.014	-0.223**	0.014	-0.120**	0.017
Age	-0.050**	0.007	-0.032**	0.007	-0.184**	0.012
Reading at home	0.085**	0.008				
Numeracy at home			0.096**	0.007		
ICT use at home					0.170**	0.014
Constant	-1.405**	0.038	-1.412**	0.037	-1.114**	0.073
R-squared	0.32		0.34		0.25	
N of respondents	162,955		162,955		106,585	
N of societies	31		31		28	

**Coefficients statistically significant at p=0.01

Note: All independent variables standardized to a common metric except books in natural logs and education in years

Figure 2. Predicted literacy, numeracy and ICT problem solving gains for respondents with different educational attainment who grew up in homes with different library sizes, based on Table 2

Figure 2a: Predicted literacy gains

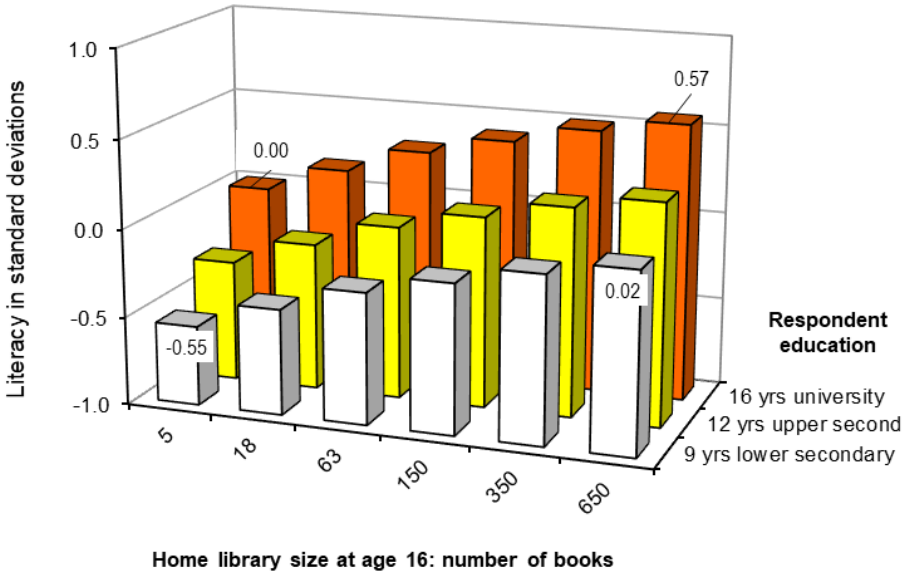


Figure 2b: Predicted numeracy gains

Figure 2 continued next page

Figure 2c: ICT problem solving gains

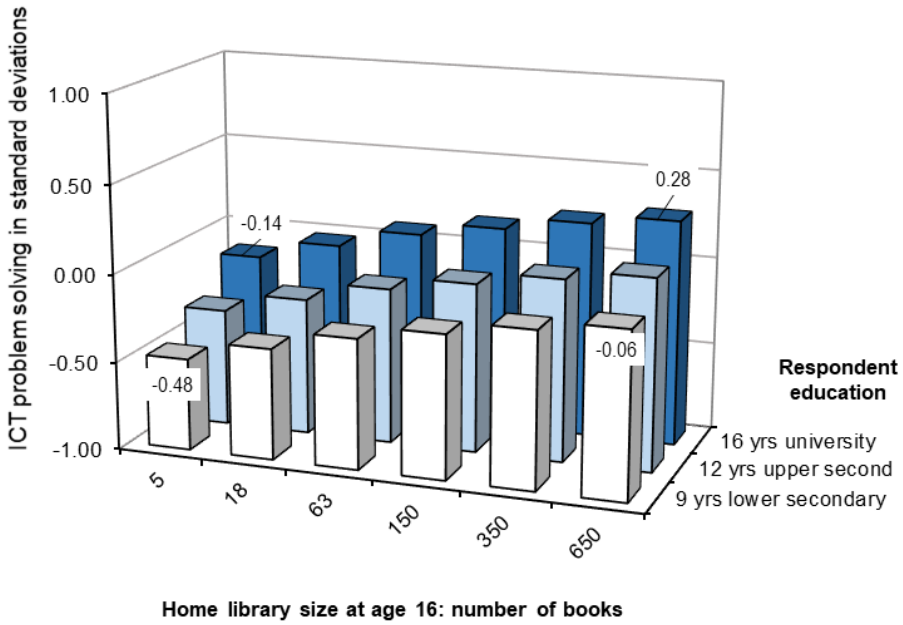


Table 3. Adult literacy regressed on home library size in adolescence: total and direct effects

