Stronger Smarter Institute
Research & Impact Footprinting

Reading Review TIMSS 2015 and PISA 2015

Stronger Smarter Meta-Strategy links:

1. Acknowledging, embracing and developing a positive sense of identity in schools → 2Embracing Indigenous leadership. →3. High Expectations Relationships → 4. Innovative and Dynamic School Models →5. Innovative and dynamic school staffing models

This Reading Review provides a summary and review of two reports released in 2017 by the Australian Council for Educational Research (ACER)

▶ The Trends in International Mathematics and Science Study (TIMSS) is an international comparative study of student achievement. In Australia, TIMSS is managed by the Australian Council for Education Research (ACER), and the full Australian report was released in early 2017.

▶ The Programme for International Student Assessment (PISA) is an international comparative study of student achievement directed by the Organisation of Economic Cooperation and Development (OECD). PISA measures how well 15-year olds are prepared to use knowledge and skills in particular areas to meet real-life opportunities and challenges.

In this review, we have concentrated on looking at the factors impacting on the performance of disadvantaged and Indigenous students.

Contents of this Review

What is the research?

The goal of the TIMSS study is to provide comparative information about educational achievement across countries in order to improve teaching and learning in mathematics and science. TIMSS looks at Year 4 and Year 8 students.

For TIMSS the study sample was

▶ one intact class from the relevant year level of each sampled school

▶ along with all Indigenous students in that year level.

TIMSS report that the statistical weighting enables these students to represent the total student population at each year level (TIMSS p. xv).

PISA aims to look at

▶ are certain ways of organising schools and school learning more effective than others?

▶ what influence does the quality of school resources have on student outcomes?

▶ what educational structures and practices maximise the opportunities of students from disadvantaged backgrounds?

For PISA, Australia took a larger sample than the one required to purposely oversample smaller jurisdictions and Indigenous students and ensure reliable estimates for those populations.

Sampling

TIMSS			PISA
6th study since first conducted in 1995			6th study since first conducted in 2000
Internationally – number of education systems	Australia sample – schools	Australia sample – students	Australia sample – 15-year olds
49 at Year 4 39 at Year 8	287 primary 285 secondary	6,057 Year 4 10,338 Year 8	758 schools 14,530 students

Areas tested

In the TIMSS survey, students were tested on knowing, applying and reasoning:

- Knowing – covers facts, procedures and concepts
- Applying – the ability of students to apply knowledge and conceptual understanding to solve problems or answer questions
- Reasoning – goes beyond the solution of routine problems to encompass unfamiliar situations, complex contexts and multi-step problems.

In the PISA survey, students were tested on the ability to apply knowledge and skills to real life problems and situations.

In both surveys, students provided background and attitudinal data, and school principals and teachers provided additional information.

Year 4 TIMSS	Year 8 TIMSS	15-year olds PISA
▶ Number ▶ Geometric shapes and measures ▶ Data display ▶ Life science ▶ Physical science ▶ Earth science	▶ Number ▶ Algebra ▶ Geometry ▶ Data and chance ▶ Biology ▶ Chemistry ▶ Physics ▶ Earth Science	▶ Science ▶ Reading ▶ Mathematics

The results

In the discussion of the results for this Reading Review, we look particularly at Australia's results for Indigenous students and for students from disadvantaged backgrounds. Both surveys show an achievement gap between Indigenous and non-Indigenous students and between disadvantaged and advantaged students. We have focused on the information provided by the student and teacher/principal questionnaires to explore reasons as to why this achievement gap occurs.

Beliefs about science

We start this discussion by looking at the PISA survey results from the student questionnaire investigating student awareness and understanding of environmental issues and epistemological value beliefs about science (PISA p.234 - 241). Students were asked questions about

- **Knowledge** – how informed they were about 7 different environmental issues.
- **Optimism** – whether they thought that the problem associated with 7 environmental issues would improve or get worse over the next 20 years.

▶ **Value beliefs (epistemological beliefs)** – students were asked to indicate their level of agreement with a series of six statements about their knowledge of how value beliefs about science are constructed.

