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Literature Review & Scoping Study

The Impact of Educational Attainment, and Literacy Scores on Economic Growth and Productivity

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Contents

1. Introduction 3
2. Measuring Productivity 6
3. Individual returns To Education and Training 10
   Returns to additional years of Education 11
   Returns to Qualifications 11
      Educational Qualifications 11
      Vocational Qualifications and Training 12
   Returns to Literacy 13
   Returns in Northern Ireland 15
      Returns to Education in Northern Ireland 15
      The impact of Literacy Scores in Northern Ireland 16
      Do Individual Returns Reflect the True value of Education? 17
4. The Impact of Education on National Economies 20
   Firm-Level studies 20
   Country Level Studies 21
      Growth Accounting Models 22
   The Augmented Neo-Classical Model 22
      Refinements of the Augmented Model 23
      Summary 26
5. Literacy Scores and National Productivity 27
   Data 27
   Results 29
      High Scores or Average Scores 32
      Males and Females 33
   Assessment 35
6. The Importance of Graduates in UK Regional Prosperity 37
7. Summary and Conclusions 41
   Returns for Individuals 41
   Impact on Company Productivity 41
   Educational Returns for Countries 41
      Literacy Scores, Per Capita GDP and Productivity 42
   Can Literacy Scores Be Improved? 44

Bibliography 46

Annex A Description of the International Adult Literacy Survey 51
   1 Introduction 51
      1.1 Background to the project 51
      1.2 Conduct of the Adult Literacy Survey 51
      1.3 Measuring literacy 52
   Analysis of Data from the 1996 Adult Literacy Survey 55
      1.4 Sample size 55

1. Introduction

Upon the subject of education, not presuming to dictate any plan or system respecting it, I can only say that I view it as the most important subject that we, as a people, can be engaged in. Abraham Lincoln.

Abraham Lincoln was far from alone among 19th century Americans in ascribing the highest priority to education. Historians have described education as the religion of 19th America, as long as that education was practical. By the mid 20th century the average American was vastly better educated than the average Britain. Heckman and Masterov (2000) show that, for those born in the 1940's, 27% of white Americans had college degrees. In Britain the figure was around 4%. Only 18% of white Americans had no qualifications, compared with 60% of Britons.

Britain's economic eclipse by the USA (and Germany) became a huge policy concern from the late 19th century, with the focus largely on lagging productivity. A series of education acts resulted, but it was not until after World War Two that the UK began to seriously erode the education gap with what by then had become the world's richest economy. By 2005 the UK, including Northern Ireland, had largely caught up in educational attainment, partly due to a very high priority given to education in the UK. The catch-up has also reflected difficulties in the USA in maintaining educational standards in a rich economy. The International Adult Literacy Survey of 1994/6 and its successor 'Learning A Living' (OECD, 2005) suggest that literacy standards in the USA have slipped towards the bottom of the developed world while those the UK have held their place. In the meantime the UK's long slide down the economic league tables has ceased. Improved education is not the only factor but is likely to have been an essential element.

The recently published OECD UK Country Report (2005) shows that although the UK has a reasonably high proportion of graduates by international standards, it still has one of the highest proportions (second only to Italy) of young people aged 25-34 with only low level qualifications. The OECD conclude that '*although schools have improved a lot in the 1990's more could still be done to improve basic standards of literacy and numeracy thus providing a stronger foundation for continued learning*'.

It is within this context that this report seeks to review the economics literature to examine the ongoing importance of education and literacy for economic growth and productivity. One aim of the report is to examine whether an increase in literacy skills would be likely to have a positive impact on the Northern Ireland economy. The report also contributes to ongoing work to develop a forecasting model of the Northern Ireland economy capable of assessing the impact of investment in education on such things as per capita GVA.

This review has been stimulated by the publication of a research paper that, for the first time, directly estimates the impact of literacy and numeracy on per capita GVA and

productivity in advanced economies. This study, undertaken in Canada by Coulombe, Tremblay and Marchand, finds that the average literacy score in a country is positively associated with economic growth and productivity. This result is promising in that it contributes to the 'missing' link between education and economic growth that has been difficult to pin down in the economics literature.

This paper is reviewed in detail in section 5, but first some background is needed to set the work in context and to provide a wider framework for assessing the impact of education. This background includes:

- An explanation of how economic growth and productivity are measured in these studies, and how Northern Ireland currently compares on these measures.
- An account of personal returns to education and literacy to assess how much this can tell us about the aggregate returns to countries.
- A review of the development in the economics literature of the approach used by Coulombe et al.

Taken together, this literature tells us much about the relationship between education and literacy on the one hand and economic growth and productivity on the other at personal, company and country levels. Because Northern Ireland is a region within the UK, we also wish to assess how educational attainment and literacy can contribute to the task of convergence towards UK national levels of wages and productivity. Since the literature on regional convergence is limited we report on the results of some our own work on the relationship between educational qualifications and wages.

In this review most of the data on literacy comes from the 1994-96 International Literacy Survey (Literacy Skills for the Information Society, OECD and Statistics Canada, (2000). Carey S, Low S, Hansboro J., Adult Literacy in Britain, TSO, London 1997 and Carey S.,Measuring Adult Literacy, ONS London 2000). Scores are reported for three types of tests i.e prose, literacy and quantitative literacy. In this review these are referred to as literacy scores. In the latest update of the International Adult Literacy Survey more direct tests of numeracy and problem solving have been added (Learning a Living, First Results of The Adult Literacy and Life Skills Survey, OECD, 2005). However this survey does not include the UK and has not been included in this review.

This review aims to be a non-technical account of a sometimes highly technical literature. Where-ever possible technical terms are avoided, but it is helpful to use some terminology widely used in the social sciences. The main such term is 'regression analysis' This refers to the fitting of a best-fit line through a 'scatter ' relationship between two or more variables. In the work considered here 'best-fit' lines are most usually fitted through 'scatter' relationships between wages on the one hand and educational attainment or literacy scores on the other The slope of the line provides a numerical value describing how one variable changes for a given change in the other. For instance in a regression between wages and years in education the slope of the line will describe how large an increase in wages occurs for a one year increase in years of education.

2. Measuring Productivity

Productivity is a measure of how much can be produced for a given application of resources. The term is usually used as a synonym for 'labour productivity' i.e. the amount that can be produced by a given number of people. For example a cutlery factory might produce a thousand spoons per employee per day.

For whole economies, or even individual firms, productivity in this sense might mean little. Workers in car assembly plants may appear highly productive in producing large numbers of cars per person when all they are doing is assembling bought-in components. A more informative measure is value-added per worker, i.e. the value they add to the purchased inputs to produce their outputs. For whole economies the value added is Gross Domestic Product (GDP, now renamed GVA or Gross Value Added). Productivity in an economy is usually measured as GDP per employee.

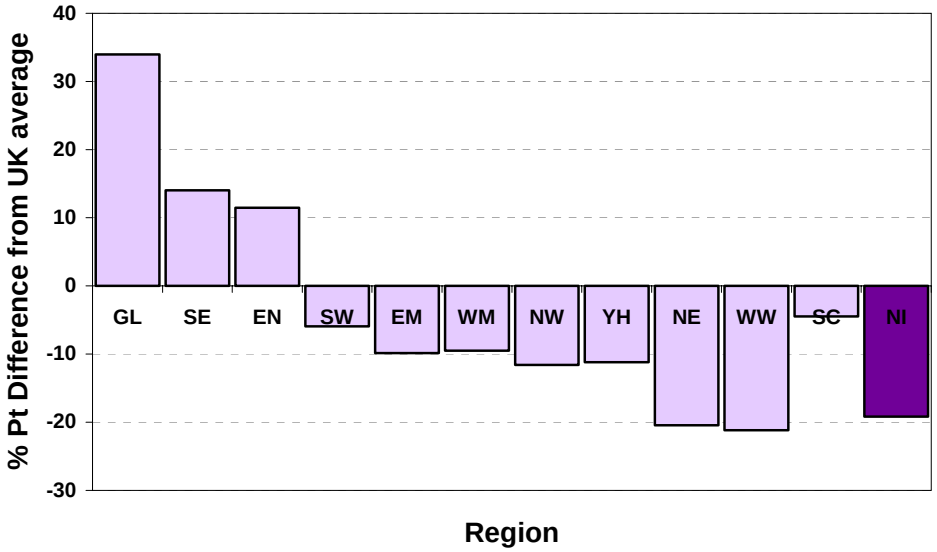
GDP forms the income of an economy and is made up of wages plus profits. Living standards in an economy are thus measured as total GDP divided by the whole population, or GDP per person. Per capita GDP is usually high when productivity (GDP per employee) is also high. However, per capita GDP is also determined by the proportion of working age people who are employed, and by the ratio of dependents to working age people. Countries like the UK with high proportions of people at work can achieve high per capita GDP even though labour productivity may not be as high as elsewhere.

The economic studies described below mostly attempt to explain why some countries have higher per capita GDP than others, or alternatively higher labour productivity than others. The main focus in these studies is to examine what influence educational attainment or literacy scores have on per capita GDP or on productivity.

Before discussing the studies it is helpful to briefly examine how GDP in Northern Ireland compares with elsewhere. Here the comparisons are with other parts of the UK. Since per capita GDP in the UK is close to that of the EU (before the recent accession of new member states), a comparison with the UK average is much the same as a comparison with the EU15 average.

Figure1 below shows that in 2003 Northern Ireland had a level of per GVA 19% below the UK average. Northern Ireland is no longer the poorest region in the UK having overtaken Wales and the North East of England in the last few years.

Figure 1: Per Capita GVA 2003. Difference from the UK Average

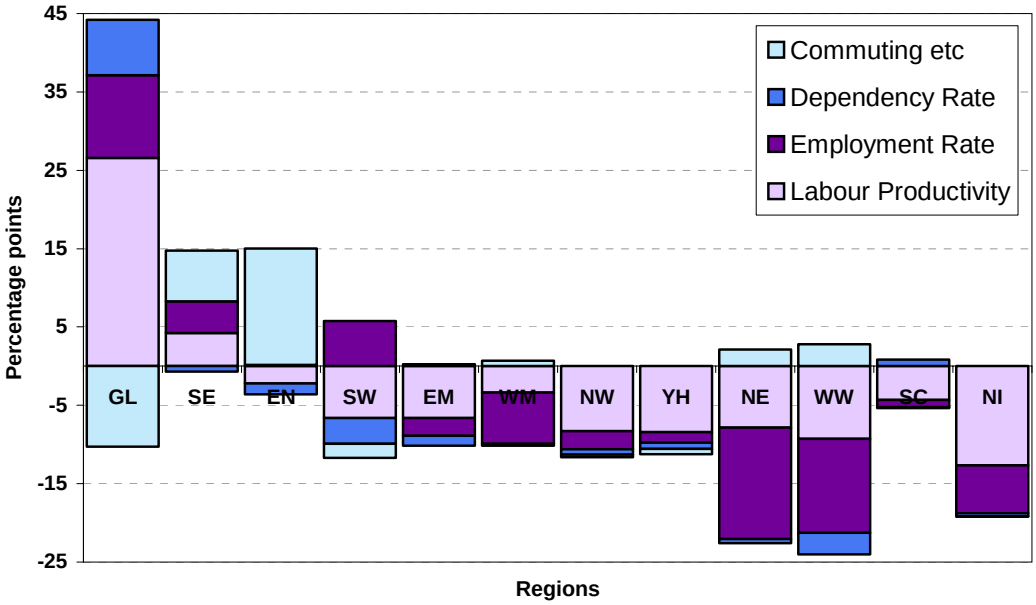


Source of data. ONS Regional accounts Workplace based nominal GVA

It is useful see how per capita GVA relates to productivity (GDP per capita). This is shown in figure 2 in which per capita is decomposed into its constituent parts. These are:

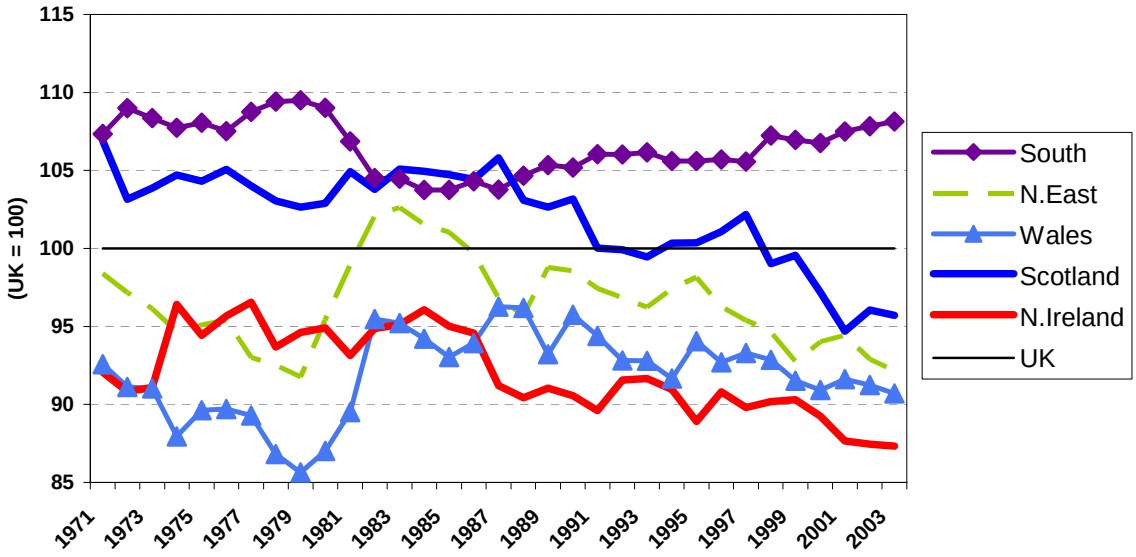
- Productivity
- Employment rates (percent of working age people who are employed)
- Dependency rate (percent of the population who are not working age)
- Commuting (mainly affects regions close to London)

Figure 2: Components of Per Capita GVA 2003. Difference from UK Average



Source of data. ONS Regional accounts Workplace and residence-based nominal GVA

Figure 3: Productivity (GVA per Employee) Relative to the UK Average

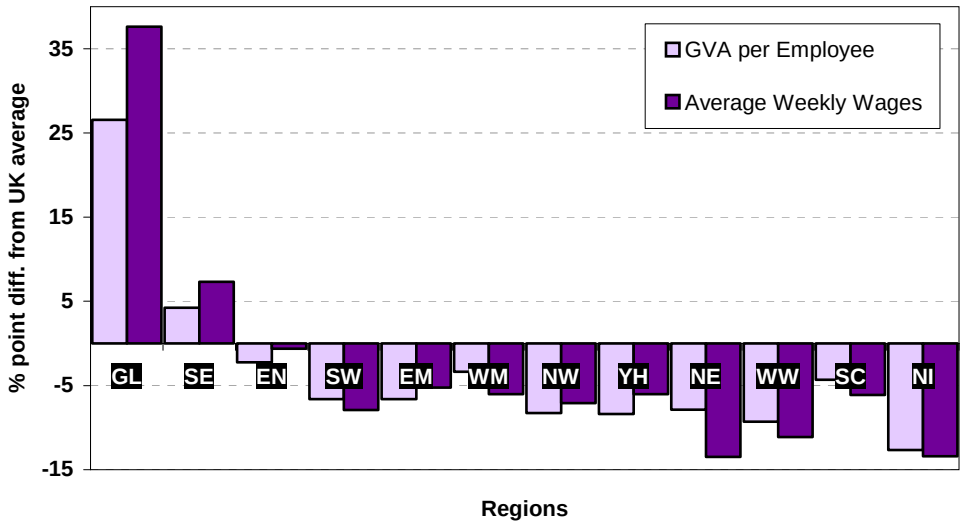


Source of data. ONS Regional accounts Workplace based nominal GVA

In Northern Ireland low per capita GVA is mainly due to low labour productivity. However, low employment rates are another factor. Dependency rates are close to the UK average since relatively large numbers of children are offset by low numbers of elderly

people. Productivity in Northern Ireland has been falling further behind the UK average since the mid-1980's (Figure 3). This is a characteristic shared with most UK regions outside the south of England. Levels of productivity are thus diverging. Levels in southern England are moving further above the UK average. Elsewhere they are getting further behind.