Literacy	Model 1: Total effects			Model 2: Direct effects													
	Books ln			Books ln		Education		Parental education		Occupation		Reading at home		Female		Age			
	Coef.	S.E.	R^2	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	R^2	N
Australia	0.27**	0.01	0.14	0.14**	0.01	0.09**	0.01	-0.013	0.017	0.19**	0.02	0.19**	0.02	-0.09**	0.03	-0.10**	0.02	0.32	6465
Austria	0.26**	0.01	0.17	0.11**	0.01	0.05**	0.01	0.062**	0.019	0.19**	0.02	0.14**	0.02	-0.06	0.03	-0.14**	0.01	0.31	4133
Belgium	0.22**	0.01	0.12	0.06**	0.01	0.10**	0.01	0.068**	0.015	0.16**	0.02	0.14**	0.02	-0.11**	0.03	-0.14**	0.02	0.38	4051
Canada	0.26**	0.01	0.13	0.12**	0.01	0.09**	0.01	0.021	0.012	0.20**	0.02	0.19**	0.01	-0.12**	0.03	-0.10**	0.01	0.33	22059
Chile	0.30**	0.02	0.15	0.07**	0.03	0.12**	0.01	0.001	0.045	0.12**	0.03	0.07**	0.02	-0.17**	0.05	-0.15**	0.03	0.41	4136
Czech Republic	0.23**	0.02	0.09	0.09**	0.02	0.08**	0.01	0.001	0.032	0.10**	0.03	0.14**	0.03	-0.04	0.04	-0.12**	0.02	0.27	4602
Denmark	0.26**	0.01	0.13	0.11**	0.01	0.07**	0.01	0.028**	0.014	0.17**	0.02	0.23**	0.02	-0.04	0.02	-0.16**	0.01	0.34	6221
Estonia	0.25**	0.01	0.12	0.11**	0.01	0.08**	0.01	0.019	0.012	0.09**	0.01	0.10**	0.02	-0.05	0.03	-0.10**	0.01	0.25	6240
Finland	0.28**	0.02	0.13	0.09**	0.02	0.07**	0.01	0.007	0.024	0.18**	0.02	0.20**	0.03	0.02	0.04	-0.25**	0.02	0.34	4569
France	0.28**	0.01	0.17	0.09**	0.01	0.09**	0.00	0.036**	0.016	0.14**	0.01	0.15**	0.02	-0.02	0.02	-0.13**	0.01	0.38	5811
Germany	0.30**	0.01	0.18	0.11**	0.01	0.09**	0.01	0.031	0.021	0.15**	0.02	0.19**	0.02	-0.06**	0.03	-0.16**	0.02	0.38	4316
Greece	0.19**	0.01	0.08	0.08**	0.02	0.05**	0.01	0.082**	0.027	0.05	0.03	0.06**	0.02	0.11**	0.04	0.08**	0.03	0.15	4235
Ireland	0.25**	0.01	0.15	0.10**	0.01	0.09**	0.01	0.026	0.020	0.11**	0.02	0.13**	0.02	-0.11**	0.03	-0.02	0.02	0.31	5210
Israel	0.27**	0.01	0.12	0.08**	0.01	0.09**	0.01	0.078**	0.018	0.22**	0.02	0.13**	0.02	-0.13**	0.03	-0.22**	0.02	0.35	4009
Italy	0.25**	0.01	0.15	0.10**	0.01	0.07**	0.01	-0.044	0.033	0.06**	0.02	0.09**	0.02	0.01	0.04	-0.04	0.02	0.27	4064
