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Investing in Our Teachers, Investing in Our Economy

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This report was written by Ben Jensen, Director of the School Education Program at Grattan Institute. Ben Weidmann provided extensive research assistance and made substantial contributions to the report.

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1. Summary

Improving teacher effectiveness would have a greater impact on economic growth than any other reform before Australian governments. The improvement in student learning could lift Australian students to the top of international performance tables.

An increase in teacher effectiveness of 10% would lift Australia's education systems into the highest performing group of countries in the world. In the longer-term, this improves the productivity of Australian workers, which increases long-run economic growth by $90 billion by 2050, making Australians 12% richer by the turn of the century. This is in addition to the other benefits to individual wellbeing and society of better education.

Improving teacher effectiveness also has substantial economic benefits for individuals. Young people who stay in school and invest in further education can expect to earn an additional 8-10% per year for each additional year of education they undertake.

Increasing teacher effectiveness is thus perhaps the single most profound economic transformation open to Australian governments. Improvements of this magnitude are achievable. Each grade needs to incorporate an extra 5% of a year's worth of learning for our students to be amongst the best in the world.

However, education policy priorities would need to change. Past investments to improve school education have not yielded results.

Policies reducing class sizes have driven much of the increase in education expenditure in Australia over the last decades. These policies have been politically popular and are intuitively appealing. Advocates argue that a teacher should be able to offer more to fewer students.

The evidence does not support these policies. The vast majority of studies around the world have shown that class size reductions do not significantly improve schooling and student outcomes. For example, recent evidence from Florida that emphasised class size reductions in the early years of education shows that policies reducing average class size by about 2.5-3 students had no impact on improved schooling, but cost over $1 million dollars per school per year.

The evidence shows that improving teacher effectiveness is the best method of improving student performance. It is more important for a student to have an effective teacher than to be in a class with a few less students. Teacher effectiveness has a greater impact on student performance than any other government school education reform. Initiatives to improve teacher effectiveness not only help students more, they cost much less.

This report does not point the finger at teachers. On the contrary, this report argues for improved investments in teacher effectiveness. This will have the greatest benefit for our students and is the most effective method of making Australia's school education systems the best in the world.

2. Overview

This report begins by analysing the performance of Australian students relative to those in other countries. Section 3.1 identifies how much improvement is needed for Australian students to be amongst the best in the world.

The research of how best to improve student performance is then discussed. The evidence in Section 3.2 and 3.3 highlights the unsuccessful investments that have been made in reducing class sizes. Increasing teacher effectiveness has a much greater impact on student learning. This research is discussed and the implications for Australia highlighted in Section 3.4.

Section 3.5 then identifies the improvement in teacher effectiveness required for Australia's students to join the best performing students in the world. The main mechanisms for improving teacher effectiveness are then briefly discussed in Section 3.6.

Section 4 analyses the economic benefits of investing in improved teacher effectiveness. The relationship between schooling and economic growth is discussed to highlight the impact of improved teacher effectiveness on Australian economic growth.

Section 4 concludes with a brief discussion of the economic benefits to individual Australians from improved school education. The research shows that for each extra year of education, the average Australian can expect to earn 8-10% more each year.

Box 1 - Measuring teacher effectiveness

Much of the research analysed in this report uses quantitative analyses of teacher effectiveness. The focus is normally on measuring the "value-add" of teachers to student progress, with progress measured by improvements in student assessments.

This research is important and instructive, but it is not how education systems should measure the effectiveness of individual teachers. Measuring teacher effectiveness is the critical step in improving teacher effectiveness. It should not be skewed by a focus on student test scores. A variety of methods, both quantitative and qualitative, should be used to evaluate teachers' effectiveness and engage them in meaningful development. These should include student progress and other measures of student outcomes, student feedback, teamwork and peer evaluation, classroom observation from senior teachers and the school principal, self-evaluation, teacher development and improvement, and a variety of other factors that measure teachers' contributions to schools.

Most of these methods for evaluating and developing teacher effectiveness rely on school-based evaluations. Schools need the autonomy to engage in meaningful teacher evaluation and development.

If teacher effectiveness is measured centrally, this often leads to a focus on either standardised student tests or adherence to centrally administered teacher standards. Australian teachers report that teacher evaluation and development already suffers from being an overly bureaucratic exercise that has little impact on improved classroom teaching (OECD, 2009a).

3. Creating the best school education

Australia should aim to provide the best school education in the world. We currently have good quality school education, but we should focus on creating the world's best. This raises an obvious question: given all the money and effort already spent on education, how can we improve to be the best in the world?

3.1 How much improvement is needed?

There is no doubt that Australia has good quality school education. We perform well in international tests, and we have generally high levels of education participation and achievement (OECD, 2010a).

International comparisons of school education systems are driven by international assessments such as PISA, PIRLS and TIMMS.[1] We concentrate here on the OECD Program for International Student Assessment (PISA) that compares the performance of 15 year olds in reading, mathematical and scientific literacy in 65 countries (including all OECD countries).