Figure 4: Per capita GVA and Average Wages Relative to the UK Average 2003



Source of data. ONS Regional accounts Workplace based nominal GVA. New Earnings Survey

Wages comprise around two thirds of GVA and hence low productivity (GVA per employee) is associated with low average wages. Productivity and wages in Northern Ireland were both around 13% below the UK average in 2003 (Figure 4).

3. Individual returns To Education and Training

This chapter looks at whether studies of differences between individuals in educational attainment or literacy provide evidence that increasing qualifications or literacy have a favourable impact on individual's wages and hence on the wider economy.

There is a large literature on the returns to individuals in terms of additional wages due to education. This shows that:

- Longer periods in education lead to higher wages and more secure employment
- More advanced qualifications also increases wages and employability
- Higher literacy scores are associated with higher incomes and higher likelihood of employment
- Each of the above factors has an influence on wages independent of the other factors

This literature is of direct relevance in demonstrating how qualifications or literacy contribute to higher wages and employability for individuals. It is also of indirect relevance to national or regional economic performance as longs as the higher wages and employability of individuals leads to a national or regional advantage. For individual advantages from education to translate into national advantage we need to know whether it is really the education that leads to higher wages, and whether those with qualifications do not simply displace other equally able people in jobs.

In the early literature on the impact of education cross –country studies showed that education had larger beneficial impacts on individuals than on countries. This in turn implied that while education helped some individuals to secure well paid and secure jobs, these individuals displaced others who thus had less well paid jobs or no jobs at all. Educational qualifications were viewed by some as providing signals to employers about the innate ability of individuals, without the education necessarily contributing fully to national economic progress.

More recently cross-country studies show a significant impact of education on economic growth and productivity. The paper by Coulombe et al (2004) suggests that the national returns to literacy may be quite large. If high literacy scores are generated by education then this work implies that education can have large impacts on national economic growth and productivity. This also suggests that individual returns to both education and literacy are a reasonable guide to the impact on countries as long as the costs of providing education are taken into account. We will show below that a number of economics studies conclude that most of the individual gains from education are genuine and do not merely reflect the underlying ability of those with qualifications.

Returns to additional years of Education

The literature for the UK is well summarised in Blundell et al (1999) and by Chevalier and Walker (2001). Blundell states that the literature for the UK and similar western economies suggests the *gross* return to an extra year's education ranges between 5% and 10%. This means that wages, for example at age 33 will be higher by 5-10% for each additional year spent in education. A graduate leaving education at age 21 can thus expect wages to be 30-60% higher than those leaving school at 16. One of the most recent studies of the UK (Dearden, 1998) finds that the average annual return of undertaking an extra full year in education is 5.5% for men and 9.3% for women. Similar, but slightly higher, returns for men and women are reported by Chevalier and Walker. The latter also suggest that the returns have increased slightly over time.

Some authors report a higher return. Harmon and Walker (1995), for instance, attempted to measure a true impact of an extra year's education free of other influences such as individual's inherent ability. They did this by measuring the impact of the raising of the school leaving age by one year, and reported a gain of 15%. Blundell et al consider this to have been a special case, and regard 15% as being too high as a general measure of the returns to additional year's education. Krueger and Lindahl also suggest that the gains from extra years in education are greater for those from disadvantaged backgrounds. In their view this is likely to explain why compulsory extensions in schooling register large returns. Compulsory changes tend to affect the disadvantaged more than others.

Krueger and Lindahl (1999) suggest that the USA may be at the top end of this range with a return to individuals of 10% for each additional year in education. It appears to be a common finding that education is well rewarded in the USA. This may reflect the fact that the USA has relatively few legal restrictions on hiring, firing and promotion and comes closest among advanced economies to achieving a free labour market. Countries with greater restrictions tend to have more equality in the distribution of earnings, and hence the returns to the same periods of education tend to be lower than in the USA. The UK is intermediate in the spectrum of intervention in labour markets, but has come closer to the USA over recent decades.

Returns to Qualifications

Educational Qualifications

Another way of measuring returns to education is to examine the wages of those who have qualifications compared to those who do not. The results in Table 1 below are from Dearden ,1999 who used data from the longitudinal National Child Development Survey with controls for such things as family background and early test scores (at age 7).

Table 1: Private Rates of Return to Educational Qualifications (% increase compared with no qualifications)

Qualification	Men	Women
Basic	7.2	6.9
GCSE	15.1	11.2
5 GCSE's	20.8	25.8
A-levels	33.6	37.1
Degree	51.8	72.5

Source: Dearden (1999)

This tables shows that men who completed five good GCSEs (O levels) had higher wages of around 21% compared with men who left school with no qualifications. Men who go on to attain A levels gain a further 13%. The returns for females tend to be higher than for men for good GCSE's or higher qualifications.

The additional returns to men for A levels relative to 5 good GCSE's is around 6% for each of the two extra years of study. The *annual* return to degrees relative to A levels is a little less than this. Other UK studies cited by Blundell et all suggest that the average *annual* return to education decreases with successively higher qualifications. Evidence from the USA and Canada also suggests that the rate of return to education declines with additional schooling.

Other research suggests that individual returns vary:

- by subject. Business, social science or science degrees have higher returns than arts degrees. Women undertaking vocational degrees have higher returns than other subjects.
- By sector. Individuals in industries experiencing rapid technological advance gain higher returns from education
- Over time. Returns in the UK rose in the 1980's compared with the 1970's

Vocational Qualifications and Training

Vocational qualifications also have significant returns for individuals in terms of higher average wages. The figures in table 2, again from Dearden 1999, show that returns are a little below those of equivalent levels of educational qualifications.

Table 2: Private Returns to Vocational Qualifications (% increase compared with no qualifications)

Qualification	Men	Women
Lower	16.2	13.2
Intermediate	25.2	21.7
Higher	40.4	51.2

Source: Dearden (1999)

Blundell et all show that training, either provided by employers or vocational training, provides extra returns to individuals of around 5% or up to 10% if vocational qualifications are obtained. Employer provided training appears to give higher returns and managerial or professional training provides higher returns than for manual skills. Most training and hence most of the returns appear to go to those with higher ability or education, and those in higher paid occupations. However there is evidence from Blundell and others that those with few qualifications have high returns from training, but rarely participate in it. This may be because such training has a high cost. Further research is needed to judge whether a expansion of training for those with few qualifications would continue to provide high returns.

Although it is difficult to separate the impact of years in education from the impact of achieving specific qualifications, some authors do so by putting both variables in the same regression equation. Chevalier and walker (2001) for instance find that each extra year in education without additional qualifications still adds around 2-3% to wages. In general, of course, extra years in education do lead to additional qualifications, and this result suggest that the time served raises wages, but that the main benefit to wages comes from gaining the qualification.

Returns to Literacy

The results of the IALS survey of Northern Ireland in 1996 showed that people with higher quantitative literacy tended to be concentrated in higher income groups and were less likely to be unemployed (Sweeney et al,1998). Other countries found similar relationships using the IALS data. For instance in New Zealand, a country with a population not much larger than Northern Ireland, people with higher literacy scores were found to earn more, on average, than those with lower skills, and were more likely to be employed (Johnston, 2004).

A substantial number of studies have, used the IALS or similar surveys, to examine the relationship between literacy and earnings or employment controlling for other influences. The results of these studies have been summarised by Johnston (2004) and are included in appendix A. The main results are:

- Literacy has a persistent, positive and statistically significant association with earnings.
- This relationship holds after taking account of other influences on earnings

- The impact of literacy is however smaller when education is included as an influence
- The relationship holds similarly for all three measures of literacy in the IALS.
- Literacy is also found to influence individual's participation in work.
- A 10 point increase in literacy scores (on the 500 point scale) results in an increase of earnings in the range 1-5%. A 3% increase is a reasonable mid-point.
- This compares with a return to an additional year of schooling of 7-10%

The returns from higher literacy scores vary between countries. A study by Denny, Harmon and O'Sullivan (2004) shows that:

- A 10 point increase on the 500 point scale of literacy scores increased hourly earnings by 3.3% in the Netherlands, but only by 1.3% in Germany (where the wage distribution is particularly flat).
- New Zealand was in the middle of this range at 2.4%.

Mare and Chapple's (2000) study of the IALS data for New Zealand showed that an increase in literacy scores of 10% (i.e. around 25 points) raised wages in New Zealand by 4.0% for males and 5.1% for females.

Several studies show that an increase in literacy at lower levels on the scale results in a greater percentage increase in wages than an equivalent increase at higher levels on the scale. Both the Mare and Chapple and Denny et al studies show this for New Zealand, although for GB the largest increases are in the mid ranges. An earlier study using literacy data, Rivera-Batiz (1990), founder a stronger impact at lower literacy levels, but the relationship was only marginally significant in the statistical sense. A similar finding was made for males in the UK by McIntosh and Vignoles (2001) but again the relationship was weak.

Several of the studies cited above also showed that people with greater literacy skills are more likely to be in employment than those with weaker literacy skills, even taking into account other relevant factors. Such people are also more likely to employed full time rather than part-time, and are less likely to be either unemployment or economically inactive. For instance McIntosh and Vignoles (2001) found that men with level 2 prose literacy skills were 9 percentage points more likely to be employed than men with level 1 skills.

A summary of the main studies linking literacy scores and both wages and employment was compiled by Johnston (2004). This is included annex B to this report.

Returns in Northern Ireland

Returns to Education in Northern Ireland

Individual's returns to education and literacy in the form of higher wages have been examined in two studies. Harmon and Walker (2000) undertook a study for DENI to analyse the economic returns to education in Northern Ireland. In a separate study Denny, Harmon and Redwood examined how literacy scores influenced returns to education over and above the impact of years of schooling and age in GB, Northern Ireland and the Republic of Ireland.

The Harmon and Walker study uses data pooled from the Continuous Household Survey and Family Expenditure Survey between 1985 and 1995. The analysis using FES data shows:

- Returns to years of schooling of 9%
- Returns were 7.6% for men and 11.8% for women
- Returns are somewhat higher for both men and women in Northern Ireland than in GB (6.3% for men and 9.9 for women).
- Returns appeared to be stable over the ten year period
- Returns were similar in both the public and private sectors

The returns for GB were similar to those reported above for the UK as a whole. Hence Northern Ireland appears to have high returns by UK standards. Other work by Harmon and Walker suggests that returns in Northern Ireland are also high by international standards. This ties in with work by Borooah (1997) showing that wage inequalities are particularly large in Northern Ireland. This in turn may reflect the presence of a large public sector paying wages at national UK rates alongside a private sector with low wages especially in textiles and clothing where many females worked during this period.

Harmon and Walker use two methods to distinguish a genuine impact of education from one based on signals to employers about innate ability. They firstly examine the self-employed, since there are no employers to signal to in this case, and find little difference in returns from employees. Secondly the use the longitudinal NCDS to controls for test scores at age 7 as a measure of innate ability. This again shows that the signalling value of education is small. They conclude that "the productivity effect is the dominant factor in the education/earnings relationship".

The study also estimates returns to qualifications. These are presented in Table 3. In each case the returns are relative to those with no qualifications.

Table 3: Private Rates of Return to Educational Qualifications in Northern Ireland (percent)

Qualification	Men	Women
CSE	24.4	16.7
GCSE	33.2	27.8
A-level	49.2	43.5
Degree	66.2	77.0

Source: Harmon and Walker (2000)

These returns are higher than for GB at lower levels but not at degree level. This may reflect the low wages available to those in Northern Ireland with no qualifications. Similarly, the
returns to vocational qualifications in Table 4 are higher than in GB for men but not for women.

Table 4: Private Rates of Return to Vocational Qualifications in Northern Ireland (percent)

Qualification	Men	Women
Lower (apprentice)	10.9	4.7
Intermediate (Commercial)	24.0	17.6
Higher (Nursing)	33.8	58.7

Source: Harmon and Walker (2000)

The study also finds that returns to social science and business degrees are higher in GB than for other subjects and have risen since the early 1980's. Returns to science degrees are lower, but only for men. For women science degrees give the highest returns of all. Arts degrees also give high returns for females, but for males are hardly distinguishable from A levels. Sample sizes made disaggregation by subject more difficult within Northern Ireland. Here science/engineering degrees had the highest returns followed by social science/business degrees.

The impact of Literacy Scores in Northern Ireland

The study by Denny, Harmon and Redmond (2004) shows that the return to years in education is smaller when ability, measured by literacy scores is allowed for. The study uses IALS data and demonstrates that:

- Average literacy scores for males in Northern Ireland were 1.2% below those in GB (in The Republic of Ireland they were 5.1% below GB)
- The unadjusted return to an extra year of schooling was 6.2% in Northern Ireland (8.2% in the ROI) and 8.9% in GB
- A composite measure of the three literacy scores has a positive impact on wages, but the impact is small. A 1% increase in literacy appears to increase wages by a little less than 1%. The main impact appears to come from quantitative literacy.

- The return to years of schooling remains significant when literacy scores are added into the equation but its value falls from 6.2% down to 4.6%.
- Similar returns are recorded for GB and the ROI but returns to both years and literacy scores appear to be little higher in GB
- The impact of literacy scores is itself related to years of schooling. Those with higher literacy scores receive much greater returns from extra years in schooling.

This last finding appears to support other suggestions that those with greater innate ability are likely to gain more from formal education. However the gains from education to those with higher literacy scores were greater in GB than in Northern Ireland.

Do Individual Returns Reflect the True value of Education?

There are a number of ways in which economists have attempted to investigate whether the measured returns to education for individuals indicate the genuine impact of education as opposed to the impact of innate ability which is being 'signaled' to employers. Card (1999) provides a comprehensive review of the literature that suggests that the return to individuals on additional years of schooling of around 6-11%. What is interesting is that his attempts to control for innate ability using data on, for instance twins, does not reduce the size of these returns. Together with evidence from Angrist and Krueger (1991) looking at the age at which children begin school, this suggests that education genuinely boosts wages and does not merely act as a signalling device for employers to identify able people.

Most economic studies accept that it is difficult to distinguish the genuine impact of education from that of inherent ability. Some authors have used the relationship between wages and education for the self-employed (where there are no employers to signal to), or measures of ability from the longitudinal NCDS (Harmon and Walker, 2001; Chevalier and Walker, 2001). Chevalier and Walker for instance suggest that "value for education as a signal is rather low".

This appears to be a common view in the economics literature, but is less accepted in the educational literature. Wolf (2002) says "we know that employers use qualifications partly as a simple screening device" Wolf's conclusion is part of her strong attack on over-enthusiastic government spending on education to achieve economic growth. Her review of the economics literature on 'signalling' is somewhat patchy, but she does draw attention to work that calculates the social return to education after i.e. deducting the costs incurred by both governments and individuals. This tends to half the gross returns but still leaves the returns well above the 6% per annum Treasury threshold for public investment.

Wolf also draws attention to the huge differences in wages earned by people with identical skills in developed and underdeveloped countries as an argument that much more is involved than education per se. It is true that a trained hairdresser, bus driver or waiter will earn many times more doing the same job in a rich country than in a poor one.