Japan	0.20**	0.01	0.11	0.08**	0.01	0.10**	0.01	-0.011	0.016	0.08**	0.02	0.11**	0.02	0.01	0.03	-0.22**	0.02	0.33	4403
Korea	0.23**	0.01	0.15	0.06**	0.01	0.07**	0.00	0.026	0.015	0.10**	0.02	0.08**	0.01	-0.08**	0.02	-0.15**	0.01	0.36	5584
Lithuania	0.16**	0.01	0.06	0.02	0.02	0.04**	0.01	0.073**	0.019	0.09**	0.02	0.16**	0.03	0.03	0.03	-0.04**	0.02	0.19	4369
Netherlands	0.28**	0.01	0.18	0.12**	0.01	0.10**	0.01	0.002	0.018	0.19**	0.02	0.15**	0.03	-0.10**	0.03	-0.20**	0.02	0.41	4196
New Zealand	0.26**	0.01	0.14	0.15**	0.01	0.08**	0.01	0.022	0.015	0.23**	0.02	0.12**	0.02	-0.05	0.03	-0.09**	0.02	0.32	4804
Norway	0.30**	0.01	0.16	0.15**	0.01	0.06**	0.01	0.039**	0.016	0.22**	0.02	0.18**	0.03	-0.08**	0.03	-0.13**	0.02	0.32	3982
Poland	0.27**	0.01	0.15	0.08**	0.02	0.08**	0.01	0.037	0.025	0.11**	0.02	0.09**	0.02	0.03	0.03	-0.06**	0.02	0.29	4892
Russian Federation	0.14**	0.02	0.04	0.11**	0.03	0.01	0.01	0.023	0.027	-0.02	0.03	0.13**	0.04	0.06	0.04	0.06**	0.02	0.08	2653
Singapore	0.33**	0.01	0.13	0.04**	0.01	0.16**	0.01	-0.001	0.020	0.22**	0.02	0.15**	0.02	-0.06**	0.03	-0.16**	0.02	0.53	4319
Slovak Republic	0.25**	0.01	0.16	0.11**	0.01	0.07**	0.01	0.071**	0.020	0.01	0.02	0.12**	0.02	0.01	0.02	-0.02	0.01	0.25	4566
Slovenia	0.25**	0.01	0.13	0.05**	0.01	0.13**	0.01	0.097**	0.016	0.12**	0.02	0.11**	0.02	-0.06**	0.03	-0.11**	0.02	0.33	4457
Spain	0.31**	0.01	0.20	0.11**	0.01	0.09**	0.01	-0.015	0.020	0.12**	0.02	0.11**	0.02	-0.11**	0.03	-0.11**	0.01	0.37	4979
Sweden	0.35**	0.01	0.20	0.20**	0.02	0.08**	0.01	-0.007	0.016	0.20**	0.02	0.16**	0.03	-0.10**	0.04	-0.14**	0.02	0.35	3627
Turkey	0.27**	0.02	0.11	0.10**	0.02	0.08**	0.01	-0.019	0.041	0.03	0.02	0.07**	0.02	-0.14**	0.05	-0.09**	0.03	0.25	4335
United Kingdom	0.26**	0.01	0.15	0.15**	0.01	0.05**	0.01	0.057**	0.022	0.25**	0.02	0.16**	0.02	-0.07**	0.03	-0.05**	0.02	0.29	7585
United States	0.29**	0.02	0.18	0.10**	0.01	0.10**	0.01	0.128**	0.021	0.18**	0.02	0.08**	0.02	-0.05	0.03	-0.05**	0.01	0.39	4083