Finland is widely considered to have the top performing education system in the world. It consistently ranks first in the PISA assessments and as Table 1 shows, has a substantial lead over other countries in the latest PISA rankings.[2]

Table 1 - Top 20 PISA 2006 performers

Country		Mean score
Finland	*Significantly higher than Australia*	563
Hong-Kong-China		542
Canada		534
Chinese Taipei	*Not significantly different to Australia*	532
Estonia		531
Japan		531
New Zealand		530
Australia		**527**
Netherlands		525
Liechtenstein		522
Korea		522
Slovenia	*Significantly lower than Australia*	519
Germany		516
United Kingdom		515
Czech Republic		513
Switzerland		512
Macao-China		511
Austria		511
Belgium		510
Ireland		508
OECD average		*500*

Source: Thompson and De Bortoli (2008) p.63.

[1] Progress in International Reading Literacy (PIRLS) and Trends in International Mathematics and Science study (TIMMS) are run by the International Association for the Evaluation of Educational Achievement.
[2] This report will be updated when new PISA results are released in 12/2010

Australia ranks 8th in the latest PISA assessment, but is only statistically significantly behind Finland, Hong-Kong China, and Canada. A 36-point gap must be overcome if Australia is to replace Finland as the top performing education system in the world.

To illustrate the magnitude of the challenge, a year's worth of learning is equivalent to 38 points on the PISA tests (OECD, 2007). Finnish students have, by the age of 15, accumulated an additional 97% of a year's learning. However, a smaller shift is required to reach the top tier of countries (Finland, Hong-Kong-China and Canada). The average score of these countries is 19 PISA points above that of Australia. Joining the top performing countries in the world implies that Australian students would need to learn another half a year's worth of curriculum in their time at school.

Improved student progress is therefore required – and is achievable. Most Australian students have at least 10 years of school education before they sit the PISA assessments. Assuming that curriculum gains are additive, each grade needs to incorporate an extra 5% of a year's worth of learning.

Box 2 – What it would take to be amongst the best?

- Australia needs to increase its PISA score by 19 points if it is to be considered amongst the top performing countries in the world
- 19 points = ½ a year's learning
- Requires students to learn 5% more each year

Box 3 – What is PISA?

PISA – the Program for International Student Assessment – is an international assessment of 15 year olds' reading, mathematical and scientific literacy. It is overseen by the Organisation for Economic Cooperation and Development (OECD).

First undertaken in 2000, the program is repeated every three years. In 2006, PISA encompassed the 30 OECD member countries, along with 27 partner countries. The assessments emphasise problem-solving abilities in mathematics, science and reading and writing literacy. Through the focus on problem solving abilities, the assessments are broader than many standardised tests such as the NAPLAN student assessments.

The PISA assessments are specifically designed to assess students' abilities that are considered essential for full participation in society. These are the problem-solving abilities that will be most important in the modern workplace. In assessing students' reading, mathematical and scientific literacy the focus is not on the mastery of the school curriculum, but on the important knowledge and skills needed in adult life (OECD, 2007).

For these reasons, the PISA assessments are ideal for the analysis presented here. They are good indicators of our students' future social and economic wellbeing and closely linked to the requirements of modern organisations. This facilitates linking these scores to changes in future economic growth.

3.2 Australia's history – much spending for little return

While Australian spending on school education is comparable with other developed countries, most spending increases in the last decades have not improved student learning.

Australia spends slightly less per primary school student than the OECD average, but more than the OECD average on pre-primary and secondary school students (OECD, 2010a). Various policies have contributed to the level of expenditure. Unfortunately, they have not resulted in overall improvements in student performance.

Australia increased its education expenditure by 41% (in real terms) between 1995 and 2006 (OECD, 2009b). However, between 2000 and 2006, Australian student performance in PISA stagnated in mathematics and significantly declined in reading (Thomson and De Bortoli, 2008). This reflects longer term trends. Between 1964 and 2003, real per child spending in school education increased 258%, while numeracy test results significantly fell by 1.1 points on the LSAY[3] scale (equivalent to 11 points on the PISA scale (Leigh and Ryan, 2008)).

Why did more spending not lead to better student performance? Much of the additional money was used to reduce class sizes in our schools (Leigh and Ryan, 2008). Australian experience is now consistent with international evidence – reducing class sizes is expensive, but does little to improve student performance.

[3] Longitudinal Survey of Australian Youth.

3.3 Smaller classes do not pay off

One of the most enduring policy prescriptions in education is to reduce class sizes. Smaller classes are intuitively appealing. It is easy to imagine that they result in more one-on-one interaction with students, more effective teaching and learning time for each student, and a reduction in the burden of dealing with negative behaviour. Unfortunately, the evidence does not support these assertions.