The general level of productivity in a country obviously matters, as does the protection afforded by labour and immigration laws. Similarly the productivity of education in the wider economy is heavily influenced by economic organisation. Communist countries managed to get relatively low returns on their sometimes heavy investment in education. Similarly some less developed countries allow much of their most educated labour to be absorbed by the public sector or to migrate to richer countries.

The key question for this review is however whether spending on education within advanced economies promotes, encourages or facilitates economic growth. It is taken for granted that we are talking about developed economies in which educational and other resources will be more or less productively utilised in the wider economy. The evidence of high individual and social returns to education in countries like the UK appears to suggest that national economies also gain since innate ability is only a small part of the economic value of educated people. However, such attempts to separate the genuine impact of education from that of innate ability have been relatively few and are inherently difficult. It is important to also look for other evidence. Some of this comes from economic theory, although again the results are mixed.

Economists have long argued that the benefits of education may not be restricted to the direct recipient but might spill over to others as well, leading to additional benefits to the country as a whole. A branch of economic theory called 'new growth theory' suggests that higher levels of human capital, i.e. higher proportions of well educated people in a country will lead not only to higher levels of per capita GVA, but also to faster rates of growth in the long term. In these so-called 'endogenous growth models' technological progress ceases to be exogenous (i.e. external) as in most economist's models of economic growth, but instead becomes endogenous (i.e. internal). Technological progress is thus a direct result of countries investing more in education. The posited link between education and technological progress is supposed to be due to factors such as more educated workforces producing more R&D and more new knowledge.

In their review of the literature on returns to education Sianesi and Van Reenan (2002) conclude that the evidence on whether these 'endogenous growth' models perform better than other models is inconclusive. In fact much the ongoing research accounting for economic growth in terms of education (including the study of Coulombe et al which is the focus of this review) is not in the 'endogenous growth' tradition. Instead it assumes that additions to the stock of education or literacy will raise the *level* of per capita GVA or productivity. However it will only raise the *growth rate* of per capita GVA or productivity in a transitional period leading to the new high level of per capita GVA. Thus in the short run the two approaches may come to the same thing, but the long run implications are quite different.

Another route through which education can enhance growth beyond its direct effects on individual's wages is through wider social effects. Sianesi and Van Reenan (2002) consider that "more education has been found to be associated with better public health and parenting, lower crime, better environment, wider political and community

participation and greater social cohesion, all of which are likely to feed back into economic growth (see OECD, 1998 for a review and references)".

Finally Dearden, Reed and Van Reenan (1999) have examined the impact of education at the level of individual firms and industries. Their conclusion is that "the literature does hint that the returns to human capital are larger for firms than individuals, suggesting that not all of the productivity gains are captured by workers:

4. The Impact of Education on National Economies

If education and literacy scores are to have a wider impact than on individuals alone the results should show up in two ways. Firstly companies should show benefits. If companies benefit, then it is likely that their national economies will also do so. More generally, comparisons of national economies should demonstrate a connection between investment in education and literacy on the one hand and economic success on the other.

Firm-Level studies

There are numerous difficulties in measuring company's returns to education, not least because it is difficult to obtain relevant data. Research often has to involve intensive studies of matched firms. The best of this was undertaken in a series of studies by the National Institute for Economic and Social Research (NIESR). (See for instance Daly, Hitchens and Wagner, 1985; Steedman and Wagner, 1987, 1989; and Prais, van Ark and Wagner, 1989), These studies compared British companies largely with those in Germany where labour productivity was generally much higher. Several of these studies were replicated at NIERC to directly compare companies in Northern Ireland with match companies in Germany or Italy (Hitchens and Birnie,1989; and Roper and Hofmann,1993)

All of the NIESR studies found that higher levels of productivity in the continental plants were closely related to the skills and knowledge of their workforces. In the UK plants a lower level of employee skill was found to lower the level of productivity attainable, through influencing:

- The choice of machinery used
- The ways in which machines were modified and linked in production lines
- The smooth running of machinery
- Introduction of new technology

The studies found for instance that machines broke down more often in British plants due to less intensive maintenance, and then took longer to repair due to lower skills. Because German maths education was generally more advanced, skilled operatives could generally read complex machine manuals and undertake repairs without having to wait for the machinery suppliers to send out specialist engineers. This series of studies stimulated huge interest in German education and vocational education systems in the 1990's. This interest has abated more recently as German industry has suffered from high costs inside the Euro. Much of the productivity gap between the UK and Germany remains. As manufacturing has declined within the UK, and been replaced by rising service sector exports, the issue has also become less pressing.

The Northern Ireland studies compared companies with matched plants in Germany for a range of manufacturing industries. In each case they found labour productivity to be much higher in Germany. Hitchens et al (1989) concluded that 'at almost every level of

the hierarchy Northern Ireland was outclassed in terms of the quality, quantity, width and intensity of skills, training and practical experience'. Roper and Hofmann (1993) examined 20 plants in four manufacturing sectors and found that labour productivity averaged only 60% of the German level. They concluded that 'higher workforce and managerial skill levels are the primary reason for the German firms' competitive advantage'.

The studies above are largely concerned with vocational skills at either operative or managerial levels. There are few studies to directly link literacy skills with company performance. However, Johnston (2004) reports the findings of several qualitative studies from New Zealand, Canada and Australia (Workbase (2000);Bloom et al,1997; Pearson, 1996). These studies showed that firms reported the following benefits from introducing literacy programmes for their employees:

- Decrease in error rates
- Better team performance and improved participation in team meetings
- Growth in employee confidence
- Improved flexibility
- Improved labour relations
- Increased output
- Perceptible cost savings

In a much cited study The UK Adult Literacy and Basic Skills Unit (ALBSU, now the Basic Skills Unit) estimated that poor literacy cost an average of £165,000 for companies employing over 50 people. However, only 15% of firms in the ALBSU survey could provide an estimate of the costs of poor literacy skills.

Country Level Studies

Although economic theory has traditionally had surprisingly little to say about the causes of large international differences in per capita GDP and productivity, a large literature has developed on these themes over the last fifteen years. This literature mostly follows the common format of reporting on cross-country regression analyses. These relate international differences in growth of per capita GDP (or equivalent measures) to:

- Initial levels of per capita GDP
- Changes in physical capital (i.e. investment in physical capital)
- Levels of human capital
- Population growth

Growth Accounting Models

Much of the research relating per capita GDP to investment and labour derives from 'production function' approach in economics. This views the level of output in an economy as determined by the levels of labour and capital multiplied by a 'total factor productivity' itself determined by the prevailing level of technology. Additions to labour or capital will increase output, but with decreasing returns if only one or the other is increased. Adding more labour without additional capital equipment will, for example, increase output but less than proportionately. Even with fixed levels of labour or capital, output will continue to grow in the long term due to technological change.

This approach is little more than a basic accounting framework with little in the way of deeper explanation. The accounting framework was used originally by Denison and others in a series of studies of the factors contributing to economic growth particularly in the USA. Denison (1979) found that improvements in educational standards had been an important influence on post-war economic growth in the USA. He estimated for instance that educational improvements accounted for 10-15% of the growth of the US economy over the postwar period up to 1973. OECD (1993) reviewed a large number of 'growth accounting' studies across seven OECD countries. In these studies the evidence suggested that 10-20% of economic growth could be explained by improvements in education.

The production function approach was independently adopted by Solow (1957) and developed into a theory of economic growth. The theory predicted that investment in capital and growth of labour would determine countries' levels of GDP. Investment would in turn reflect the savings rate in each country. Because savings rates and population growth vary across countries difference countries would reach different stable or 'steady-state' levels of income. The higher the rate of saving, other things being equal, the richer the country. The faster the rate of population growth, other things being equal, the poorer the country.

This is a limited explanation of country's wealth because it does not attempt to say what determines savings rates or population growth. However, it does predict that capital or labour would flow into countries where they were in short supply, since this is where their marginal productivity would be highest and returns would be greatest. Solow's model also predicted that economies would converge towards the steady state consistent with their rates of saving and population growth.

The Augmented Neo-Classical Model

As a first approximation Solow's theory was consistent with the evidence of countries' wealth, although this was not apparent until after 1988 with the availability of internationally comparable data. When it was tested against the new data it became obvious that it had some flaws. The estimated impact of savings (and hence investment in

physical capital) was implausibly large. Two developments of economic growth theory attempted to correct for this deficiency:

- The 'augmented neo-classical' model added human capital to the basic Solow model. Human capital was initially measured as years of schooling, or as percentages of the population enrolled in secondary or higher education, but most recently literacy scores have begun to replace these early measures. Neo-classical growth models treat human capital as an investment in the same way as machines. The models assume that human capital will also be subject to diminishing returns.

- 'Endogenous growth' models make much more of the role of human capital, and hypothesise that the accumulation of skills and ideas will be self-perpetuating unlike physical capital. In these models, instead of decreasing returns to human capital, the returns are constant or increasing. The higher the stock of human capital the faster the future *growth* of output.

The key paper in the augmented neo-classical mould was that of Mankiw, Romer and Weil (1992). This paper took the basic Solow model and added a variable for the proportion of a countries population enrolled in secondary education. This augmented model provided a better fit to the international differences in per capita GDP, including the richer, i.e. OECD, countries, and also provided more plausible estimates of the impact of savings and hence investment in physical capital. School enrolment was statistically significant for all sets of countries, including for the OECD countries alone. However the overall fit of the whole equation for the OECD countries alone was poor.

A conclusion was that both physical and human capital had similar impacts on countries levels of per capita GDP alongside growth in the population. Countries in which physical and human capital grew faster than population became richer. The stable or long-run level of per capita GDP (relative to a world average) was predicted by the savings rate, and the accumulation of human capital (i.e. education) relative to the rate of population growth. A long period of convergence may be necessary to reach a new steady state if any of the long-run influences change. In addition, countries will still become richer as technology advances, but this is predicted to be a common factor across countries, and will not change their position relative to other countries.

Refinements of the Augmented Model

This section summarises the main work published between the pioneering paper of Mankiw et al (1992) and the recent Canadian study of Coulombe et al (2004). This section can be skipped if the evolution of this approach is not of interest.

Since the paper by Mankiw et al in 1992, a growing series of 'cross-country growth regressions' have appeared that include measures of human capital. Studies typically attempt to explain countries' economic growth experiences from 1960 onwards. Some use a formal framework derived from one of the two theoretical approaches listed above.

Others are more ad hoc. In general the augmented neo-classical approach, in the tradition of Mankiw et al, tends to dominate. Each paper tends to make improvements in the statistical specification of the models, and attempts to improve the measurement of human capital. We should also note that the addition of human capital variables increases the explanatory power of these models. Although savings, population growth and human capital accumulation remain exogenous (i.e. given), the fact that human capital is not particularly mobile internationally, points towards national policy factors as explanations.

Both Islam (1995) and Barro (1997) used average years in education for the population aged 25 and over as measures of human capital. Both estimate the influences on per capita GDP in countries over 5 or 10 periods from 1960 to 1985 or 1990. Both fail to find a significant relationship between years in education and per capita GDP for OECD countries. At this point more attention began to be given to the quality of the data for human capital, and from 2000 onwards studies begin to use literacy and numeracy test scores alongside years in education.

One study still using years of schooling without test scores, for OECD countries alone, found that adding an extra year of schooling raised per capita GDP by about 6% (Bassanini and Scarpeta (2001). In this study there was also a rapid convergence to a new steady state i.e. around 6 years compared to the 20-30 years in other neo-classical growth studies. This long-run impact of years in education is similar in size to the individual returns reported in chapter 3. This in turn suggests that individual returns do indeed translate into similarly sized gains for the whole economy.

Another important study (Krueger and Lindahl, 1999) closely examined the reliability of international data on schooling and found substantial differences between the two main data sets. This study uses data on average years in education from the World Values Survey (WVS) conducted in 41 countries in 1990 and 1993. Krueger and Lindahl found that the impact of years of schooling on changes in per capita GDA varied between countries. The size of the impact peaked at about 7.5 years which is below the average for OECD countries. Among these countries the impact of adding extra years of education was not significantly different from zero.

Some of these points are evident in the charts below which take the WVS data on years in education and plot it against per capita GDP. Figure 5 shows a positive relationship between years schooling and per capita GDP at the start of the period. There are large differences in per capita GDP between the richer group of countries and a poorer group (that includes a number of post-communist Eur0pean states), irrespective of years in education. A similar relationship holds in figure 6 for years in education against per capita GDP ten years later. However, the relationship for changes in years in education (in figure 7) is neutral and if anything slightly negative. That is to say that a greater number of years in education at the start of a period does not lead to higher growth over the next ten years.

Figure 5 Per Capita GDP 1990 v Years Schooling

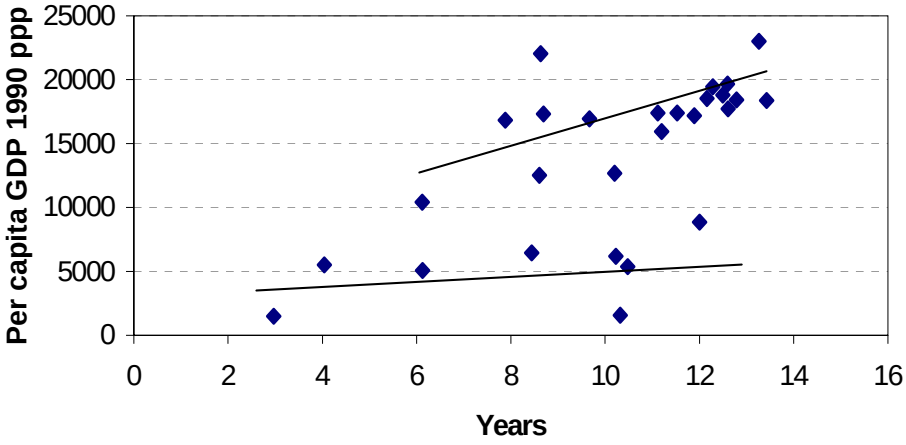


Figure 6 Per Capita GDP 2000 v Years Schooling

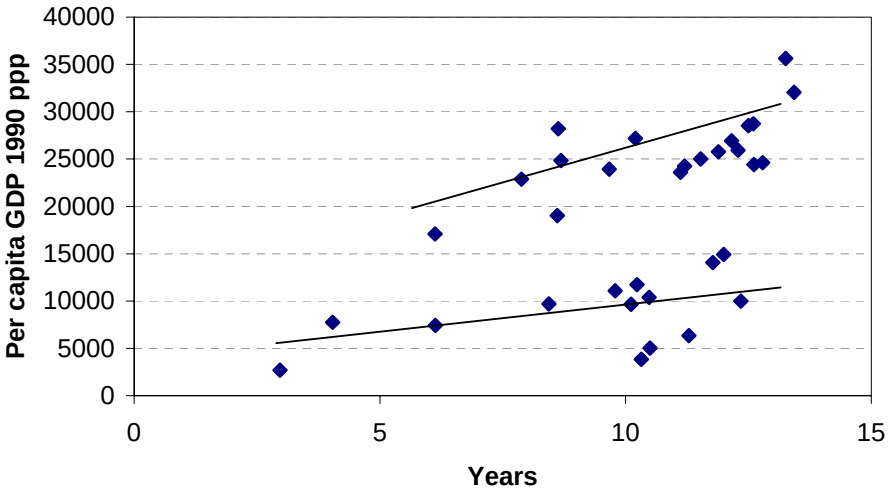
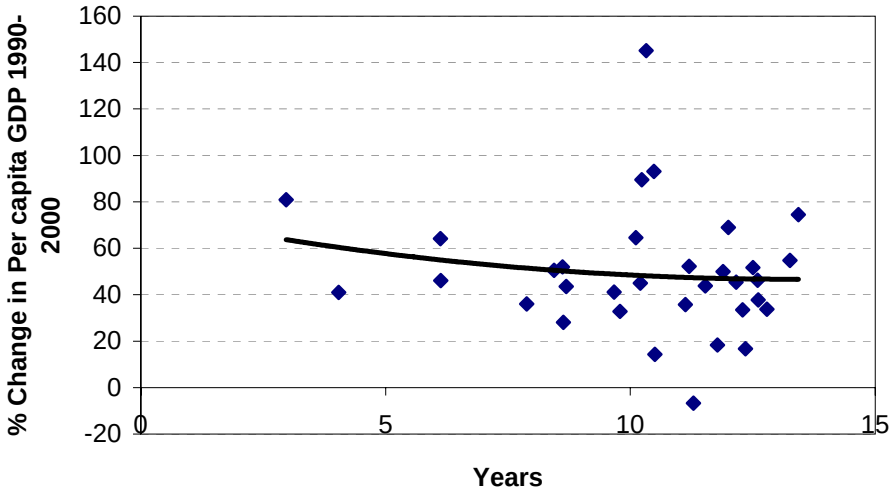


Figure 7 % Change in Per Capita GDP 1990-2000 v Years Schooling in 1990



Studies which introduced literacy test scores found that these were a much more significant influence on growth in per capita GDP than years in education. Hanushek and Kimko (2000) used international test scores in science and mathematics for 31 countries over the period 1960-1990. Barro (2001) used similar test scores but included scores for reading alongside maths and science.