The results are that on all three scales, Indigenous students scored significantly higher than non-Indigenous students. In other words, Indigenous students in Australia, compared to non-Indigenous students have

▶ significantly higher awareness of environmental issues

▶ slightly higher level of environmental optimism

▶ significantly more knowledge of how science beliefs are constructed – and in fact show significantly more knowledge than the average for all OECD countries, whereas non-Indigenous students scored slightly below the OECD average

The PISA report states that there is a positive relationship between these three areas and scientific literacy performance. And yet, despite these results, both TIMSS and PISA show that there is a considerable achievement gap between Indigenous and non-Indigenous students.

This Reading Review explores possible reasons why, if Indigenous students have a higher awareness of environmental issues and knowledge of science beliefs, this is not translated to academic achievement.

The achievement gap

Both the TIMSS and PISA reports show that there are significant achievement gaps

▶ between Indigenous and non-Indigenous students

▶ depending on location – students in metropolitan areas achieve better than students in remote areas

▶ depending on socio-economic status – of both the student and the school

Indigenous students – achievement gap

Averages are lower

▶ In PISA, Indigenous students achieved around 2.5 years of schooling lower than non-Indigenous students
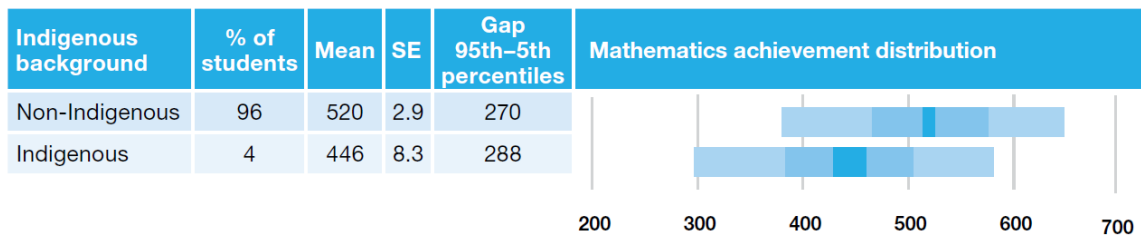
Less students reach proficient standard.

▶ 30% of Indigenous students did not reach the low benchmark in Year 4
▶ In PISA, 31% of Indigenous students achived proficient standard compared to 62% for non-Indigenous students

At the high benchmarks there are also achievement gaps

▶ 1% of Indigenous students reach the advanced benchmark compared to 10% of non-Indigenous students.
▶ In PISA, 3% of Indigenous students are high performaers in scientific literacy compared to 12% for non-Indigenous students

Nothing much has changed in 20 years – the achievement gap is still the same for both TIMSS and PISA.

Figure 2.21 from the TIMSS report shows the difference in Indigenous/Non-Indigenous results for Year 4 Mathematics. The graphs for Science and for Year 8 are all similar.
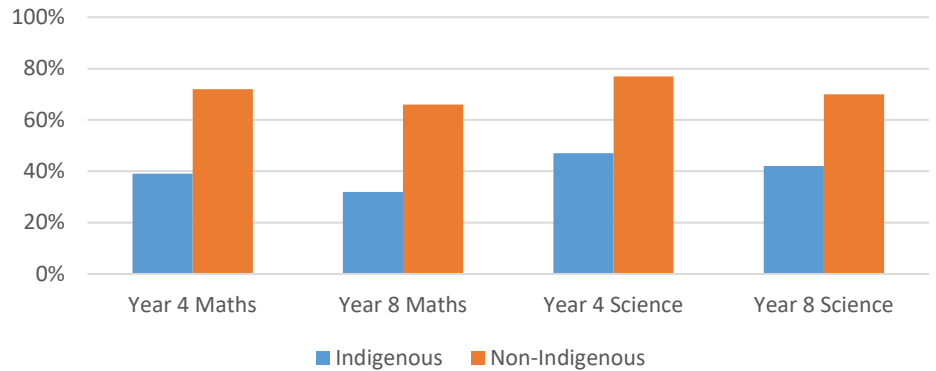
Indigenous background	% of students	Mean	SE	Gap 95th–5th percentiles	Mathematics achievement distribution
Non-Indigenous	96	520	2.9	270	
Indigenous	4	446	8.3	288	

Note: See Reader's Guide for interpretation of graph.