In fact, most studies find that despite spending significant resources on reducing class sizes, the effect on student performance is either negligible or there is no effect at all (Hoxby, 2000; Bohrnstedt and Stecher, 2002; Jepsen and Rivkin, 2009; Chingos, 2010).

In a meta-analysis of nearly 60 studies, Hanushek found that less than 15% reported a positive and significant effect of reducing class sizes (Hanushek, 1997; Hanushek, 2003). This meta-analysis has been disputed on technical grounds. Krueger (Krueger, 1999) challenged the methodology of the meta-analysis[4] but his revised version still did not support the efficacy of class size reductions. Only one-third of studies in this revised meta-analysis reported significant positive results (see Table 2) (Krueger, 2002; Krueger, 2003). One thing is clear, the majority of studies (between 66% - 85%) in both Hanushek's and Krueger's analysis of the research literature showed that class size reductions had no impact on student learning (Mishel and Rothstein, 2002).

[4] And Hanushek then challenged Krueger's methodology in what was a protracted and eventful debate between the two researchers.

Table 2 – Results of meta-analyses for the effect of reducing class size

Result	Hanushek's meta-analysis	Krueger's review of meta-analysis
Positive significant effect	14.8%	33.5%
Negative significant effect	13.4%	8.0%
Insignificant effect	71.9%	58.4%

Source: Mishel & Rothstein (2002) p.14

Reforms in Florida provide a more recent but typical example. Class size reductions focused on the early years but were mandated across school education (new class size maximums were introduced of 18 students in pre-kindergarten–3rd grade, 22 students in 4th–8th grade, and 25 students in 9th-12th grade).[5] A recent analysis of this policy concluded that the program "had little, if any, effect on cognitive and non-cognitive outcomes" (Chingos, 2010). This included not only student performance measures (between grades 4-8) but also indicators such as student absenteeism, suspensions and factors associated with school bullying such as violence and crime.

Florida's class size reductions followed policies in other countries (and other U.S. States) that concentrate on reductions in the early years of education. The majority of studies examining class size reductions find no positive impact on students (even in the early years). Of the minority (15%-33%) of studies that find a positive impact on students, a greater proportion of these focus on the early years. However, the positive impact is small with students only showing marginal improvement. The evidence is clear: Class size reductions, even in the early years, are very expensive and have a negligible impact on student outcomes.

Even if there were positive outcomes, the question remains whether reducing class sizes offers good value for money. Reducing class sizes, even by just a few students, has a large impact on school budgets as more teachers are required to teach the greater number of smaller classes. Teacher salaries comprise around two-thirds of all education expenditure in Australia (OECD, 2010a). For many individual schools, the proportion of their budget dedicated to teacher salaries is higher, often closer to 90%. While the precise costs of class size reduction vary depending on the system and the method by which class sizes are reduced, it will have a large impact on the costs of providing school education.

The costs of the Florida reforms were substantial. Average class sizes reduced by 5 students in pre-kindergarten-3rd grade (22% reduction), just over 2 students in classes in 4th-8th grades (a 9% reduction) and no change from the existing average for classes in 9th-12th grades. Reductions of this magnitude (average class size across school education reduced by about 2.5-3 students) cost the Florida Department of Education in excess of USD 20 billion over eight years with additional on-going costs of USD 4 billion each subsequent year (Florida Department of Education, 2009).

Even if we ignore the substantial implementation costs of USD20 billion, the USD4 billion annual operating costs equate to over USD1,500 per student and approximately USD 1.1 million per school per year (Florida's schools had an average size of over

[5] See www.fldoe.org/classsize.

700 students).[6] These are considerable costs for a program that had "little if any" impact on students.

While it would be easy to focus on this apparent waste of money, it is more important to consider how the money could have been better invested to improve schools.

3.4 Teacher effectiveness is the most valuable lever for system-wide improvements

The evidence overwhelmingly shows that investing in improved teacher effectiveness rather than the number of teachers is the most successful method of improving student learning and creating top performing education systems.

Many of us are fortunate enough to remember the teacher that had a great impact on our learning. Parents want effective teachers for their children. School principals often receive requests from parents that their child be placed in a class with a particular teacher or, in some cases, not in a class taught by a teacher considered to be ineffective. The evidence supports these beliefs. It is more important for a student to have an effective teacher than to be in a class with a few less students. Teachers have a greater impact on student learning than any other factor outside of family background (OECD, 2009a).

The impact of teacher effectiveness outweighs the impact of any other school education program or policy (Hanushek *et al.*, 1998; Rockoff, 2004; Hanushek *et al.*, 2005; Aaronson *et al.*, 2007; Nye *et al.*, 2007; Leigh and Ryan, 2010). In fact, the research findings on the relationship between teacher effectiveness and student performance are remarkably consistent. Australian research measuring how much teacher effectiveness improves student performance is similar to findings in other countries (Hanushek, 1992; Sanders and Rivers, 1996; Jordan *et al.*, 1997b; Wright *et al.*, 1997; Aaronson *et al.*, 2007; Leigh, 2010).