Summary

The large number of cross-country regression studies conducted by economists have struggled to find a clear relationship between human capital and growth in per capita GVA for OECD countries. The finding of Mankiw et al that secondary school enrolments did influence economic growth was not always confirmed when years in education was used instead as the measure of human capital. However, when literacy scores were introduced as a measure of human capital a more positive and significant relationship was observed. It was at this stage that the IALS data became available and was used for the first time by Coulombe, Tremblay and Marchand (2004) in across-country growth regression in the augmented neo-classical tradition. As we shall see in the next chapter, their finding is that test scores have a clear positive impact on economic growth.

5. Literacy Scores and National Productivity

Canada has taken a great interest in international comparisons of educational achievement and literacy, and its statistics agency, Statistics Canada has been a sponsor of the International Adult Literacy Survey in 1994 and its successor the Learning a Living Report in 2005. The 1994 IALS survey is described in annex A. The study by Coulombe ,Tremblay and Marchand, published by Statistics Canada in 2004, was one of a series of analyses of the IALS data. The study aimed to contribute to the analysis of the relationship between human capital and economic growth across OECD countries by making the best use of direct measures of human capital based on literacy scores.

The study examined growth in per capita GDP for 14 OECD countries over a series of 5 year periods from 1960 to 1990. This is done through a series of growth regressions in which percentage changes in per capita GDP in each country over 5 year periods are explained by:

- Per capita GDP at the start of each period
- Rate of investment in physical capital (average of 5 years)
- Fertility rate (average of 5 years)
- Openness of the economy (sum of exports and imports as a share of GDP)
- Level of Human capital (average literacy score for 17-25 year olds at the start of each period)

Data

Each of the variables is expressed as relative to the 14-country average for each period. Hence a level of per capita GDP of 10% below the average is expressed as 0.9. The authors make this adjustment to avoid confusing the main influences with economic cycles and other extraneous occurrences during the period.

Most the variables in the above list are available for each of the 8 five-year periods. The exception are the literacy scores. These come from the single IALS survey in 1994-96. The main innovation in this study is the way it uses this single survey to construct values for each of the 8 five-year periods for each of the 14 countries.

This is done by taking the average literacy score for different age groups in 1994 and assuming that the score would have been the same as when the people were entering the labour market aged 17-25. For instance those aged 51-59 in 1994 were aged 17-25 in 1960. Their average literacy scores in 1994 were taken as the scores that would have been observed for 17-25 year olds in 1960. Similarly those aged 46-54 in 1994 were used as the cohort for 1965 and so on. This procedure has obvious potential flaws. If literacy ability tends to improve, or deteriorate, with age the procedure may be invalidated. Even

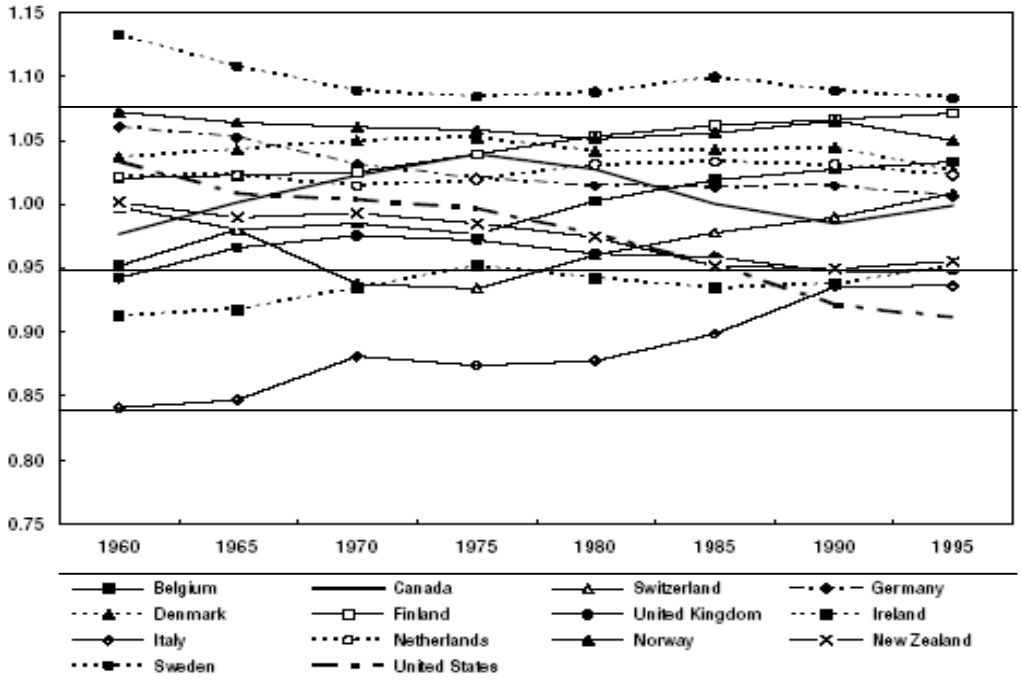
worse, if improvements over time were to occur at different rates in different countries the data would be particularly misleading.

Johnston (2004) also expresses doubts about the accuracy of the IALS data. He calculates the percentage of each country's population aged 16-24 who are classified to level 1 of the 5 level scale of the IALS. He then compares this with the proportion of 15 year olds in the same countries who were classified to level 1 of the prose literacy scale in the 2000 PISA (Programme for International Student Assessment) survey. The PISA survey included a subset of the prose literacy tests from the IALS study and are hence comparable, although the age of those surveyed differs somewhat, and the dates of the surveys are 8 years apart.

The results of the two surveys show little correlation. The USA was for instance second to bottom on the IALS but in the top third in the PISA survey. New Zealand was 5th in the PISA survey but 6th from bottom in the IALS. In general, Scandinavian and northern European countries scored better in the IALS than PISA. For English speaking, Mediterranean and former communist countries the opposite was true. There may have been larger improvements in education in some countries over the 8 years, but the real reasons for the differences are unknown.

Estimated average IALS literacy scores for 17-25 year olds at each date are shown for each of the 14 countries in figure 8 below

Figure 8 Average literacy score of population aged 17 to 25 relative to the cross-section mean



The literacy scores in Figure 8 are really for different age groups in each country with older age groups on the left. Adopting the assumption of no improvement or deterioration in average literacy scores beyond age 25, the literacy scores can be taken as indicative of the dates shown on the horizontal axis of Figure 8. The figure shows that most countries retained their relative positions over the period. The UK, for example has been close to 95% of the 14-country average for the whole period. The Scandinavian countries and Finland have the best scores throughout the period, although Sweden's initial advantage has weakened a little. The two main exceptions are the USA and Italy. The USA began the period 4% above the average, but declined steadily to almost 10% below average by 1995. The more recent Learning A Living survey suggests that the USA may have subsequently slipped further again. Italy began the period with easily the lowest literacy scores but has subsequently improved, overtaking the USA and coming close to the UK by 1995.

Results

To introduce the results of the study we first illustrate the relationships by examining some simple correlations using data from the study. Figures 9-11 show simple relationships between literacy scores for 17-25 year olds in 1990 and per capita GDP both in 1990 and ten years later in 2000. Figure 9 shows the IALS literacy scores for 1990 compared with per capita GDP in 1990. This shows that countries with below average literacy scores had lower per capita GDP, However a plateau appeared to have been reached in that countries with above average literacy scores did not have per capita GDP which was also above average The USA has been omitted from Figure 9 because it does not fit the general relationship. The USA had close to the lowest literacy scores but the highest per capita GDP. This might suggest that the relationship between literacy and GDP does not work for the USA, but an alterative interpretation is that the USA's former high levels of literacy have underpinned its high productivity and living standards. The fall in US literacy rates over recent decades will, on the evidence of Coulombe et al's results, take a long time to come through, but may eventually reduce the USA's productivity level to below the average for other rich economies.

Figure 9 Literacy Scores for 17-25 years olds in 1990 v GDP 1990 excluding USA

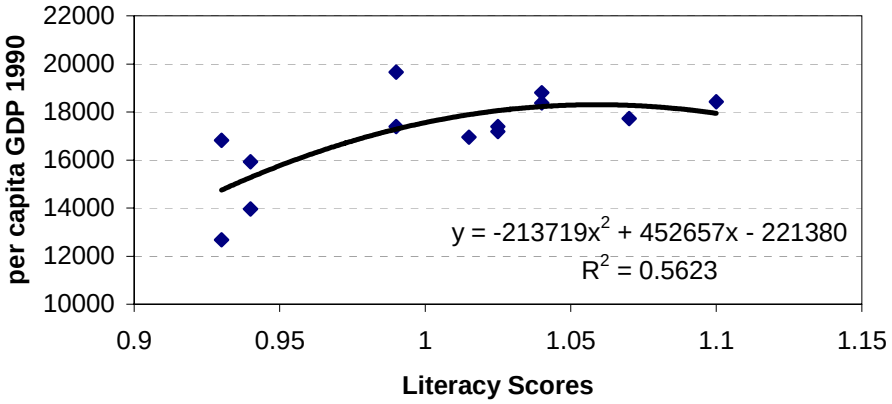


Figure 10 Literacy Score for 17-25 year olds in 1990 v GDP 2000 excluding USA

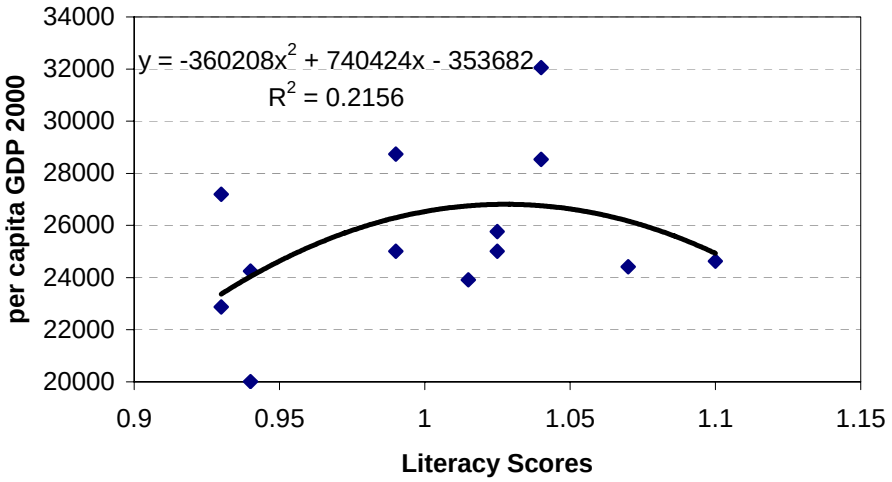
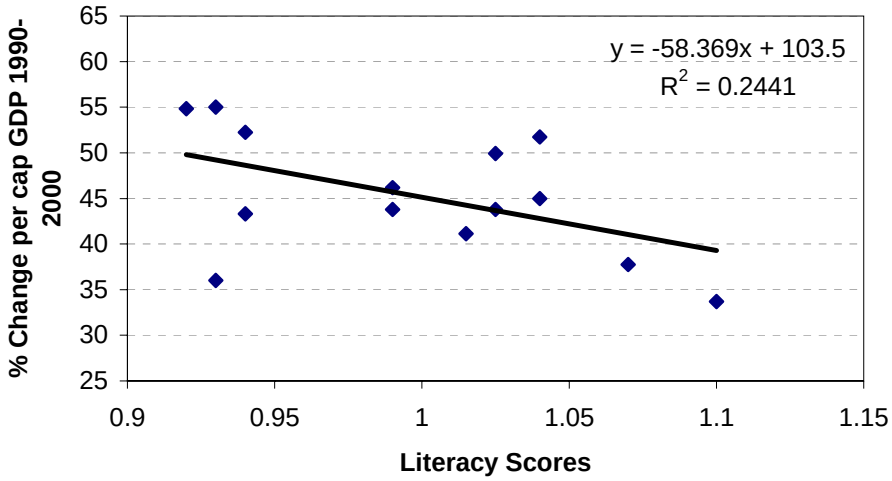


Figure 10 shows the same literacy scores as in the previous chart (i.e. for 1990), but compared in this case with per capita GDP ten years later in 2000. In this case there is little evidence of any significant correlation. If the USA were included, the relationship would be even weaker. Since literacy scores were positively associated with GDP in 1990, but not by 2000 this suggests is that literacy rates were inversely associated with *growth* in per capita GDP over this ten year period. Figure 11 shows that was indeed the case. The relationship is not strong, but the tendency is for countries with the highest literacy scores for 1990 to have slower growth 1990-2000. In this case the USA is included but the very high growth rates for Ireland and Norway have been adjusted to take account of special factors in each case (i.e mis-measurement of GDP in Ireland and the impact of oil in Norway).

Figure 11 % change in Per Capita GDP 1990-2000 v Literacy Scores for 17-25 year olds in 1990



What the study of Coulombe et al does is to assess the impact of literacy scores above and beyond other probable influences on growth in per capita GDP. As already mentioned these other influences include investment in physical capital and the tendency of poorer countries to converge towards the all-country average level of per capita GDP due to their ability to share technical knowledge embodied in new machines etc. It is this tendency to convergence that may, for instance, cause the apparent negative correlation in figure 11. Coulombe et al also take into account literacy scores for all dates and not only one year as in figures 9-11.

The results of the study's growth regressions showed that literacy scores were a strong and positive influence on economic growth across the period. This holds irrespective of which of the three types of literacy (prose, document or quantitative is used). The influence of literacy scores on economic growth is estimated as a single value across all 14 countries. This is equivalent to assuming that literacy has the same impact in each country. Some authors regard this as too restrictive, possibly leading to erroneous inferences.

The main results for literacy scores are:

- In the short run, a rise of 10% in the relative literacy score (e.g. from 0.9 of the 14-country average to 0.99) results in a short term rise in the 5 year *growth rate* of per capita GDP of 1%. The short-run impact on labour productivity is similar but a little higher.

- **In the long run, a permanent rise of 10% in the literacy rate results in a level of per capita GDP of 15%. For productivity (GDP per employee) a 10% rise in literacy rate leads to a rise of 25%.**

- These long term improvements in relative GDP will take a long time to be realised since the short-term convergence is slow. The authors state that it would take between 12 and 33 years to close half of the gap following a policy change that shifted average literacy scores up or down. Our own calculation based on the Coulombe results is that a sustained 10% improvement in literacy scores, from 90% of the average to 99%, would take over 30 years to realize half of the 25% long-term gain in productivity.