**Coefficients statistically significant at p=0.01, constants and their SE not shown due to space constraints but available from the authors upon request

Table 4. Adult numeracy regressed on home library size in adolescence: total and direct effects

	Model 1: Total effects			Model 2: Direct effects														
Numeracy	Books ln			Books ln		Education		Parental education		Occupation		Numeracy at home		Female		Age		
	Coef.	S.E.	R^2	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	R^2	N
Australia	0.27**	0.01	0.13	0.14**	0.01	0.08**	0.01	0.002	0.017	0.20**	0.02	0.21**	0.02	-0.29**	0.03	-0.06**	0.02	0.35	6465
Austria	0.24**	0.01	0.15	0.11**	0.01	0.07**	0.01	0.039	0.022	0.19**	0.02	0.16**	0.02	-0.19**	0.03	-0.07**	0.01	0.31	4133
Belgium	0.20**	0.01	0.10	0.05**	0.01	0.10**	0.01	0.049**	0.016	0.15**	0.02	0.13**	0.02	-0.28**	0.03	-0.11**	0.02	0.39	4051
Canada	0.24**	0.01	0.12	0.11**	0.01	0.10**	0.01	0.032**	0.013	0.19**	0.01	0.19**	0.01	-0.31**	0.02	-0.07**	0.01	0.35	22059
Chile	0.33**	0.03	0.17	0.08**	0.02	0.13**	0.01	-0.004	0.035	0.16**	0.03	0.13**	0.03	-0.38**	0.04	-0.14**	0.02	0.52	4136
Czech Republic	0.27**	0.02	0.13	0.13**	0.02	0.09**	0.01	0.014	0.026	0.11**	0.03	0.13**	0.03	-0.16**	0.04	-0.09**	0.02	0.34	4602
Denmark	0.23**	0.01	0.11	0.10**	0.01	0.08**	0.01	0.014	0.014	0.16**	0.02	0.18**	0.02	-0.21**	0.03	-0.07**	0.01	0.32	6221
Estonia	0.24**	0.01	0.12	0.09**	0.01	0.09**	0.01	0.031**	0.012	0.11**	0.01	0.15**	0.01	-0.18**	0.02	-0.05**	0.01	0.31	6240
Finland	0.24**	0.01	0.11	0.08**	0.01	0.06**	0.01	0.006	0.022	0.19**	0.02	0.23**	0.02	-0.19**	0.03	-0.15**	0.02	0.34	4569
France	0.29**	0.01	0.18	0.09**	0.01	0.10**	0.01	0.024	0.017	0.19**	0.01	0.18**	0.01	-0.20**	0.02	-0.07**	0.01	0.45	5811
Germany	0.29**	0.01	0.17	0.10**	0.01	0.11**	0.01	0.025	0.020	0.14**	0.03	0.21**	0.02	-0.23**	0.03	-0.11**	0.01	0.43	4316
Greece	0.19**	0.01	0.09	0.06**	0.02	0.07**	0.01	0.045	0.026	0.09**	0.03	0.07**	0.02	-0.11**	0.04	0.06**	0.02	0.22	4235
Ireland	0.25**	0.01	0.14	0.10**	0.01	0.09**	0.01	0.029	0.020	0.13**	0.02	0.13**	0.02	-0.27**	0.03	-0.01	0.02	0.32	5210
Israel	0.27**	0.01	0.12	0.08**	0.02	0.10**	0.01	0.077**	0.022	0.21**	0.02	0.16**	0.02	-0.31**	0.04	-0.14**	0.02	0.35	4009