In the Australian context, conservative estimates suggest that a student with an effective teacher can achieve in three quarters of a year what would take a full year with a less-effective teacher.[7] To extend the comparison, a student with a teacher in the top 10% of teachers in the country could achieve in a half year what a student with a teacher in the bottom 10% of effectiveness achieves in a full year (Leigh, 2010). These estimates echo international research, reporting that the gap in outcomes between a student who has a less-effective teacher and a student who has a highly effective teacher can be as much as a full year's difference in achievement (Hanushek, 1992).

The impact of highly effective teaching is cumulative (Sanders and Rivers, 1996; Jordan *et al.*, 1997b). Students who are taught by less effective teachers over multiple years are considerably more likely to fall behind. US research shows that students who had three 'effective' teachers in a row were 49 percentile points higher on school assessments compared to students assigned 'ineffective' teachers over a three year period (Jordan *et al.*, 1997a). This is echoed by the findings of Sanders and Rivers

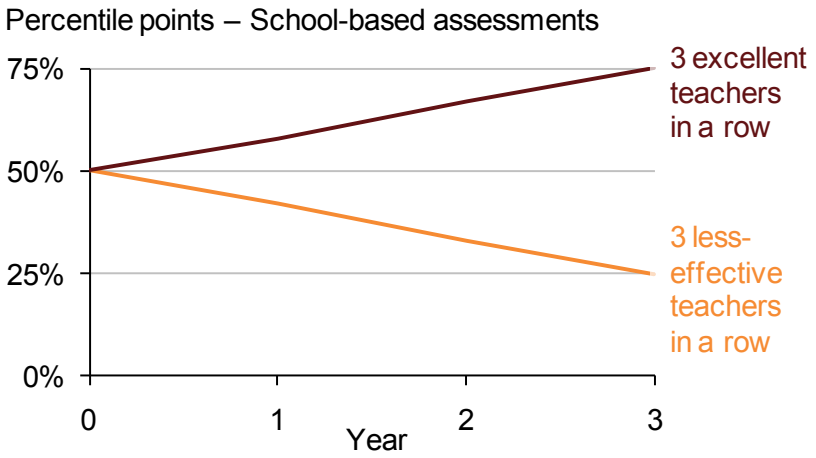
[6] This information was obtained from the website of the Florida Department of Education (www.fldoe.org). For the year 2009-10, Florida had over 2.6 million students and over 2600 public schools, with an average school size of over 700 students.

[7] "Effective" here means a teacher in the 75th percentile of teacher effectiveness, while "less effective" means a teacher in the 25th percentile. See Leigh (2010)

(1996) who found that students who were assigned high performing mathematics teachers three years in a row achieved scores approximately 50 percentile points higher than students who initially started with comparable maths scores but were then assigned to low performing teachers three years in a row.

Because of this cumulative effect (illustrated in Figure 1), even relatively modest increases in teacher effectiveness could make a substantial difference to individual students and the quality of school education overall.

Figure 1 – Impact of teacher effectiveness on student performance



Sources: Sanders & Rivers (1996); Jordan, Mendro & Weerasinge (1997)

Box 4 – What policies would it take to be amongst the best?

- Investing in improving teacher effectiveness is the best policy to improve schooling
- Spending money on class sizes is expensive and has negligible impact on students

3.5 How large an increase in teacher effectiveness is required to be amongst the best?

As discussed earlier, for Australian school education systems to be amongst the best in the world, students would need to learn 5% more in each year of their schooling. We estimate that this improvement would occur if all Australian teachers were 10% more effective, or if the least effective 14% of Australian teachers improved to the level of teachers at the 14th percentile.

In calculating this estimate, the evidence shows that:

- Australian students' performance would need to increase by 19 PISA points to be amongst the best in the world.
- 19 PISA points equates to a 5% increase in student learning in each year of school.
- A 5% increase in learning requires an improvement of 0.025 standard deviations in test scores (based on Australian research showing that an entire year's learning is equivalent to one standard deviation in test scores).

- Improving test scores by 0.025 standard deviations requires the effectiveness of all of Australia's teachers to improve by 0.25 standard deviations (based on Australian research showing that a 0.1 standard deviation increase in test scores is associated with 1 standard deviation in teacher effectiveness (Leigh, 2010)).