- A change in literacy scores has a long-term impact three times as large as a change in physical capital. However this may not translate into economic returns three times since the cost of increasing human capital by a given percentage may be higher than for increasing the investment rate.

- The higher impact of literacy rates on productivity (GDP per employee) than on per capita GDP implies that while literacy scores raise productivity they may also indirectly reduce employment rates or raise net in- migration (both of which would reduce the increase in per capita GDP below that in productivity)

- It does not matter which of the three measures of literacy are used. All give similar results.

- Literacy scores are a better predictor of per capita GDP (or labour productivity) than years of schooling. When both variables are included in the growth regressions, only the literacy scores are statistically significant.

The results also show that growth in per capita GDP is faster for countries that are initially poorer. This implies convergence over time, other things being equal. Even if relative rates of literacy or investment do not change. This can be due to the fact that countries with a small capital stock, and hence low wages, are likely to attract high rates of investment in physical capital. Ireland, north and south, and countries like Spain or Portugal have all gained from this effect over recent decades. It can also reflect the benefits of technology embodied in new machines and equipment. Once again the rate of convergence is very slow. Once established, countries are likely to retain their advantages or disadvantages for a long time.

High Scores or Average Scores

An important aspect of the study for the Essential Skills strategy in Northern Ireland is whether the impact of literacy is achieved across the board at all levels of literacy, or alternatively is achieved mainly at the higher or lower end of the literacy spectrum. As noted above, there is some evidence that returns to qualifications or years of schooling are greatest at the lower end of the spectrum.

In the Coulombe study a test was to included which examined the impact of only the percentages of individuals attaining level 4 (i.e. graduate-level) literacy scores in each

country in place of literacy scores for everyone as in the main analyses. The authors conclude that:

"*measures based on average test scores over all individuals are much better indicators of the aggregate level of human capital investment than measures based on the proportion of individuals that achieved relatively high levels of literacy …it is consistent with the view that human capital investment fosters growth by making the overall labour force more productive, as opposed to developing highly talented individuals who may, among other things, have a positive impact on growth through their contribution to innovation and technological progress".*

In other words, average literacy scores were more closely associated with high per capita GDP, or high productivity, than were scores of those at the upper end of the spectrum. This conclusion indicates that there is no reason to target investment in literacy at the high end of the spectrum. It is also in line with the recommendation in the 2005 OECD UK Country Report that the UK should continue to focus *" on raising the general low skills level of the labour force".*

The authors did not undertake a specific test for improvements in literacy for those at the lower end of the literacy spectrum so it is not possible to draw direct conclusions about improvements in literacy for those with poor literacy. Their cross-country regression using the percentage of people with level 1 or level 2 literacy not surprisingly showed a negative correlation with growth in per capita GDP. Large numbers of people with low literacy are obviously not in themselves a stimulant to growth. This however tells is little about the value of raising literacy from low levels.

Males and Females

An important and surprising result of the study is that female literacy is more important than male literacy in accounting for high levels of per capita GDP and productivity. The study finds that:

- Female literacy scores have a statistically significant impact on both per capita GDP and productivity, and the impact is similar to that reported above for males and females together

- Male literacy scores have a statistically significant impact on productivity but the size of the impact is around half that for females

- Male literacy scores have a measured impact on per capita GDP half that of females, but this impact is not statistically significantly different from zero.

We noted in the previous section on individual returns to educational qualifications that returns for females tended to be higher than those for males, and the Coulombe et al result should not be a complete surprise. However the size of the male/female difference

is much larger than expected. Also the lack of statistical significance in one of the male regressions leads to some concerns about the interpretation of the study as a whole.

One technical influence on the result is the inclusion of an additional new variable in the separate male and female regressions. This variable is the participation rate of females in the labour force relative to that of men. This variable is significant and negative in each of the regressions. The higher the relative level of female participation, the lower is growth in per capita GDP or productivity. The reason for the negative relationship is presumably that in countries where female participation is already high there is less potential labour to fuel rapid growth. It is included in the regressions to take account of the fact that rising educational attainment by females is likely to be associated with rising participation of females in the labour force. The measured impact of literacy scores is thus independent of any change in female participation.

The inclusion of this additional variable is likely to reduce the measured impact of female literacy scores since it blocks off one route through which rising literacy might be correlated with per capita GDP and productivity. It is thus not fully obvious why the authors include it. However, the regression equations for females do show that higher literacy scores increase per capita GDP and productivity even after changes in participation are allowed for. The new female participation variable is also included in the male regression equation. In this case, the impact of male literacy scores take into account the impact of changing female participation. As we have seen, when female participation is taken into account the impact of male literacy scores is small.

The authors make little comment on the importance of these findings for the overall study. However they do speculate on what factors might cause the difference between the impact of male and female literacy rates. Without attempting to reach any particular conclusion they suggest that 5 factors could be responsible for the differences:

- Only the more able females may have received the education necessary to raise literacy scores
- Initial levels of female literacy may have been low leading to high marginal returns
- Low levels of initial female literacy may have led to imbalances between physical and human capital. The correction of these imbalances would lead to high returns
- Changing economic structures with more service activities may lead to higher economic returns for females.
- There is more variability between countries in literacy scores for females than for males among the older age groups. More recently countries have converged in female literacy scores. This might account for the gender gap effect.

More research is clearly needed to establish why female literacy scores have a larger impact on per capita GDP and productivity. The more immediate question is whether the low impact recorded for males tends to invalidate the general conclusion that raising literacy scores will benefit the wider economy. Our view is that there may be technical statistical reasons for the low measured impact and that it is too early to say whether the

results for males invalidate the general conclusion. The main technical issue concerns the inclusion of the female participation variable in the male equation. Since rising female participation is likely to be associated with higher female literacy scores, the inclusion of this variable may represent an alternative measure of changing overall literacy scores. In this case the impact of male scores alone would be diminished.

Assessment

The main purpose of the study by Coulombe et al has been to test a standard model of economic growth across countries in which growth in productivity is determined by investment in physical and human capital. The author's interest in literacy scores is mainly in their usefulness as a measure of human capital. From their point of view one of the main results of the paper is to show that literacy scores perform better as an indicator of human capital than commonly used alternatives such as years spent in education.

However, the paper has attracted international interest chiefly for what it says about education. It says firstly that education clearly matters as an influence on economic growth. Secondly it says that a measure of output from education i.e. literacy scores, are a better measure than inputs such as time spent in education. This appears to point to the importance of the quality of education more than the quantity, with all that implies for education policy.

The value of the approach used in this study is that the impact of literacy scores is considered alongside other important influences on growth. The impact of literacy scores is thus over and above these other factors and there is less danger of drawing false inferences than with a simple direct comparison of literacy scores and economic growth.

The disadvantages of this 'cross country regression' approach are changes in the specification of the equations or measurement of the data can influence the measured impact of literacy. The difficulties with the study include:

- the data is itself partially constructed and depends on assumptions about the ways in which literacy scores might change as people age.
- The IALS data may not be a definitive measure of countries' literacy. It does not match well with the PISA data on school children's test scores
- the impact of literacy scores on GDP can change if the specification of the equations changes. The authors are quite careful in this respect, but the introduction of the female participation variable shows how new variables alter results
- the low estimated impact of male literacy introduces doubts about the general influence of literacy.

One possibility is that the importance of literacy in economic growth depends on economic circumstances and on the structure of the economy. The application of complex

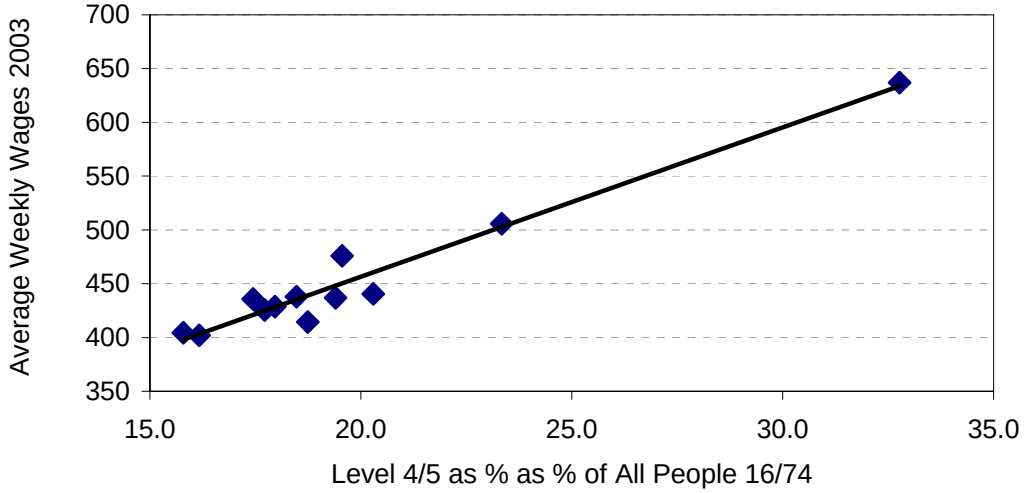
technology and the rising importance of R&D and innovation more generally appear to increase the value of literacy to the functioning of an economy. Similarly the virtual disappearance in recent decades of a need for human muscle power and the relentless rise of sedentary, office-based service sector activities, also increase the value of literacy. They also, of course, at least equalise the competitive advantage of males and females in the labour market compared with earlier ages. As the authors suggest, this may be one reason why rising female literacy has had a larger impact on economic growth.

6. The Importance of Graduates in UK Regional Prosperity

One the key results from the Coulombe study was the conclusion that general literacy matters more than the percentage of people scoring at level 4, the level generally expected of graduates. This appears to contradict the widespread belief that in modern 'knowledge-based' economies in which research-based activities are particularly important, the possession of top-level skills are paramount. The apparent falling behind of general literacy in the USA for instance may be offset by the USA's ability to dominate the world in first-rate universities (17 of the top 20 science-based universities in the Shanghai Index for instance), and the USA's ability to attract post-graduate talent from all corners of the world.

This is not to argue that general literacy scores are unimportant. They clearly are important, and we agree with the conclusion of the OECD UK Country Report (2005) that policy in the UK needs to focus on raising the general low level of skills. As the NIESR and NIERC company productivity studies showed good levels of literacy are needed to main high productivity in a range of modern industries.

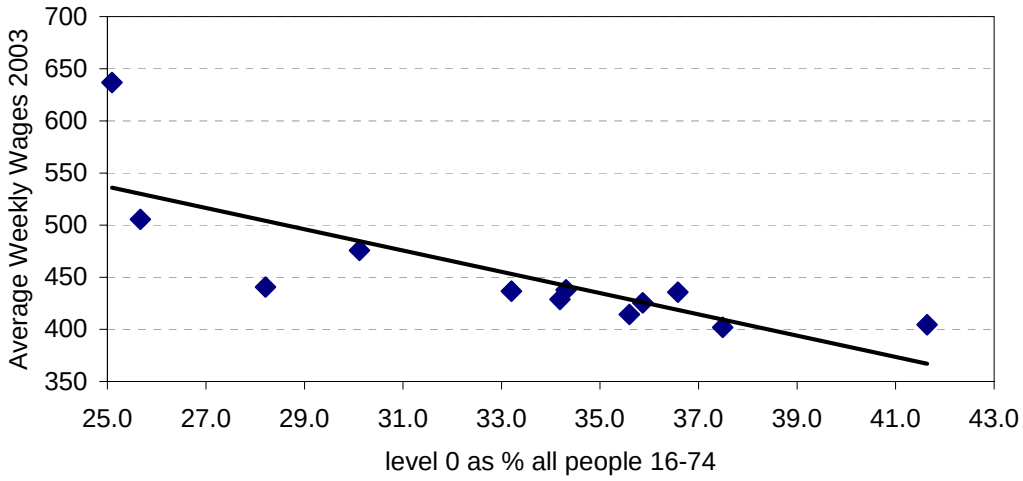
Figure 12 Level 4/5 Qualifications (% of all 16-74) & Wages by Region



However, the evidence of our own research on UK regional economies suggests that wealth is closely associated with the proportion of graduates in the labour force. Figure 12 shows the close relationship across UK regions between average wages and the proportion of working-age people with graduate qualifications. Since wages are closely associated with productivity this can be taken as a relationship between productivity and graduates. Northern Ireland has the lowest percentage of graduates and one of the lowest average wages on this chart.

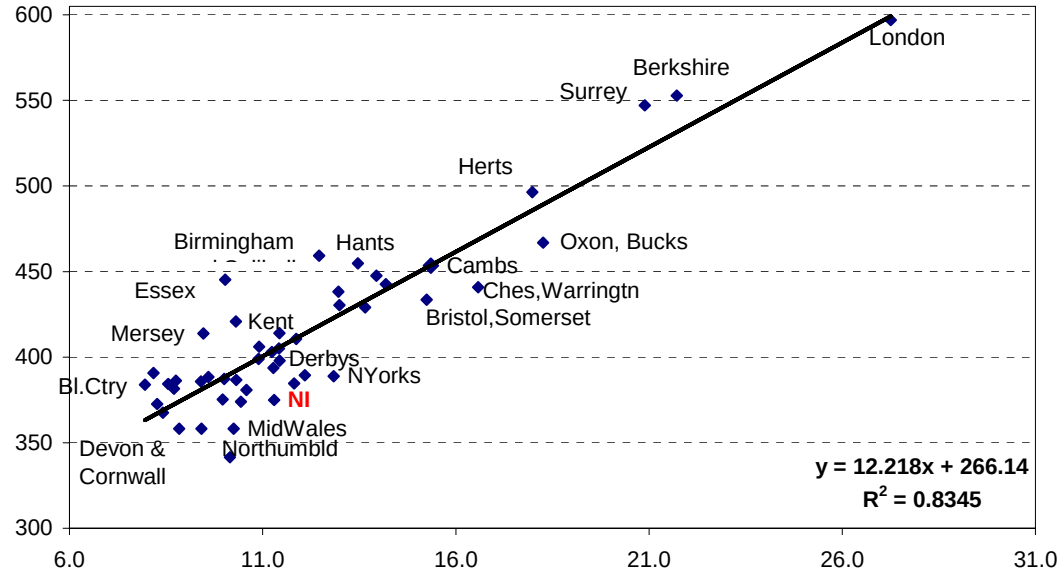
Similarly there is an inverse relationship between average wages and the proportion of people with no qualifications (Figure 13). Again Northern Ireland emerges at the wrong end of the scale, with the highest percentage of people possessing no qualifications.