FIGURE 2.21 Mean scores and distribution of Year 4 mathematics achievement within Australia, by Indigenous background

The percentages of Indigenous students reaching proficient standard is much lower than for non-Indigenous students, on all TIMSS and the PISA measures. Chart 1 shows TIMSS results.

Chart 1: Percentage reaching proficient standard (TIMSS data)
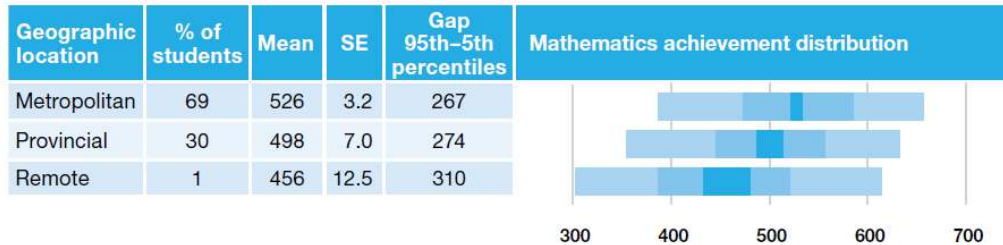

The achievement gap between Indigenous and non-Indigenous students has not changed for 20 years (Figure 2.23).

FIGURE 2.23 Trends in Year 4 mathematics achievement within Australia, 1995–2015, by Indigenous background
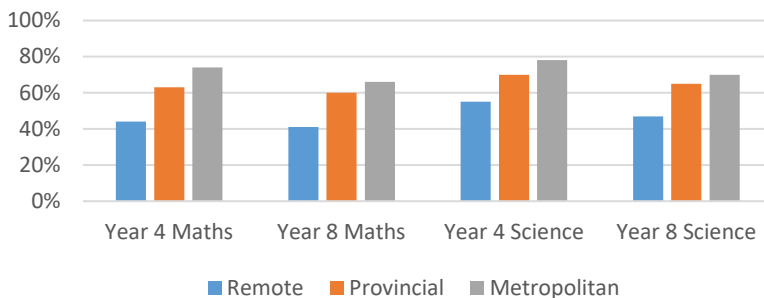
Achievement gap - Location

The TIMSS data shows that students perform better in metropolitan schools than in remote schools. For instance, Figure 2.26 shows the results for Year 4 mathematics achievement by location.

Geographic location	% of students	Mean	SE	Gap 95th–5th percentiles	Mathematics achievement distribution
Metropolitan	69	526	3.2	267	
Provincial	30	498	7.0	274	
Remote	1	456	12.5	310	

Note: See Reader's Guide for interpretation of graph.

FIGURE 2.26   Mean scores and distribution of Year 4 mathematics achievement within Australia, by geographic location

Chart 2: Percentage of students reaching proficient standard (TIMSS)

The percentages of students reaching proficient standard varies significantly by location (see Chart 2 from TIMSS data).

PISA data (PISA p.xxiii) shows that students in metropolitan areas perform significantly higher than students from provincial or remote schools. Students from provincial and remote schools performed at a statistically similar level.