Italy	0.26**	0.01	0.17	0.13**	0.01	0.07**	0.01	-0.086**	0.029	0.08**	0.03	0.10**	0.02	-0.23**	0.03	-0.05**	0.02	0.31	4064
Japan	0.19**	0.01	0.11	0.08**	0.01	0.10**	0.01	-0.007	0.018	0.12**	0.02	0.12**	0.01	-0.17**	0.03	-0.11**	0.01	0.31	4403
Korea	0.23**	0.01	0.15	0.06**	0.01	0.09**	0.01	0.020	0.015	0.11**	0.01	0.08**	0.01	-0.14**	0.02	-0.12**	0.01	0.38	5584
Lithuania	0.23**	0.01	0.12	0.07**	0.01	0.06**	0.01	0.092**	0.018	0.14**	0.02	0.15**	0.02	-0.08**	0.03	-0.06**	0.02	0.29	4369
Netherlands	0.25**	0.01	0.16	0.11**	0.01	0.10**	0.01	-0.014	0.016	0.16**	0.02	0.15**	0.01	-0.24**	0.02	-0.10**	0.01	0.41	4196
New Zealand	0.28**	0.01	0.15	0.17**	0.01	0.08**	0.01	0.019	0.014	0.23**	0.02	0.17**	0.02	-0.27**	0.03	-0.05**	0.02	0.36	4804
Norway	0.30**	0.01	0.15	0.16**	0.02	0.08**	0.01	0.019	0.018	0.20**	0.02	0.16**	0.02	-0.24**	0.03	-0.05**	0.02	0.33	3982
Poland	0.26**	0.01	0.15	0.09**	0.01	0.08**	0.01	0.037	0.026	0.09**	0.02	0.16**	0.02	-0.13**	0.03	-0.02	0.02	0.29	4892
Russian Federation	0.13**	0.02	0.05	0.09**	0.03	0.03**	0.01	0.006	0.022	0.01	0.03	0.12**	0.03	0.01	0.04	0.03	0.02	0.09	2653
Singapore	0.34**	0.01	0.13	0.05**	0.01	0.19**	0.01	-0.008	0.018	0.26**	0.02	0.12**	0.02	-0.16**	0.03	-0.13**	0.02	0.58	4319
Slovak Republic	0.30**	0.01	0.19	0.14**	0.01	0.08**	0.01	0.067**	0.022	0.05**	0.02	0.16**	0.01	-0.08**	0.02	0.01	0.01	0.33	4566
Slovenia	0.27**	0.01	0.15	0.07**	0.01	0.16**	0.01	0.085**	0.022	0.12**	0.02	0.13**	0.02	-0.19**	0.03	-0.11**	0.02	0.37	4457
Spain	0.30**	0.01	0.21	0.12**	0.01	0.08**	0.01	-0.031	0.019	0.12**	0.02	0.11**	0.01	-0.26**	0.03	-0.09**	0.01	0.41	4979
Sweden	0.32**	0.01	0.18	0.18**	0.01	0.08**	0.01	-0.015	0.017	0.20**	0.02	0.17**	0.02	-0.26**	0.03	-0.06**	0.02	0.34	3627
Turkey	0.33**	0.02	0.12	0.12**	0.02	0.10**	0.01	-0.008	0.049	0.08**	0.03	0.09**	0.02	-0.39**	0.05	-0.11**	0.04	0.35	4335
United Kingdom	0.26**	0.01	0.14	0.15**	0.01	0.04**	0.01	0.055**	0.020	0.27**	0.02	0.18**	0.02	-0.28**	0.03	0.01	0.02	0.32	7585
United States	0.31**	0.02	0.19	0.11**	0.01	0.11**	0.01	0.121**	0.020	0.17**	0.02	0.17**	0.02	-0.30**	0.03	-0.02	0.01	0.43	4083