Figure 13 Level 0 Qualifications (% of all 16-74) and Wages by Region



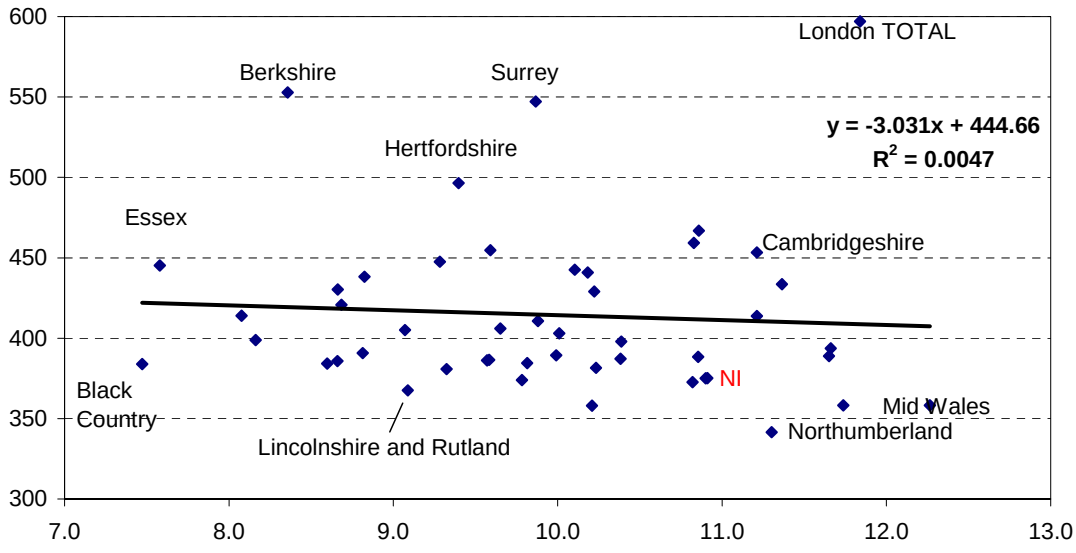
We can go one step further and ask whether this relationship holds for both the public and private sectors. This has been investigated for individual labour market areas in England

Figure 14 % of Employed Population 16-74 Graduates in Private Sector 2001 vs Average Earnings 2001 (workplace-based)



and Wales. Data is thus far unavailable for Scotland and Northern Ireland. What emerges is a strong positive relationship between wages and graduates working in the private sector (figure 14). A 10 percentage point increase in the percentage of the workforce who are graduates working in the private sector leads to 30% higher wages for all workers (i.e. not only for the graduates themselves). The percentage of private sector graduates 'explains' almost 84% of the differences in wages between labour market areas. There is no equivalent relationship for graduates working in the public sector (Figure 15). In this case there is no correlation at all between wages and graduates.

Figure 15 % of Employed Population 16-74 Graduates in Public Sector 2001 Vs Average Earnings 2001



We have not yet been able to investigate why high proportions of graduates working in the private sector should raise average wages for all local workers by so much. The direct impact of the wages of the graduates themselves accounts for only about a quarter of the general rise. Hence, the wages of non-graduates are also higher in areas with large numbers of graduates in the private sector. This could be, for instance, because graduates either create or facilitate the creation of high value added activities which create the demand for specialised (and highly paid) non-graduate labour. Within the UK large numbers of graduates may also create a demand for all labour in such a way as to bid up wages for non-graduates. It is also possible that the causation runs the other way, i.e. from high wages in an area to high demand for graduates in sectors like finance or legal services. However, the relationship appears too strong for this to be the main effect.

This evidence of a strong correlation between graduates and wages tells us that we need to be cautious in interpreting the evidence of any one study like that of Coulombe et al. It is true that the Coulombe study used literacy scores as a measure of human capital and the evidence in this chapter concerns qualifications. The IALS study showed that not all graduates have level 4 literacy, while some people with no qualifications have level 4 literacy. Nonetheless there is a strong relationship between qualifications and literacy scores. We would thus expect a good relationship between literacy and wages at the regional scale.

Even though graduates working in the private sector may be a key differentiating factor for regional wages and productivity, it still may be true that all regions have serious deficiencies at lower levels of literacy. The fact that the UK has a relatively high proportion of graduates compared with other countries, but lacks intermediate and vocational skills, points in this direction. The OECD (2005) believes that attention to these lower level skills should be a key focus of educational policy. In the OECD's words:

" A relative lack of intermediate and vocational skills appears to be an important impediment to the economy's capacity to absorb innovations, explaining the comparatively low proportion of UK firms engaged in successful innovations. Indeed, while the number of persons having university and advanced research degrees (PhDs) is not much different from that in comparable countries, the UK has a large share of pupils leaving school before completion of the upper secondary level and without an education giving specific competence in a professional field."

As we have seen, Northern Ireland has a higher proportion of its working age population than any region with no qualifications. Many of those with no qualifications are outside the workforce, being either unemployed or economically inactive. Many are on Incapacity Benefit. These people are not included in the wage charts above, but do contribute to the relatively low proportion of working age people in Northern Ireland who have a job.

7. Summary and Conclusions

A wide range of studies demonstrate conclusively that improved educational attainment produces economic gains. This is true irrespective of whether the studies are of the wage-gains for individuals, of productivity gains for companies, or of improvements in per capita GDP for whole economies.

Returns for Individuals

For individuals, every study shows that more education, better qualifications and higher literacy all result in higher wages. Authors who have attempted to differentiate purely personal gains from gains to the wider economy conclude that most of the wages gains made by better educated individuals are likely to reflect genuine benefits of education rather than merely being signals to employers about the inherent abilities of individuals. Benefits in terms of higher wages were typically measured as 5-10% for each additional year in education, and around 50-75% for having degree qualifications (compared to no qualifications.

Higher literacy appeared to produce directly proportional increases in wages. That is to say a 1% increase in IALS test scores (an increase of 3 points) results in a 1% increase wages. These gains vary by gender, by subject studied and across countries. Some countries have more equal wage distributions than others and thus provide fewer rewards for better education. Free market economies like the USA appear to provide the greatest gains, and as the UK has become more like the USA there is some evidence that wage gains from education have moved towards the US end of the international spectrum.

Impact on Company Productivity

Studies of company productivity have typically compared firms in the UK or Northern Ireland with those in Germany. The results have shown substantially higher productivity in German companies and this has been ascribed by a range of authors to superior standards of vocational trained. Better trained workers tend to be more flexible, to realize higher gains from investment through avoiding breakdowns and repairing equipment more rapidly. An ability to understand complex machine manuals was one factor contributing to these advantages.

Educational Returns for Countries

The main focus of this review has been on cross-country studies of differences in national productivity measures as per capita GDP or GDP per employee. Such studies are numerous and almost form a sub-discipline within economics. The relevance to education and literacy lies in the way in which these studies have been forced to include variables measuring educational attainment in order to account for the wide differences in GDP

between countries. At first the educational variables tended to measure years spent in education, but most recently studies show that literacy scores perform better in accounting for economic differences between countries.

Literacy Scores, Per Capita GDP and Productivity

The largest international differences in literacy and productivity of course occur between developed and underdeveloped countries. However such wide differences are of limited relevance to policy-making in advanced countries, including Northern Ireland, and this review focuses on studies of the advanced countries themselves. Here, it has proved less easy to identify clear economic benefits of superior educational attainment, but recent studies have done so with careful measurement of educational attainment. The more recent of these, and the chief focus of this review has been a Canadian study undertaken using IALS data on literacy scores for 14 developed countries including the UK.

This study examines the influence of literacy scores on economic growth, alongside the other major accepted influences in order to measure a 'pure' effect with other things being equal. The main conclusions are:

- In the short run, a rise of 10% in the relative literacy score (e.g. from 0.9 of the 14-country average to 0.99) results in a short term rise in the 5 year *growth rate* of per capita GDP of 1%. The short-run impact on labour productivity is similar but a little higher.

- **In the long run, a permanent rise of 10% in the literacy rate results in a level of per capita GDP of 15%. For productivity (GDP per employee) a 10% rise in literacy rate leads to a rise of 25%.**

- These long term improvements in relative GDP will take a long time to be realised since the short-term convergence is slow. The authors state that it would take between 12 and 33 years to close half of the gap following a policy change that shifted average literacy scores up or down. Our calculation is that a sustained 10% improvement in literacy scores, from 90% of the average to 99%, would take over 30 years to realize half of the 25% long-term gain in productivity.

The analysis is not without problems. One of these is that the authors find that most of the impact of literacy scores comes from female scores rather than from male scores. The reasons for this are unclear and may reflect the technical specification of the model. Indeed the possibility that changes in specification, for instance through adding new explanatory variables, will change the results is a general concern. It is a concern that can only be addressed through further research. The study however show that literacy scores perform much better than years in education as an influence on GDP. This is a potentially important finding, but again some authors have raised concerns about the value of the

IALS data on literacy. They show for instance that comparisons with the PISA test scores for 15 year olds is much weaker than we might expect.

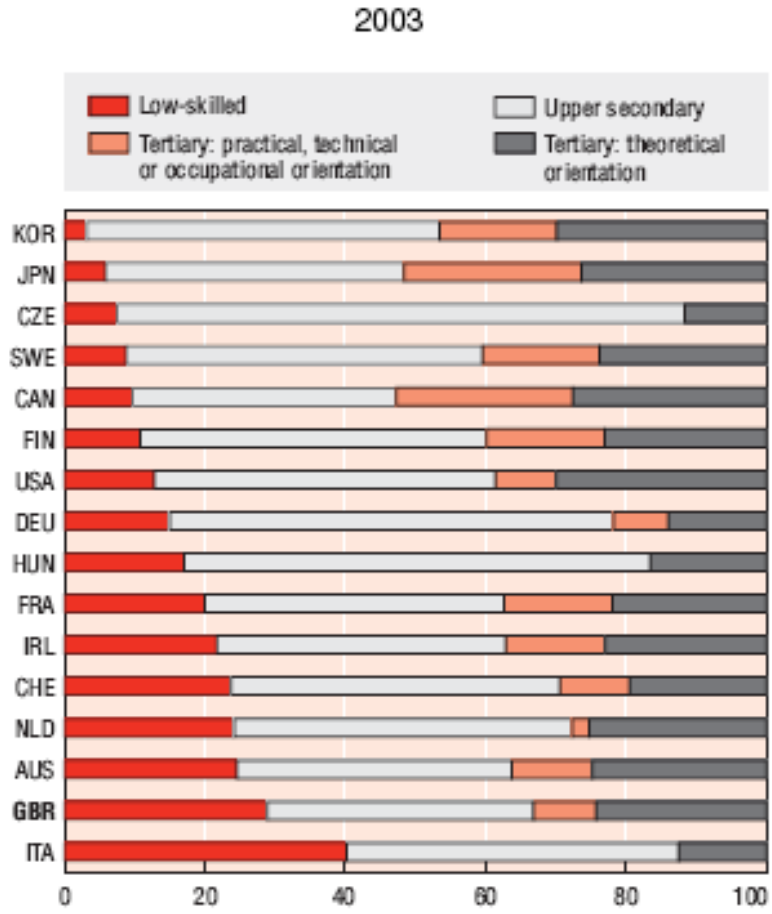
Another important conclusion from the study is that improvements in average literacy scores are more significant than improvements in the proportion of people with graduate-level literacy scores. While the huge attention given to R&D, innovation, high-technology and financial sectors as foundations for economic success all points towards graduates as a key resource, this study appears to say that wider improvements in literacy are more important. This is line with studies on individual gains from education that suggest that benefits from improvements in educational attainment are greater at the lower end of the spectrum. The jury must be considered to be still out on this issue, since our own research shows average wages across the regions of the UK closely follow the proportion of employees in each region who are graduates working the private sector.

The possibility is that both things may be true. Improvements at both ends of the educational spectrum may pay economic dividends. The recent OECD study of the UK economy views the UK as reasonably well endowed with graduates and points to the high proportion of working-age people with low qualifications as a priority for education policy. The chart below shows that the UK is second only to Italy in its high proportion of low-skilled people. Within the UK, Northern Ireland is the worst-placed region in this respect and hence is the region with most to gain from up-skilling the low skilled.

It is clear that more research is needed on the impact of literacy scores on the productivity of national economies. However, taking the Canadian studies results at face value suggests that improvements in average literacy scores could potentially raise the average productivity of the Northern Ireland economy. In the 1996 IALS average literacy scores were 1.2% below the UK average. Raising the average score to the UK average might result in a 2.5% gain in the level of GDP per employee, but it could take decades to realize the full gain. If the improvement in literacy was unique to Northern Ireland (i.e. not shared by GB) this might close about a quarter of the current gap in productivity between Northern Ireland and GB. Of course larger improvements in average literacy scores could potentially close all of the gap.

We should also note here that education does not itself guarantee high wages or national economic success. Economic organization and incentives have to be favorable. The failure of communist countries to generate high wages or economic success occurred in spite of their often high educational and literacy standards. Instead it reflected badly organized economies with poor incentive structures.

Figure 16. International Comparisons of Educational Attainment in OECD Countries



1. "Low-skilled" comprises persons having primary school, lower secondary school or ISCED 3C short programmes as their only formal qualification. Upper secondary includes post secondary non-tertiary programmes. Tertiary type A includes type B for Czech Republic, Hungary and Italy.

Source: OECD (2005), *Education at a Glance*.

Can Literacy Scores Be Improved?

This leads to a further important question about the feasibility of raising average literacy scores. Evidence from the USA suggests that improvements may be difficult to achieve. However, much of this evidence comes from schemes in which social security benefits are tied to compulsory attendance on literacy courses. More relevant evidence comes from a UK study published in 2001 by the Basic Skills Agency (Brooks et al, 2001). This was based on measured improvements in literacy by voluntary attendees at literacy courses over a 20 week period. The study showed improvements of around 5% in literacy

scores with the best improvements not surprisingly being realized by those who attended most intensively. Professional and well resources teaching also produced better results.

The message of this study is that improvements in literacy can be produced from well organized and well resourced courses. The measured improvements are not insignificant. If literacy standards for the bottom quarter of the spectrum could be raised by the 5% shown in Brooks study, the result would be to raise literacy scores in Northern Ireland to the UK average. The Canadian study would then argue that significant improvements in productivity would eventually flow from this. The long timescale probably reflects the need for other adjustments in the economy. The availability of labour with better literacy may attract more inward investment, for instance, but this would take time.

One final point is that even if remedial adult literacy scores can be shown to raise literacy, with potentially beneficial impact on productivity, it would be better to achieve the same scores through school education. Approaches like reading recovery have been shown to have good results at school level, and getting literacy right first time is preferable to remedial measures for adults. Having said this, past defects in education can only be corrected through remedial action and if schools do not succeed in raising literacy there is likely to be a continuing need for adult courses.

Our overall conclusion is that education improves national productivity. The most recent research suggests that literacy scores might be the best single measure of educational attainment, however qualifications levels are likely to form an adequate alternative. This overall conclusion accords with the common sense view that a relatively rich country like the UK, including Northern Ireland, has increasingly to compete economically on the basis of the superior knowledge content of its goods and services. Well organized, low wage countries like India or China can increasingly produce basic and intermediate goods at much lower cost than in the west. Large numbers of poorly qualified people with low literacy will in future not be able to command reasonable wages in rich countries. The only option is to continue to raise educational standards. While unskilled jobs will continue to exist, unrestricted migration will ensure that wages remain low in these jobs. I the long run, the most prosperous regions and countries will be those most able to maintain average standards of education and literacy.

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Annex A Description of the International Adult Literacy Survey

1 Introduction

1.1 Background to the project

The Adult Literacy Survey carried out in Britain in 1996 was part of an international programme of surveys known as the International Adult Literacy Survey (IALS).[1] Over 20 countries had participated in the study worldwide by the end of 1998. The British survey was carried out by the Office for National Statistics and was commissioned by a consortium of Government Departments.[2]

The IALS was the first literacy survey to be carried out in Britain on a national random probability sample of adults of working age.[3] It set out to profile the literacy abilities of adults aged 16-65 using an internationally agreed measurement instrument and internationally agreed survey implementation protocols covering such aspects as interviewer instructions and scoring procedures. Details of the survey procedures and sample are given at Appendix A. The survey results for Britain as a whole are reported in Carey et al (1997) *Adult Literacy in Britain*.[4]

1.2 Conduct of the Adult Literacy Survey

The survey was conducted by personal interview in respondent's homes and consisted of two main elements, a background questionnaire and a literacy assessment. Both instruments were developed collaboratively by countries participating in the first round. The background questionnaire collected information on the socio-demographic characteristics of the respondent such as age, sex, education, occupation and income as well as asking about literacy activities such as reading as part of their job or for pleasure, television viewing, and participation in training or adult education. In Britain both the questionnaire and administration of the assessment used Computer Assisted Interviewing methods.