Achievement gap - Socio-economic status

There is an achievement gap depending on both the socio-economic background of the student and the school. Finding from PISA reveal that the difference between advantaged and disadvantaged students in equivalent to around three years of schooling (Schleicher, 2017, PISA p.xxv).
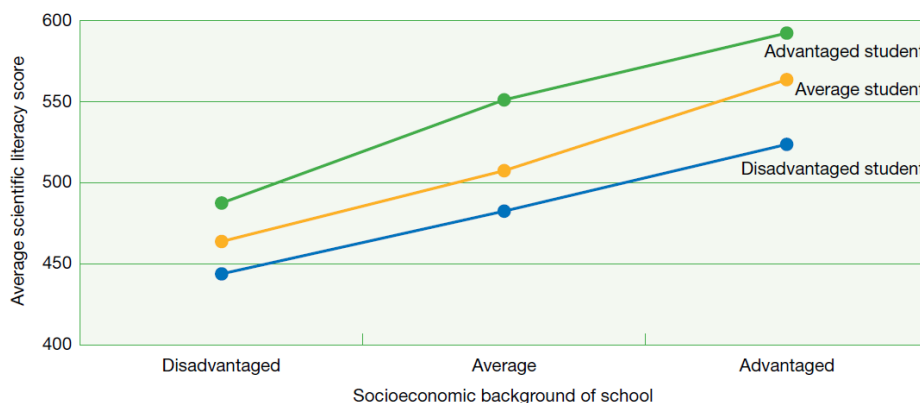

FIGURE 6.7   Scientific literacy achievement of students and schools by socioeconomic background

Regardless of socioeconomic background, students enrolled in a school with high average socioeconomic background tend to perform at a higher level than students enrolled in a school with a low average socioeconomic background. (PISA p.xxx, TIMSS p.152). PISA figure 6.7 (previous page) shows that Australian students preform relatively lower when they attend disadvantaged schools but disadvantaged students suffer the most.

ACER summarises these results as follows: *Disadvantaged students in average socioeconomic level schools are almost a year of schooling higher than those in disadvantaged schools. Similarly, disadvantaged students in advantaged schools are more than one year of schooling higher than those in average socioeconomic level schools. (ACER, 2017)*

The PISA report confirms this, suggesting that in Australian 12% of the variation in achievement is explained by socio-economic background of the student (PISA p.209). However, the social composition of the school has just as strong an impact on the likelihood of being a low achiever as the student's own family background. After the student's family's socioeconomic status is taken into account, the student in the disadvantaged school is four times more likely to be a low performer. (PISA p.206)

Home environment

What makes a difference

► **Parental education** – e.g. at Year 8, 59% of students whose parents who didn't complete secondary school didn't reach proficient standards compared to 18% with at least one parent holding a university degree

► **Resources** – students score higher when they have more books at home.

► **Parental engagement** – PISA found that students whose parents reported 'spending time just talking to my child', or 'discussing how well my child is doing at school' daily or nearly every day were between 22 per cent and 39 per cent more likely to report high levels of life satisfaction (Schleicher, 2017 b).

What doesn't make a difference

► **Language spoken at home:** TIMSS found no significant differences between students who mostly speak English at home and those who speak a language other than English.

► PISA found that students who speak English at home performed significantly higher in science and reading, but there was no significant difference in mathematics.

► **Where born:** Australian-born students performed lower than first generation students, and statistically similar to foreign-born students ((PISA p.xxvi)

Impacting factors

Both reports gathered information that allows an analysis of factors that might be impacting on achievement.

Home situation

In the home situation, higher parental education and greater resources at home correlate with improved outcomes. These two factors are also likely to vary with socio-economic status.

School environment

The results show that the school environment does make a difference (TIMSS, p.149). Higher achievement is associated with students who report a greater sense of school belonging, a safe, orderly school learning environment, and a high emphasis on academic success (ACER, 2017). In the Stronger Smarter Approach, we would describe this as schools with High-Expectations Relationships – schools who are emphasising both the 'Strong' (sense of belonging, sense of cultural identity) and the 'Smart' (high academic expectations).

The PISA study (PISA, p.xxxi) showed that principals stating that student behaviour was disrupting teaching was most apparent in disadvantaged schools. Students also thought the same. Students in the PISA reported classroom discipline levels that placed Australia below the OECD average. About one-third of the students in affluent schools, and about half of those in disadvantaged schools, reported that in most or every class there was noise and disorder, students didn't listen to what the teacher said, and that students found it difficult to learn. (ACER, 2017).