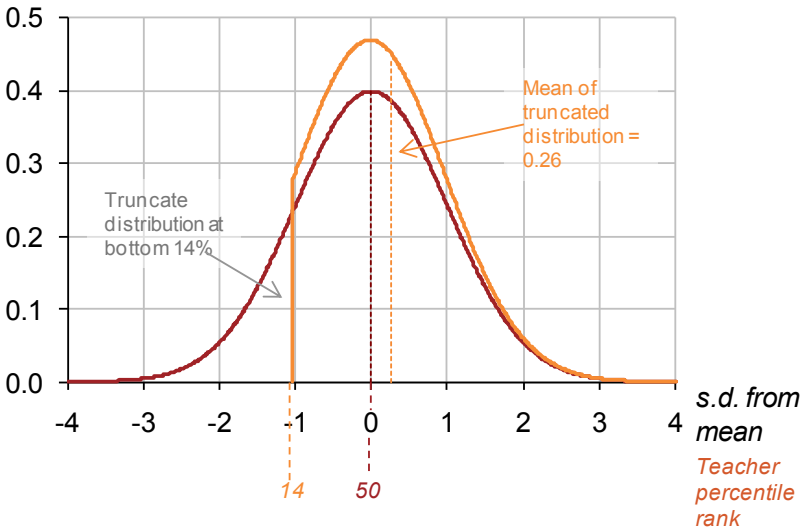
- Improving teacher effectiveness by 0.25 standard deviations requires a 10% increase in teacher effectiveness (assuming that teacher effectiveness is normally distributed).[8]

If we improve the effectiveness of the least effective 14% of teachers (to the effectiveness of teachers at the 14th percentile) it would have the same effect, lifting Australia's students to amongst the best performing education systems in the world.

As illustrated in Figure 2 this is modelled by truncating the standard normal distribution of teacher effectiveness. The impact on student progress of the least effective 14% of teachers has been shown to be more than 1.09 standard deviations below the average level of effectiveness (Leigh 2010). If we increase the effectiveness of these teachers or simply replace the least effective 14%, we have a new distribution with a mean of 0.26.[9]

From a policy perspective, it is doubtless worthwhile both to improve teacher effectiveness generally and to respond to under-performing teachers. Meaningful investments in improving teacher effectiveness would develop all teachers and address issues of under-performance.[10]

Figure 2 - Effect on teacher effectiveness of truncating the lowest 14% of the distribution



[8] An increase in teacher effectiveness of 19% would take Australian school education to the top of the international rankings. The increased learning would see Australian students replace Finnish students as the world's top performers.
[9] For a treatment of truncated normal distribution, see Greene (2003) p.759

[10] Cost considerations should be central to these investments. Specific programs aimed at sub-groups of teachers will have different costs and these should be weighed against their benefits.

3.6 Developing teacher effectiveness

There are five main mechanisms to improve teacher effectiveness:

1. Improve the quality of applicants to the teaching profession
2. Improve the quality of teachers' initial education and training
3. Evaluate and provide feedback to develop teachers once they enter the profession and are working in our schools
4. Recognise and reward effective teachers
5. Move on ineffective teachers who have been unable to increase their effectiveness through development programs.

These objectives and their policy responses are related. For example, moving on ineffective teachers first requires that effective teachers are recognised.

Meaningful evaluation is a critical initial step in increasing teacher effectiveness, particularly for mechanisms 3-5 above. It is a complex task that requires more than analysis of student test scores. Effective teacher evaluation includes multiple sources of feedback, both quantitative and qualitative, and is sought after by teachers (Jensen, 2010).[11]

This paper does not advocate using test scores to dismiss the lowest performing 14% of teachers. Teachers and school principals have both highlighted the need to address problems of under-performance. Teachers report that in their schools, not only are problems with poor performing teachers rarely addressed, but relatively less effective teachers receive greater recognition. Nearly three-quarters of Australian lower-secondary teachers report that in their school, teachers with sustained poor performance are not dismissed. In addition, nearly all Australian school principals report that they would not take steps to alter the monetary rewards of a persistently under-performing teacher (OECD, 2009a; Jensen, 2010). Furthermore, research conducted by the Boston Consulting Group for the Victorian Department of Education and Training, estimated that 99.85% of teachers were granted a 'satisfactory' outcome on their performance review. In contrast, school principals considered that up to 30% of teachers were either 'below average performers' or 'significant under-performers' (BCG, 2003).

Many of these problems stem from a lack of meaningful teacher evaluation and development. It is, therefore, ineffective (and grossly unfair) to dismiss poorly performing teachers who have never before received effective teacher evaluation and development. All teachers need to have effective evaluation that identifies their strengths and weaknesses and feeds into individualised development plans.

A development program may aim to increase the performance of teachers found to have specific weaknesses. Development steps should be undertaken so that they can raise their effectiveness to sufficient levels. Many will improve. Some will leave the profession of their own accord and some will be dismissed for not improving their performance. As shown, this will improve learning in schools and lift Australia's students to amongst the world's best.

[11] Future Grattan reports will look at the various methods for effective teacher evaluation, emphasising the need for multiple sources of feedback.

4. Economic benefits of investing in teacher effectiveness

Investing in teacher effectiveness is the most potent reform to boost Australia's economic growth. A 10% increase in teacher effectiveness improves student performance and, in the longer-term, the productivity of the labour force. The increased productivity of Australian workers would increase long-run economic growth by $90 billion by 2050, making Australians 12% richer by the turn of the century.