After taking part in the interview respondents were asked to complete a short screening assessment which sought to identify those with very limited literacy skills. Respondents who correctly answered at least two of the six screening tasks were then asked to complete a larger assessment booklet which measured the three dimensions of literacy. Although respondents had to write their answers in the booklet, the assessment did not measure writing ability. In order to ensure as broad a range of item content as possible the total number of tasks in the assessment was larger than any one individual could reasonably be asked to complete. Each respondent therefore was only asked to complete a subset of the total assessment. The assessment items were grouped into seven blocks and a Balanced Incomplete Block (BIB) design was used to arrange the blocks in different combinations into seven booklets. Each booklet contained three blocks of items and each block appeared at each possible location, the beginning, middle or end of a booklet in a

spiral effect. Respondents were allowed to take as much time as they required to complete the booklet. The booklets were scored using a scoring guide common to all countries. The scoring differentiated between correct answers, incorrect answers and items that had not been attempted. Sequences of consecutive items coded as not attempted were used to identify incomplete assessments.

1.3 Measuring literacy

The International Adult Literacy Survey had its genesis in work carried out in the US during the 1980s, in particular the Young Adult Literacy Assessment (YAL).[5] This used open-ended rather than multiple- choice assessment tasks as it aimed to reflect more closely the context in which adults have to perform literacy tasks. The assessment tasks were taken from a broad range of contexts simulating the range of tasks that adults would encounter in everyday life. Unlike previous studies the YAL study did not treat literacy as a single dimension. Rather it identified three scales that represented three different aspects of literacy - prose, document and quantitative - which better reflected the diversity of literacy tasks that are encountered in daily life. The definition of literacy adopted for IALS is that used in the YAL survey.

Using printed and written information to function in society, to achieve one's goals and to develop one's knowledge and potential.

This definition does not treat literacy as a dichotomous condition that people either have or do not have but rather defines literacy as a broad range of skills required in a varied range of contexts. The survey measured three dimensions of literacy:

- Prose literacy: the knowledge and skills required to understand and use information from texts such as newspaper articles and passages of fiction. The texts have a typical paragraph structure.
- Document literacy: the knowledge and skills required to locate and use information contained in various formats such as timetables, graphs, charts and forms. The texts have a varied format, use abbreviated and/or informal language and use a variety of devices and visual aids to convey meaning, such as diagrams, maps or schematics.
- Quantitative literacy: the knowledge and skills required to apply arithmetic operations, either alone or sequentially, to numbers embedded in printed materials, such as calculating savings on items advertised in a sale or working out the interest required to achieve a desired return on an investment.

Each of the three scales measuring these dimensions of literacy is a continuum ranging from 0 to 500. Scores have been grouped into five literacy levels; Level 1 represents the lowest ability range and Level 5 the highest. Each level, as shown in Table 1.1, implies an ability to cope with a particular type of task. Although the three scales are highly correlated, individuals do not necessarily perform equally well on each scale.

All of the stimuli included in the IALS assessment were real items drawn from the countries taking part in the first round of the international survey. The items represent a broad range of contexts and are intended to reflect the diversity and challenges of everyday life.[6] The difficulty of an item is associated with the characteristics of the task and the attributes of the text, so that performance on any particular task reflects the interaction between the characteristics of the task itself and both the context and the format of the text.

The IALS made use of Item Response Theory (IRT), a statistical method for scaling test items for difficulty so that the item has a known probability of being correctly completed by an individual with a given proficiency level. To be placed at a particular level on a scale respondents have to consistently perform tasks at that level correctly. The definition of consistent performance for the survey was set at 80%. Individuals at Level 3, for example, should perform tasks at that level consistently - getting them right 80% of the time. They would have a higher than 80% probability of correctly answering lower-level items. Similarly, they would sometimes be able to answer a higher-level task correctly but they would not be able to perform items at higher levels consistently, that is, getting them right at least 80% of the time. Respondents received a score based on their performance on the literacy assessment. Some respondents only completed part of the assessment and where they had completed insufficient tasks to calculate their performance an imputation process was used to estimate their proficiency.

Table A1.1 Description of the prose, document and quantitative literacy levels

Level	Prose	Document	Quantitative
Level 1 (0-225)	Locate one piece of information in a text that is identical or synonymous to the information in the question. Any plausible incorrect answer present in the text is not near the correct information.	Locate one piece of information in a text that is identical to the information in the question. Distracting information is usually located away from the correct answer. Some tasks may require entering given personal information on a form.	Perform a single simple operation such as addition for which the problem is already clearly stated or the numbers are provided.
Level 2 (226-275)	Locate one or more pieces of information in a text but several plausible distractors may be present or low level inferences may be required. The reader may also be	Tasks at this level are more varied. Where a single match is required more distracting information may be present or a low-level inference may be	Single arithmetic operation (addition or subtraction) using numbers that are easily located in the text. The operation to be performed may be easily

	required to integrate two or more pieces of information or to compare and contrast information.	required. Some tasks may require information to be entered on a form or to cycle through information in a document.	inferred from the wording of the question or the format of the material.
Level 3 (276-325)	Readers are required to match information that require low-level inferences or that meet specific conditions. There may be several pieces of information to be identified located in different parts of the text. Readers may also be required to integrate or to compare and contrast information across paragraphs or sections of text.	Literal or synonymous matches in a wide variety of tasks requiring the reader to take conditional information into account or to match on multiple features of information. The reader must integrate information from one or more displays of information or cycle through a document to provide multiple answers.	At this level the operations become more varied and include multiplication and division. Sometimes two or more numbers are needed to solve the problem and the numbers are often embedded in more complex texts or documents. Some tasks require higher order inferences to define the task.
Level 4 (326-375)	Match multiple features or provide several responses where the requested information must be identified through text-based inferences. Reader may be required to contrast or integrate pieces of information sometimes from lengthy texts. Texts usually contain more distracting information and the information requested is more abstract.	Match on multiple features of information, cycle through documents and integrate information. Tasks often require higher order inferences to get correct answer. Sometimes, conditional information in the document must be taken into account in arriving at the correct answer.	A single arithmetic operation where the statement of the task is not easily defined. The directive does not provide a semantic relation term to help the reader define the task.
Level 5 (376-500)	Locate information in dense text that contains a number of plausible answers. Sometimes high-level inferences are required and some text may use specialised language.	Readers are required to search though complex displays of information that contain multiple distractors, to make high-level inferences, process conditional information or use specialised language.	Readers must perform multiple operations sequentially and must state the problem from the material provided or use background knowledge to work out the problem or operations needed.

1.4 Sample size

The overall achieved sample in Britain was 3,811, which was 68% of eligible respondents. Disproportionate sampling fractions were used in Northern Ireland, Scotland and Wales in order to be able to show separate estimates.

Survey data were weighted to adjust for the different probabilities of selection introduced by sampling just one individual per household and, for estimates for Britain as a whole, for over-sampling in Northern Ireland, Scotland and Wales. An adjustment was also made for non-response bias by weighting IALS data to reflect the distributions on the Labour Force Survey for age group, sex and highest level of education.

Notes and references

1 For further information about IALS and international results, see:
Literacy, Economy and Society: Results of the first International Adult Literacy Survey. OECD and Statistics Canada (1995)
Literacy in the Information Age: Final report of the International Adult Literacy Survey. OECD and Statistics Canada (2000).
2 The main funding was provided by the Department for Education and Employment. Other contributing departments included the Department for Trade and Industry, the Scottish Office, the Department for Social Security, Socio-Economic Statistics and Analysis Group of the Office for National Statistics as well as the Basic Skills Agency (BSA). The survey was also carried out in Northern Ireland where it was conducted by the Central Survey Unit of the Northern Ireland Statistics and Research Agency.
3 Previous literacy surveys carried out in Britain were based on cohort studies or did not use probability sampling at all stages of the sample design so that each respondent did not have an equal probability of selection. Probability sampling, where each respondent has an equal probability of selection allows the use of statistical techniques to generalise to the population.
4 Carey S, Low S, and Hansbro J. *Adult literacy in Britain.* TSO: London (1997) Further research on IALS in the European context is reported in: Carey S (ed.) *Measuring Adult Literacy: The International Adult Literacy Survey in the European context.* ONS: London (2000).
5 Irwin S Kirsch and Ann Jungeblut. *Literacy: Profiles of America's Young Adults.* Educational Testing Service (1986 Princeton, N.J).
6 For a fuller description of the assessment methodology see Irwin Kirsch. Literacy performance on three scales: definitions and results. In *Literacy, Economy and Society.* OECD and Statistics Canada (1995) pp 27-54.

Appendix 1 – Studies of literacy, earnings and employment

Study	Country	Dataset	Sample	Type of model	Dependent variable (log for earnings)	Measure of literacy	Controls for	Results for men (women)
EARNINGS								
Studies using IALS data								
Maré and Chapple (2000) Tables 7 and 8	New Zealand	IALS	workers	OLS	annual earnings	average literacy score (log)	demographics, education	10% increase in score raises earnings by 4.0% (5.1%)
							aa, plus quantity of time worked in the previous year	10% increase in score raises earnings by 5.0% (3.2%)
Blau and Kahn (2001) Table 2	multi-country	IALS	full-time workers	OLS	weekly earnings	average literacy score	age	1 s.d. increase in score raises earnings by: 13.8% (25.3%) in Canada 19.7% (15.8%) in the Netherlands 10.0% (7.7%) in Sweden 11.1% (11.8%) in Switzerland 24.2% (22.1%) in the United States
							aa, plus education	1 s.d. increase in score raises earnings by: 9.3% (16.7%) in Canada 16.3% (12.5%) in the Netherlands 7.6% (3.3%) in Sweden 8.1% (9.3%) in Switzerland 16.4% (11.9%) in the United States
Boothby (2002)	Canada	IALS	full-time workers	OLS	annual	average literacy score	demographics, education	10 point increase in score raises earnings by 3% (4%)

Study	Country	Dataset	Sample	Type of model	Dependent variable (log for earnings)	Measure of literacy	Controls for	Results for men (women)
Table 5			born in Canada		earnings			
Green and Riddell (2003) Table 3	Canada	IALS	full-year, full-time, male workers	quantile regression	annual earnings	average literacy score	experience, education, parents. education	at the median a 10 point increase in score raises earnings by 5.7% results were very similar at the 10th, 25th, 75thand 90thpercentiles
Denny*et al*(2004) Table 2	multi-country	IALS	workers	OLS	hourly earnings	average literacy score	sex, age, immigrant status, urban/rural, education	Results are for men and women combined. 10 point [1 s.d.] increase in score raises earnings by: 1.9% [9.6%] in Belgium 1.4%* [8.2%*] in Canada (English) 1.8%* [9.6%*] in Canada (French) 2.7% [11.7%] in the Czech Republic 2.0% [7.4%] in Denmark 2.1% [8.2%] in Finland 1.3% [5.3%] in Germany 2.6% [13.7%] in Great Britain 1.9% [7.9%] in Hungary 3.2% [16.8%] in Ireland 2.0% [10.8%] in Italy 3.3% [12.9%] in the Netherlands 2.4% [11.8%] in New Zealand 2.6% [14.5%] in Northern Ireland 1.7% [6.7%] in Norway 1.8% [8.1%] in Sweden 2.1% [8.9%] in Switzerland (French) 2.9% [14.6%] in Switzerland (German) 3.0% [17.6%] in the United States
Lee and Miller (2000) Table D1	Australia	IALS	not stated	OLS	annual earnings	level on the document literacy scale (included as a dummy variable)	demographics, education, immigration status, disability, self-perception of maths skills	increase in earnings compared to having Level 1 literacy skills: 11.1%* (2.7%*) for being at Level 2 14.5% (13.7%*) for being at Level 3 15.6%* (4.8%*) for being at Level 4 13.2%* (19.3%*) for being at Level 5

Study	Country	Dataset	Sample	Type of model	Dependent variable (log for earnings)	Measure of literacy	Controls for	Results for men (women)
McIntosh and Vignoles (2001) Table A3	United Kingdom	IALS	workers not in full-time education and not self-employed	OLS	annual earnings	prose literacy level (included as a dummy variable)	demographics, parents. education, part-time status, weeks worked	increase in earnings compared to having Level 1 literacy skills: 18.1% (16.9%*) for being at Level 2 19.0% (30.0%) for being at Levels 3-5
						prose literacy level	aa, plus education	increase in earnings compared to having Level 1 literacy skills: 11.5%* (14.0%*) for being at Level 2 9.5%* (19.2%) for being at Levels 3-5
						quantitative literacy level (included as a dummy variable)	demographics, parents. education, part-time status, weeks worked	increase in earnings compared to having Level 1-2 numeracy skills: 10.3%* (10.6%*) for being at Level 3 24.8% (32.3%) for being at Levels 4-5
						quantitative literacy level	aa, plus education	increase in earnings compared to having Level 1-2 numeracy skills: 7.2%* (4.3%*) for being at Level 3 13.2%* (17.5%) for being at Levels 4-5
Studies using other cross-sectional data								
Ishikawa and Ryan (2002) Table 6	United States	NALS	not stated	OLS	weekly wages	prose literacy score	demographics, disability, occupation, industry, family income, parents. education	10 point increase in score raises wages by: 4.1%†(5.4%†) for Whites 4.0%†(0.5%†) for Blacks 10.0%†(3.0%†) for Hispanics
					annual earnings	aa	aa	10 point increase in score raises wages by: -0.3%†(5.3%†) for Whites -2.6%†(-4.6%†) for Blacks 3.7%†(-3.9%†) for Hispanics
Pryor and Schaffer (1999) Table 5.3	United States	NALS	full-time workers, age 25-49	OLS	weekly wages	average literacy score	demographics, education, occupation, industry	10 point increase in score raises earnings by 1.7% (2.1%) 1 s.d. increase in score raises earnings by 9.0% (10.0%)
Sum (1999) Appendix 7B tables	United States	NALS	full-time workers	OLS	weekly earnings	prose literacy score	demographics, enrolled at school, education, disability, marital status, immigration status, self-reported	10 point increase in score raises earnings by 1.9% (2.1%)

Study	Country	Dataset	Sample	Type of model	Dependent variable (log for earnings)	Measure of literacy	Controls for	Results for men (women)
							proficiency in English	
					annual earnings	aa	aa	10 point increase in score raises earnings by 2.2% (2.5%)
Raudenbush and Kasim (1998) Table 4	United States	NALS	people working, or wishing to work, full-time, aged 25-59	OLS	average weekly wages over past year	average literacy score	gender, ethnicity, work experience, parents. education	10 point increase in score raises earnings by 2.7% 1 s.d. increase in score raises earnings by 17.7% [men and women combined]
Charette and Meng (1998) Tables 5 and 6	Canada	LSUDA 1989	native-born Canadians, employed at some time in the prev 12 months, age 25-69	selection-corrected regression	annual income	literacy and numeracy test scores (both 0-500 scale)	demographics, disability, first language, education	10 point increase in score raises income by 2.9% (3.9%) in the case of literacy 0.7%* (4.2%) in the case of numeracy [literacy and numeracy included in the model at the same time]
						literacy test score	aa	10 point increase in literacy score raises income by 3.2% (4.4%)
						numeracy test score	aa	10 point increase in numeracy score raises income by 2.1% (5.4%)
			native-born Canadians, age 25-69, who were in the labour force in the last 12 months	OLS	weeks worked in the last 12 months	literacy and numeracy test scores	aa	10 point increase in score increases weeks worked by 0.3 (0.3) weeks in the case of literacy 0.2 (0.3*) weeks in the case of numeracy [literacy and numeracy included in the model at the same time]
Finnie and Meng (2001) Table 3	Canada	LSUDA 1989	employed at some time in the prev 12 months, age 16-24	selection-corrected regression	annual income	literacy and numeracy test scores	marital status, immigration status, first language, disability, education	10 point increase in score raises income by -0.9%* (6.2%) in the case of literacy 7.3% (3.3%*) in the case of numeracy [literacy and numeracy included in the model at the same time]
			people not in school, age 16-24	selection-corrected regression	weeks worked in past 12 months	literacy and numeracy test scores	marital status, immigration status, first language, disability, education	10 point increase in score increases weeks worked by 0.4 (0.4) weeks in the case of literacy -0.1* (0.6) weeks in the case of numeracy [literacy and numeracy included in the model at the same time]
Rivera-Batiz (1990) Table 2	United States	YALS 1985	workers aged 21-25	selection-corrected regression	hourly wages	literacy test score (0 to 500 scale)	work experience, education, vocational training, region, industry	10 point increase in score raises earnings by: 6.9% for Blacks 6.1%* for Whites [men and women combined]