**Coefficients statistically significant at p=0.01, constants and their SE not shown due to space constraints but available from the authors upon request

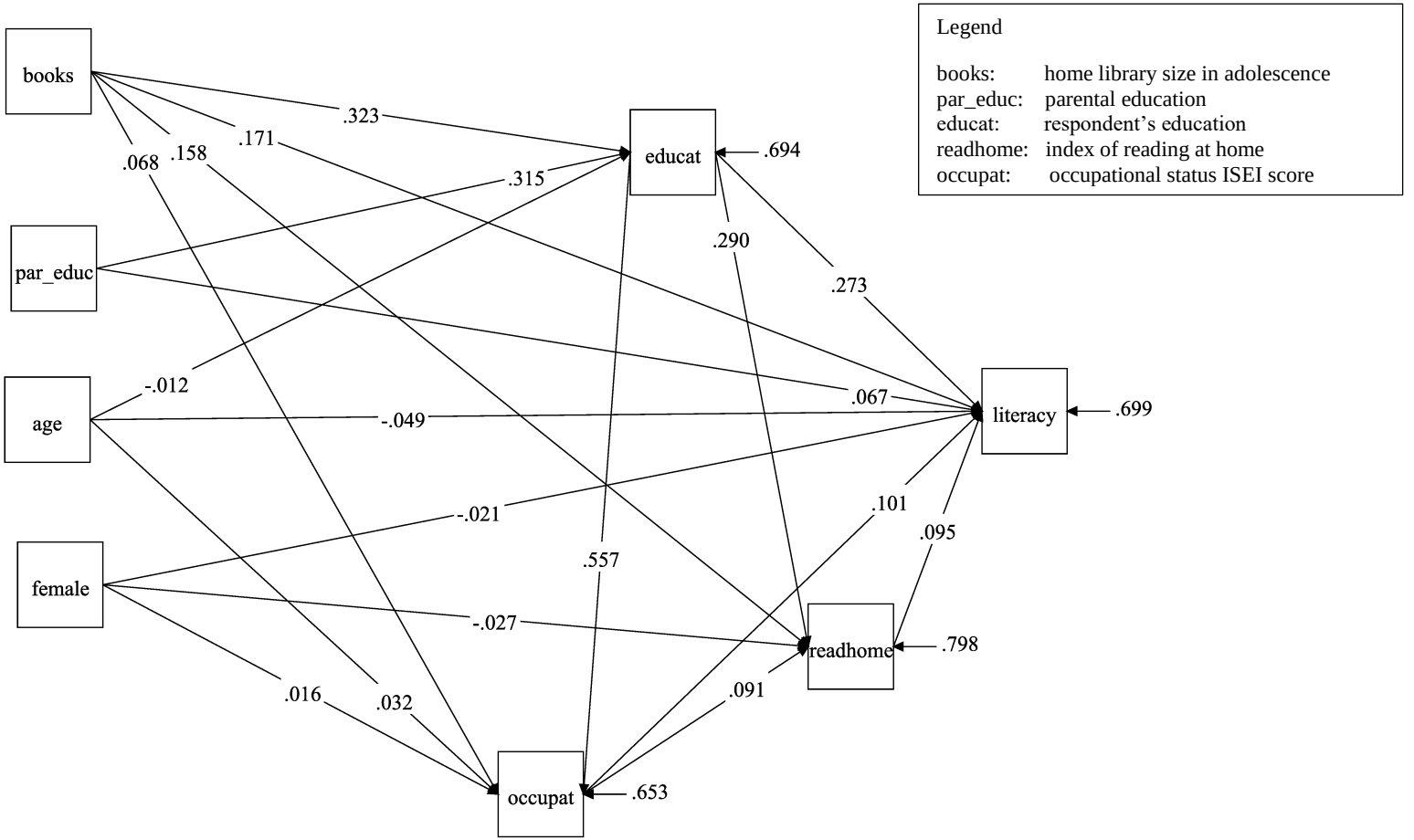
Table 5. Adult information and communication technology problem solving skills regressed on home library size in adolescence: total and direct effects