4.1 Years of schooling and economic growth

For several decades researchers have analysed the relationship between countries' education and their economic growth. Initial research focused on the effect of education, as measured by the average years of schooling in a country.

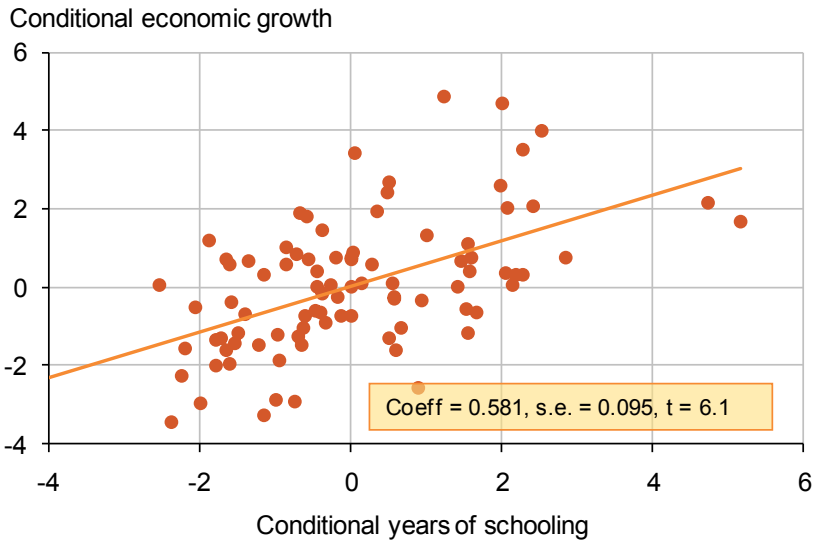
Figure 3 shows that there is some relationship between economic growth and the number of years students spend at school. This research was focused on the impact of compulsory schooling policies but there are difficulties in drawing conclusions about the impacts on economic growth (Oreopoulos, 2006).

Focusing on the *quantity* (i.e. the number of years) of education assumes that a year of schooling is the same in all countries. Few people would seriously believe that a student in Kyrgyzstan (a country with very low international test scores) would gain the same skills in a year of schooling as a student in Korea (a country with high international test scores) (OECD, 2010b, p.13).

Box 5 – Other benefits of improved education

Focusing on output-based economic measures (i.e. workforce participation, productivity and economic growth) ignores the many social benefits of education that are difficult to measure in dollar terms. These benefits range from effective democratic participation (Putnam and Helliwell, 2007), increasing awareness about environmental issues (OECD, 2007), and overcoming disadvantage to promote equal access to fulfilled lives (Isaacs *et al.*, 2008) Naturally, these benefits, and others such as improved health and crime avoidance, should be included in a complete evaluation of education investment but are beyond the scope of this brief review.

Figure 3 – Impact of *years of schooling* on real per capita GDP growth, in a model without a measure of student performance



Note: These results are from a regression of the average annual rate of growth (in percent) of real GDP per capita in 1960–2000 on average years of schooling in 1960 and the initial level of real GDP per capita in 1960.

Source: Reproduced from Hanusheck and Wößmann (2007)

There is also the issue of whether years of education *cause* economic growth. Even though there is a correlation between years of education and economic growth, does increasing the quantity of education increase economic growth? Or is it the case that countries with higher rates of economic growth invest more in education (Bils and Klenow, 2000)?

These difficulties have contributed to a shift in the empirical research. Increasingly, analysis is focusing more on what students learn and less on how many years they attend school.

4.2 Student performance and economic growth

Empirical analysis of the relationship between student performance and economic growth has built on a significant body of economic theory – called endogenous growth theory – which suggests that country growth rates will be determined by the skill level (or, put more broadly, the human capital) of the labour force (Lucas, 1988; Barro and Sala-i-Martin, 1995; Lucas, 2000). The idea here is that a higher level of human capital corresponds to the creation of new ideas and technologies, which lifts growth (Romer, 1986; Romer, 1994).[12]

Figure 4 shows that economic growth correlates more closely with student performance (as measured by test scores) than with years of schooling.

This focus on skills (rather than years of schooling) allows cross-country analysis to remove the unrealistic assumption that studying for a year in Kyrgyzstan and Korea has the same effect. It also provides some reassurance for policy makers around the issue of causation. There are three strong indicators that education (as measured by test scores) *causes* higher rates of growth.