Study	Country	Dataset	Sample	Type of model	Dependent variable (log for earnings)	Measure of literacy	Controls for	Results for men (women)
Studies using longitudinal data								
McIntosh and Vignoles (2001) Table A3	United Kingdom	NCDS	workers not in full-time education and not self-employed, age 37	OLS	hourly earnings (recorded at age 33)	literacy level at age 37 (included as a dummy variable)	demographics, family background (parents. education, social class and financial difficulties), age 7 reading test	increase in earnings compared to having low literacy skills, males and females together: 7.1%* for having medium literacy skills 16.3% for having high literacy skills
						literacy level at age 37	aa, plus age 16 reading test, education level	increase in earnings compared to having low literacy skills, males and females together: 1.3%* for having medium literacy skills 8.0%* for having high literacy skills
						numeracy level at age 37 (included as a dummy variable)	demographics, family background (parents. education, social class and financial difficulties), age 7 reading test	increase in earnings compared to having low numeracy skills, males and females together: 8.9% for having medium numeracy skills 18.0% for having high numeracy skills
						numeracy level at age 37	aa, plus age 16 mathematics test, education level	increase in earnings compared to having low numeracy skills, males and females together: 5.7%* for having medium numeracy skills 7.6%* for having high numeracy skills
Murnane*et al*(1995) Tables 3 and 4	United States	NLS72 HS&B	workers NLS sample in 1978, aged 24 HS&B sample in 1986, aged 24	OLS	hourly wages	score on test of basic maths skills, given at age 18	demographics, parents. education, no. of siblings, single parent household, education, work experience, part-time status	1 s.d. increase in score raises earnings by: 2.8% (6.3%) in the NLS72 7.9% (11.0%) in the HS&B
						score on test of basic reading skills, given at age 18	aa	pattern of results similar to maths test results above, but quantitative impacts on wages are smaller (no figures given)
Murnane, Willett, Duhaldeborde and Tyler (2000) Tables 5 and 6	United States	NLS72 HS&B	workers with a high school dipl. NLS sample in 1985, aged 31	OLS	annual earnings	score on test of basic maths skills, given at age 18	ethnicity, work experience, family background (incl. parents. education, no. of siblings, region)	1 s.d. increase in score raises earnings by: 14.6% (9.4%) in the NLS72 11.1% (11.9%) in the HS&B

Study	Country	Dataset	Sample	Type of model	Dependent variable (log for earnings)	Measure of literacy	Controls for	Results for men (women)
			HS&B sample in 1991, aged 27				aa, plus post-school education	
Dougherty (2003) Table 1	United States	NLSY	people working at least 30 hours a week	OLS	hourly earnings, measured in 1988, 1992 and 1996	score on tests of literacy and numeracy, given in 1980 when aged 15-23	ethnicity, work experience, parents. education, where living at 14, region and SES of current residence, unionisation, score on speeded tests (interpreted as a measure of ability) aa, plus education (years of high school, years of college and interaction terms with num and lit)	1 s.d. increase in score raises earnings by: 9.5% (1.4%) in the NLS72 6.7% (6.3%) in the HS&B 1 s.d. increase in score raises earnings by: 9.5% in the case of numeracy 1.4%* in the case of literacy [both literacy and numeracy were included in the model at the same time] 1 s.d. increase in score raises earnings by: 2.8% in the case of numeracy 1.9% in the case of literacy [literacy and numeracy included in the model at the same time]
EMPLOYMENT								
Studies using IALS data								
Maré and Chapple (2000) Table 12	New Zealand	IALS	whole sample	logit	prob. of being employed	average literacy score	demographics, education, parents. education, disability, first language not English	10% increase in score raises prob. of employment by 1.2 p.p. (2.2 p.p.)
McIntosh and Vignoles (2001) Table A6	United Kingdom	IALS	not in full-time education	probit	prob. of being employed	prose literacy level (included as a dummy variable) prose literacy level	demographics, parents. education, part-time status, weeks worked aa, plus education	increase in prob. of employment compared to having Level 1 literacy skills: 11.3 p.p. (16.8 p.p.) for being at Level 2 20.4 p.p. (14.9 p.p.) for being at Levels 3-5 increase in prob. of employment compared to having Level 1 literacy skills: 9.0 p.p. (13.5 p.p.) for being at Level 2

Study	Country	Dataset	Sample	Type of model	Dependent variable (log for earnings)	Measure of literacy	Controls for	Results for men (women)
								16.2 p.p. (8.5 p.p.*) for being at Levels 3-5
						quantitative literacy level (included as a dummy variable)	demographics, parents. education, part-time status, weeks worked	increase in prob. of employment compared to having Level 1-2 numeracy skills: -4.0 p.p.* (11.3 p.p.) for being at Level 3 6.3 p.p.* (16.4 p.p.) for being at Levels 4-5
						quantitative literacy level	aa, plus education	increase in prob. of employment compared to having Level 1-2 numeracy skills: -4.6 p.p.* (9.0 p.p.) for being at Level 3 3.3 p.p.* (12.3 p.p.) for being at Levels 4-5
Lee and Miller (2000) Table 11	Australia	IALS	whole sample	logit	prob. of being in the labour force	level on the document literacy scale (included as a dummy variable)	demographics, education, immigration status, disability, self-perception of maths skills	In general, the higher the literacy level the higher the labour force participation rate, for both men and women. No interpretation of logit coefficients is given.
			people in the labour force	logit	prob. of being unemployed	level on the document literacy scale	aa	In general, the higher the literacy level the lower the unemployment rate, for both men and women. No interpretation of logit coefficients is given.
Studies using other cross-sectional data								
Pryor and Schaffer (1999) Table 2.4	United States	NALS	people aged 25-49	logit	prob. of being employed	average literacy score	demographics, education, immigration status	1 s.d. increase in score raises prob. of being employed by 3.5 p.p. (7.2 p.p.)
Sum (1999) Appendix 7B tables	United States	NALS	whole sample	logit	prob. of being in the labour force	prose literacy score	demographics, enrolled at school, disability, marital status, immigration status, self-rep proficiency in English	10 point increase in score raises prob. of being in the labour force by 0.8 p.p. (men and women together)
							aa, plus education	10 point increase in score raises prob. of being in the labour force by 0.5 p.p.
					prob. of being employed	prose literacy score	demographics, enrolled at school, disability, marital status, immigration status, self-rep proficiency in English	10 point increase in score raises prob. of being employed full-time by 1.0 p.p. being employed full-time, for all the previous year, by 1.0 p.p.
							aa, plus education	10 point increase in score raises prob. of being employed by 0.7 p.p.

Study	Country	Dataset	Sample	Type of model	Dependent variable (log for earnings)	Measure of literacy	Controls for	Results for men (women)
								being employed full-time by 0.4 p.p. being employed full-time, for all the previous year, by 0.5 p.p.
			respondents in the labour force	logit	prob. of being unemployed	prose literacy score	demographics, enrolled at school, disability, marital status, immigration status, self-rep proficiency in English	10 point increase in score raises prob. of being unemployed by -0.6p.p.
							aa, plus education	10 point increase in score raises prob. of being unemployed by -0.4 p.p.
Raudenbush and Kasim (1998) Table 4	United States	NALS	people working, or wishing to work, full-time, aged 25-59	logit	prob. of being unemployed	average literacy score	gender, ethnicity, work experience, parents. education	1 s.d. increase in score reduces odds of being unemployed by 26.4%
Charette and Meng (1998) Table 3	Canada	LSUDA 1989	native-born Canadians, age 25-69	probit	prob. of being in labour force in last 12 months	literacy and numeracy test scores (both 0-500 scale)	demographics, disability, first language, education	1 s.d. increase in score raises prob. of being in the labour force by -0.4 p.p.* (0.3 p.p.*) in the case of literacy 1.5 p.p. (6.8 p.p.) in the case of numeracy [literacy and numeracy included in the model at the same time]
				probit	prob. of being employed in last 12 months	literacy and numeracy test scores	aa	1 s.d. increase in score raises prob. of being employed by 0.5 p.p.* (0.9 p.p.*) in the case of literacy 1.9 p.p. (6.8 p.p.) in the case of numeracy [literacy and numeracy included in the model at the same time]
				probit	prob. of being employed full-time in last 12 months	literacy and numeracy test scores	aa	1 s.d. increase in score raises prob. of being employed full time by 3.8 p.p. (1.4 p.p.*) in the case of literacy 1.7 p.p. (5.4 p.p.) in the case of numeracy [literacy and numeracy included in the model at the same time]
				probit	prob. of being unemployed in last 12 months	literacy and numeracy test scores	aa	1 s.d. increase in score raises prob. of being unemployed by -2.2 p.p. (-0.2 p.p.*) in the case of literacy -0.8 p.p.* (-0.01 p.p.*) in the case of numeracy [literacy and numeracy included in the model at the same time]
Finnie and Meng (2001) Table 2	Canada	LSUDA 1989	people not in school, age 16-24	probit with sample selection	prob. of being employed	literacy and numeracy test scores	marital status, immigration status, disability, education	1 s.d. increase in literacy score raises prob. of employment by 4.5 p.p. for men (not sig. and not given for women) 1 s.d. increase in numeracy score raises prob. of employment by 4.2 p.p. for women (not sig. and not given for men)

Study	Country	Dataset	Sample	Type of model	Dependent variable (log for earnings)	Measure of literacy	Controls for	Results for men (women)
								[literacy and numeracy included in the model at the s
					prob. of having been unemployed in last 12 months	literacy and numeracy test scores	marital status, immigration status, disability, education	1 s.d. increase in literacy score raises prob. of unemp p.p. for men (not sig. and not given for women)
								1 s.d. increase in numeracy score raises prob. of une 5.8 p.p. for women (not sig. and not given for men)
								[literacy and numeracy included in the model at the s
Rivera-Batiz (1992) Table 2 and footnotes	United States	YALS 1985	non-students aged 21-25	probit	prob. of being employed full time	literacy and numeracy test scores (0 to 500 scale)	education, ethnicity, marital status, region, vocational training	1 s.d. increase in score raises prob. of being employe 2.2 p.p. (8.2 p.p.) in the case of numeracy Correspon figures were not given but probit coefficients
								were positive and, at least for women, were significar
								[literacy and numeracy included in the model at the s
Studies using longitudinal data								
McIntosh and Vignoles (2001) Table A5	UK	NCDS	not in full-time education, age 37	probit	prob. of being employed	literacy level at age 37 (included as a dummy variable)	demographics, family background (parents. education, social class and financial difficulties), age 7 reading test	increase in prob. of employment compared to having 5.9 p.p. (0.9 p.p.*) for having medium literacy skills 7.5 p.p. (2.9 p.p.*) for having high literacy skills
						literacy level at age 37	aa, plus age 16 reading test, education level	increase in prob. of employment compared to having skills
								3.9 p.p. (-3.7 p.p.*) for having medium literacy skills 4.6 p.p.* (-3.0 p.p.*) for having high literacy skills
						numeracy level at age 37 (included as a dummy variable)	demographics, family background (parents. education, social class and financial difficulties), age 7 reading test	increase in prob. of employment compared to having skills
								4.2 p.p. (4.4 p.p.*) for having medium numeracy skills 6.4 p.p. (7.8 p.p.*) for having high numeracy skills

numeracy level at age 37	aa, plus age 16 mathematics test, education level	increase in prob. of employment compared to having skills 2.7 p.p.* (2.0 p.p.*) for having medium numeracy skill 4.2 p.p. (1.8 p.p.*) for having high numeracy skills

Study	Country	Dataset	Sample	Type of model	Dependent variable (log for earnings)	Measure of literacy	Controls for	Results for men (women)
Caspi*et al*(1998) Table 1	New Zealand	DMHDS	whole sample	tobit	prob. and duration of unemployment between 15 and 21	score on the Burt Word Reading test, measured at age 15	gender, school qualifications, school involvement, family background, delinquency, mental and physical health, all measured at age 15	adolescents with low reading scores had a 12.1 p.p. greater probability of being unemployed and, when unemployed, averaged 1.7 more months of unemployment

* not statistically significant at 5% level

. significance not given

DESCRIPTIONS OF THE STUDIES

National Adult Literacy Survey(NALS) was conducted in the United States in 1992. NALS is the forerunner to IALS: it was designed by the same organisation that designed IALS and has prose, document and quantitative scales ranging between 0 and 500. A nationally representative sample of nearly 13,600 individuals were interviewed in their homes and a sample of over 1,000 was also drawn from the prison population.

The Young Adult Literacy Assessment(YALS) was conducted in the United States in 1985. This was a nationally representative household survey of 3,600 21-25 year olds. Again, prose, document and quantitative literacy scores were created, ranging from 0 to 500.

Statistics Canada.s 1989 Survey of Literacy Skills Used in Daily Activities(LSUDA) was based on YALS, and was a nationally representative survey of around 9,500 people. LSUDA measures reading ability and numeracy on a scale from 0 to 500.

The National Child Development StudyNCDS is an ongoing birth cohort study of 17,000 people living in Great Britain who were born between 3 and 9 March 1958. A full survey was undertaken in 1991, and a 10% sub-sample was surveyed in 1995, when the cohort was 37. The 1995 survey included a test of basic literacy and numeracy skills. As with IALS, the tasks in this test measured participants. ability to apply literacy and numeracy skills in an everyday context, for example in using a Yellow Pages directory. The test in the NCDS was considerably shorter than IALS, however, consisting of 41 questions and taking around 30 minutes to complete.

TheNational Longitudinal Study of the High School Class of 1972(NLS72) and the High School and Beyond study of 1980 (HS&B) are two large longitudinal surveys of United States students first surveyed as high school seniors. In both surveys, participants were given very similar tests of basic mathematics, reading and vocabulary skills in their last year of high school. Scores in the maths tests had means between 12 and 14, depending on the year and whether the respondent was male or female, and standard deviations of around 7.

The National Longitudinal Survey of Youth (NLSY79) is a nationally representative sample of 12,686 14-22 year olds in the United States, first surveyed in 1979. In 1980, participants were tested on the Armed Services Vocational Aptitude Battery which included tests of mathematics knowledge, arithmetic reasoning (combined into a numeracy measure), word knowledge and paragraph comprehension (combined into a literacy measure).

The Dunedin Multidisciplinary Health and Development StudyDMHDS is a longitudinal study of a birth cohort of 1,037 children born in Dunedin between April 1972 and March 1973. Members of the cohort have been studied at various ages from 3 to 26. At age 26, 95% of the original sample of children were still participating in the study.

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