	Model 1: Total effects			Model 2: Direct effects														
ICT skills	Books ln			Books ln		Education		Parental education		Occupation		ICT at home		Female		Age		
	Coef.	S.E.	R^2	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	R^2	N
Australia	0.20**	0.01	0.09	0.13**	0.01	0.05**	0.01	-0.01	0.02	0.16**	0.02	0.17**	0.02	-0.07	0.04	-0.16**	0.02	0.27	4775
Austria	0.21**	0.01	0.11	0.11**	0.02	0.04**	0.01	0.04	0.02	0.13**	0.02	0.17**	0.02	-0.19**	0.03	-0.27**	0.02	0.32	3023
Belgium	0.16**	0.01	0.06	0.04**	0.01	0.07**	0.01	0.06**	0.02	0.14**	0.02	0.25**	0.02	-0.14**	0.03	-0.30**	0.02	0.39	3283
Canada	0.21**	0.01	0.08	0.10**	0.01	0.06**	0.01	0.04**	0.01	0.17**	0.02	0.23**	0.02	-0.10**	0.03	-0.19**	0.01	0.27	17026
Chile	0.26**	0.02	0.11	0.07**	0.02	0.09**	0.02	0.09**	0.04	0.12**	0.05	0.17**	0.03	-0.18**	0.06	-0.31**	0.04	0.38	2399
Czech Republic	0.27**	0.03	0.07	0.11**	0.03	0.05**	0.01	0.11**	0.04	0.18**	0.03	0.16**	0.03	-0.10	0.05	-0.24**	0.02	0.27	3269
Denmark	0.23**	0.01	0.10	0.10**	0.01	0.06**	0.01	0.02	0.02	0.15**	0.01	0.21**	0.02	-0.13**	0.03	-0.33**	0.02	0.38	5123
Estonia	0.27**	0.01	0.10	0.11**	0.01	0.06**	0.01	0.07**	0.01	0.13**	0.02	0.19**	0.02	-0.11**	0.04	-0.27**	0.02	0.33	3963
Finland	0.25**	0.01	0.10	0.07**	0.01	0.06**	0.01	0.04	0.02	0.15**	0.02	0.24**	0.03	-0.08**	0.03	-0.39**	0.02	0.44	3647
Germany	0.26**	0.02	0.12	0.10**	0.02	0.06**	0.01	0.03	0.02	0.18**	0.03	0.24**	0.02	-0.12**	0.04	-0.27**	0.02	0.37	3510
Greece	0.15**	0.02	0.04	-0.01	0.03	0.07**	0.01	0.04	0.04	0.08**	0.04	0.22**	0.04	0.05	0.05	-0.07**	0.03	0.18	2557
Ireland	0.24**	0.01	0.13	0.11**	0.01	0.08**	0.01	0.03**	0.01	0.10**	0.02	0.18**	0.02	-0.16**	0.03	-0.19**	0.02	0.35	3430
Israel	0.17**	0.02	0.04	0.02	0.02	0.05**	0.01	0.11**	0.03	0.20**	0.04	0.26**	0.03	-0.12**	0.05	-0.26**	0.02	0.27	2564
Japan	0.15**	0.02	0.04	0.06**	0.02	0.08**	0.01	0.03	0.02	0.11**	0.03	0.19**	0.03	-0.19**	0.04	-0.40**	0.03	0.30	2720
Korea	0.16**	0.01	0.06	0.04**	0.01	0.06**	0.01	0.04**	0.02	0.10**	0.02	0.11**	0.01	-0.17**	0.03	-0.30**	0.03	0.29	3533
Lithuania	0.24**	0.02	0.10	0.05**	0.02	0.04**	0.01	0.10**	0.02	0.12**	0.03	0.29**	0.03	-0.05	0.04	-0.14**	0.02	0.37	3018
Netherlands	0.22**	0.01	0.12	0.09**	0.01	0.07**	0.01	0.01	0.02	0.15**	0.02	0.23**	0.02	-0.14**	0.03	-0.26**	0.02	0.39	3699
New Zealand	0.24**	0.01	0.10	0.15**	0.01	0.05**	0.01	0.03	0.02	0.21**	0.02	0.19**	0.02	-0.03	0.04	-0.23**	0.02	0.29	4301
Norway	0.28**	0.01	0.15	0.14**	0.01	0.07**	0.01	0.01	0.02	0.16**	0.02	0.19**	0.02	-0.13**	0.03	-0.30**	0.02	0.40	3424
Poland	0.24**	0.03	0.07	0.07**	0.03	0.07**	0.02	0.10**	0.04	0.15**	0.04	0.11**	0.04	-0.25**	0.06	-0.23**	0.03	0.24	2446
Russian Federation	0.14**	0.04	0.02	0.07	0.05	0.01	0.01	-0.02	0.04	0.02	0.05	0.21**	0.04	0.08	0.10	-0.03	0.06	0.08	1737
Singapore	0.20**	0.01	0.07	0.05**	0.01	0.12**	0.01	0.01	0.02	0.16**	0.02	0.12**	0.02	-0.09**	0.03	-0.31**	0.02	0.39	3046
Slovak Republic	0.19**	0.02	0.06	0.09**	0.02	0.06**	0.01	0.07**	0.03	0.04	0.03	0.04	0.02	-0.07	0.04	-0.09**	0.02	0.14	2560
Slovenia	0.28**	0.02	0.12	0.09**	0.02	0.12**	0.02	0.12**	0.02	0.16**	0.03	0.18**	0.03	-0.14**	0.03	-0.28**	0.02	0.37	3176
Sweden	0.32**	0.02	0.16	0.15**	0.01	0.07**	0.01	-0.01	0.02	0.19**	0.02	0.22**	0.02	-0.13**	0.03	-0.31**	0.02	0.42	3155
Turkey	0.18**	0.02	0.06	0.04	0.02	0.05**	0.01	0.15**	0.05	0.04	0.04	0.15**	0.04	0.06	0.07	-0.10**	0.04	0.17	1681
United Kingdom	0.23**	0.01	0.11	0.12**	0.02	0.04**	0.01	0.05**	0.02	0.23**	0.02	0.22**	0.02	-0.22**	0.03	-0.19**	0.02	0.36	6166
United States	0.22**	0.02	0.10	0.08**	0.02	0.06**	0.01	0.09**	0.02	0.17**	0.02	0.20**	0.02	-0.11**	0.04	-0.14**	0.02	0.31	3354

**Coefficients statistically significant at p=0.01, constants and their SE not shown due to space constraints but available from the authors upon request

Note: Data not available in France, Italy and Spain

Figure 3. Impact of adolescent home library size on adult education, occupation, frequency of reading outside of work and literacy skills. Standardized solution STDYX, generated in Mplus 7. Unstandardized solution for the effects of books corresponds to what is shown in Table 2.



Note: Only significant pathways shown (correlations between independent variables not shown). Path analyses for numeracy and ICT skills are in Supplementary materials