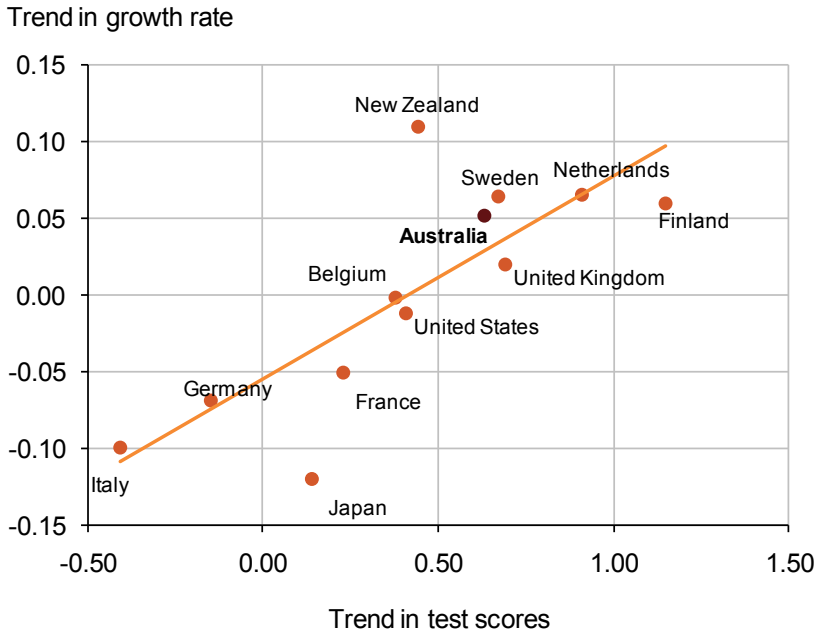
[12] It should be noted that numerous researchers have emphasised the role of human capital in economic growth without using endogenous growth modelling (Mankiw *et al.*, 1992).

First, increasing investments in education have not increased student performance. Test scores for maths and science are not systematically related to resources devoted to schools in the years prior to tests (Hanushek and Kimko, 2000).[13]

Second, countries with higher test scores in 1980 went on to have higher growth rates from 1980-2000 (OECD, 2010b).

Third, changes in test scores correlate strongly with changes in economic growth rates. Figure 4 shows a simple plot of trends in growth rates and trends in test scores.[14] Hanushek and Wößmann consider more complex and rigorous relationships, but the results hold – there is a strong correlation between changes in test scores and changes in economic growth rates (OECD, 2010b).

Figure 4 - Trends in student performance and economic growth rates



Note: Only 12 countries have participated in international tests over a sufficiently long period to look at trends over a 30 year period. In the chart, the 'trend in growth rate' is simply a bivariate regression of test scores on time. Trends in test scores are similarly derived. The plot provides the pattern of slopes from the test regressions.

Source: OECD (2010), originally presented in Hanushek & Wössmann (2009)

4.3 The impact of student performance on GDP

OECD and World Bank research has brought considerable prominence to the idea that school quality (as measured by student performance in international tests) drives economic

[13] The lack of a strong effect of resources on test results has been found to be true whether the indicator of resources is expenditure per student, pupil-teacher ratios or a range of other measures (Hanushek and Kimko, 2000).

[14] Hanushek and Wößmann compile countries results using the US based NAEP (National Assessment of Educational Progress). This can produce different results from other studies. For example, Leigh and Ryan (2010) analyse progress of Australian students by matching identical questions in student assessments over time.

growth. While estimates of the impact of student performance on GDP growth vary, a conservative estimate is that increasing international test scores by one standard deviation would lift GDP growth by 1%.

A series of studies, driven by Eric Hanushek and Ludger Wößmann and Dennis Kimko, have estimated that one standard deviation increase in test scores lifts long-run GDP growth by 1.4%-2% (OECD, 2010b; Hanushek & Kimko, 2000).

These estimates can be sensitive to a range of factors, including:

- choice of model
- selection of period analysed
- countries included in the sample
- which test scores are used (math, science, reading, adult literacy)
- how the index of test-score achievement is constructed.

Other studies suggest that the economic benefits of improving Australian school education may be smaller, although still very significant. A brief summary of some recent research is presented in Table 3.

These estimates (presented in column 5 of Table 3) illustrate that Hanushek and Wößmann assign the largest impact of student performance on economic growth. Their estimate that a one standard deviation increase in test scores lifts GDP growth by 2% is at the top end of the research. When they restrict their analysis to OECD countries this estimate reduces to an impact on growth rates of 1.7%. And it reduces further to 1.5% when including institutional variables such as measures of the openness of the economy and the security of property rights.

Other studies estimate the impact of a one standard deviation increase in test scores on GDP growth between 0.8%-1.2%.

This does not mean that the Hanushek and Wößmann research should be ignored (particularly as it addresses many of the methodological concerns raised in previous analysis). Rather, it should be placed in the context of other research.

It is conservative to estimate that a one standard deviation in international test scores would increase GDP growth rates by 1%. The actual association may be larger, and the World Bank and OECD research suggests that it is above 1%, but a cautious approach is preferred as it reflects a broader range of research findings.

Table 3 Summary of recent research estimating the relationship between student performance and economic growth rates

Study	Year	Sample size	Education performance measure	Change in GDP growth from one standard deviation increase in student performance	Qualifications
Lee & Lee	1995	17 in total, 14 OECD.	IEA test in 1970-71 of high school science	1.2%	
Hanushek & Kimko	2000	31 countries	Standardised scores of 6 international assessments conducted by IEA and IEAP.	1.4%	
Barro	2001	43 in total. OECD + others	One cross-section from 1990s. Science, maths, reading variables all modelled	1.0%	
Ramirez, Loe, Schofer and Meyer	2006	38	Cross-sectional ave. of FIMS, FISS, SIMS SISS, IAEP I and II [same as Hanushek and Kimko (2000)]	(between 1970-90) 0.6% (between 1980-2000) Not significant at p=0.05	Link between test scores and growth 'reduced when the four Asian Tigers…are removed', and weaker over last 20 years
Hanushek & Wößmann	2007	50 countries	Average of mathematics and science scores over all international assessments	1.3%	
Altinok	2007	120	TIMMS, PIRLS, PISA, SACMEQ, PASEC, LLCE, MLA	0.9%	
Appleton, Atherton & Bleaney	2008	120	Hanushek & Kimko (2000) dataset	0.8%	
OECD	2010	23 OECD countries	Standardised scores for all countries on all assessments between 1964 and 2003. This includes the major international assessments (e.g. PISA, TIMMS) and 12 different international tests of mathematics, science, or reading	1.5 – 2.0%	Impact reduces to 1.5% when controlling for institutional factors and restricting analysis to OECD countries

4.4 What is the impact on GDP if we increase teacher effectiveness?

A 10% increase in teacher effectiveness would improve test scores by 19 PISA points and put Australia amongst the best performing education systems in the world. This would increase the long run GDP growth rate by 0.2% *every year,* adding $90 billion to Australia's GDP by 2050 and make Australians 12% richer by the end of the century.[15]

Naturally it takes a significant period of time for improvements in the skills of students to feed into the labour market. However, because the effects are cumulative, the long term increase in wealth can be dramatic.

Obviously, these projections involve large degrees of uncertainty – particularly given the length of the time. However, the evidence clearly shows improvements to education can make a fundamental difference to a country's economy. They can out-perform other areas of reform that typically dominate discussions of economic policy.

4.5 The returns to individual Australians

Better education also provides substantial returns to individuals. For each extra year of education, the average Australian can expect to earn 8-10% more each year.

Some recent studies from Australia and other countries are presented in Table 4 and highlight the remarkable consistency of research findings since Mincer's seminal work in 1974 (Mincer, 1974; Rummery *et al.*, 1999; Acemoglu and Angrist, 2000; Harmon *et al.*, 2000; Voon and Miller, 2005; Miller *et al.*, 2006; Leigh and Ryan, 2008).

Australian research suggests returns of 8-10% for each extra year of education (although Miller *et al.* (2006) estimate a return of only 5% in their study of Australian twins). These figures are in line with international evidence, in which the wage benefit associated with an extra year of education centres roughly around 10% (Hanushek and Wößmann, 2007).

[15] This is based on the conservative assumption that a one standard deviation in international test scores would increase GDP growth rates by 1%. The World Bank and OECD research indicate that the impact on GDP would be much larger. These calculations also assume that reform to improve student performance occurs between 2010-2030, and a working life of 40 years.

Table 4 – Wage premiums associated with an extra year of education

Study	Sample	Wage increase for extra year of education
Leigh & Ryan (2008)	HILDA	10%
Miller, Mulvey & Martin (2006)	Australian Twin Register, 1031 fraternal twin pairs, 759 identical twin pairs	5-7%
Voon & Miller (2005)	Australian Census data	9%
Rummery, Vella, Et al. (1999)	Longitudinal survey of Australian Youth	8%
Harmon, Oosterbeek & Walker (2003)	British Household Panel Survey	7-11%
Acemoglu & Angrist (2000)	U.S. Census data	10%
Oreopoulos (2006)	U.K General household survey, Northern Ireland Continuous Household Surveys U.S. and Canada census data	10-14%
Mincer (1974)	U.S. Census data	10%

There is also Australian evidence estimating the returns to educational qualifications (Leigh, 2008; Wei, 2010). Table 5 shows that the average Australian can expect to earn around 45% more if they complete a bachelor degree than if they finished their education at high school (Leigh, 2008).

Table 5 - Wage premiums associated with higher qualifications

Qualification	Sample	Wage increase compared to school graduate
Bachelors degree	HILDA	45%
	Census*	50%
Masters or Doctorate	HILDA	67%
	Census*	63%

Note: *Results are weighted averages for males and females, where weights are based on workforce representation
Source: Leigh (2008), Wei (2010)

This research focuses on the benefits gained from additional years of education and obtaining additional qualifications. It does not normally focus on test scores as these are normally confidential and not available to researchers. However, recent Australian research shows that literacy and numeracy scores are significantly associated with increased wages and labour force participation (Shomos, 2010).

The returns to individual Australians support the finding linking increased teacher effectiveness to increased economic growth. People with better education are more likely to earn more due to their increased productivity that increases economic growth.

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