The percentage of students in the school who speak English as their first language makes a difference – and yet at the student level, the

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school environment

What makes a difference

Higher achievement is associated with

▶ **First language:** schools where more than 50 percent of the student population have English as their first language.

▶ **Students reporting a greater sense of school belonging (e.**g. in TIMSS, Year 3 students with a high sense of school belonging scored around 70 points higher than those with little sense of school belonging (TIMSS p.163).

▶ **Attendance –** being absent once a week has an impact, but the impact is small for students absent once every two weeks (TIMSS, p.189).

▶ **School emphasis on academic success –** this relationship is stronger at Year 8 than at Year 4 (e.g. Year 8 Science the difference between a medium and very high emphasis on academic success is 70 points (TIMSS p.167).

▶ **Safe orderly schools with few discipline problems** (TIMSS p.172 and 174).

What doesn't make a difference

▶ **School Resources** – there is a small impact in terms of school resources, but the impact is greater for science than for mathematics (TIMSS p.159).

▶ **School condition** – no impact at

language spoken at home doesn't make a difference. This would be interesting to explore further to understand whether the issue is lack of resources to teach students with English as a second language, or whether there is an impact from the fact that schools with high percentage of second language speakers are likely to be either in Aboriginal communities or high migrant areas. Is it possible that both these situations are also associated with low socio-economic status and low expectations?

Student attendance appears to have less impact that might be expected. Being away from school once a week does make a difference, but beyond that the differences in attendance on student achievement are relatively small. School resources and school condition also have minimal impact.

These results have potential implications for how money is spent in schools. Putting resources into teacher professional development and supporting Aboriginal Education Workers to provide greater support to teachers may have a greater impact than physical resources or attendance schemes.

Schleicher (2017b) suggests that schools can also support disadvantaged students by creating an environment of co-operation with parents and communities. *Teachers can be given better tools to enlist parents' support, and schools can address some critical deficiencies of disadvantaged children, such as the lack of a quiet space for studying. If parents and teachers establish relationships based on trust, schools can rely on parents as valuable partners in the cognitive and socio-emotional education of their students.*

Students' attitudes, engagement and aspirations

Higher student achievement is associated with students who indicate that they like mathematics or science, are confident, and value it, and consider they are taught in an engaging way (although this relationship for engaging teaching is more important at Year 8 than at Year 4) (TIMSS p.130).

Both reports then go on to show a clear relationship between disadvantage and attitudes and aspirations. Disadvantaged students

▶ like mathematics and science less

▶ are less confident

Teachers and teaching

Factors that don't make a difference

The TIMSS results show no clear relationships between mathematics and science achievement and

▶ teacher job satisfaction

▶ the degree to which teachers emphasised science investigation in class (TIMSS p.199)

▶ the average time that Year 8 students spent on homework – for science there is no significant difference between spending 45 minutes and week or 3 hours or more a week.

- value maths and sciences less

- are less likely to report that their teachers are very engaging or supportive

- have lower aspirations for the future.

The PISA report compared attitudes of Indigenous and non-Indigenous students. Indigenous students reported

- Lower levels of interest in broad science topics (PISA, p.229)

- Lower levels of enjoyment of learning science (PISA, p.231)

- Less instrumentally motivated to learn science (PISA, p.223), where motivation was based on career aspirations

Schleicher (2017b) reporting on PISA findings states that

- On average across countries, students who reported that their teacher is willing to provide help and is interested in their learning are also about 1.3 times more likely to feel that they belong at school.

- Conversely, students who reported some unfair treatment by their teachers were 1.7 times more likely to report feeling isolated at school.

Schleicher (2017b) says this is particularly important in Australia where students' sense of belonging in schools is lower than in many countries. Students who feel that they are part of a school community are more likely to perform better academically and be more motivated in school.

Other studies have also shown that teacher support and high expectations can make a difference. California Safe and Supportive schools studied 793 public high schools over the period 2008 - 2010 using data from a number of different sources. They concluded that there is a correlation between high levels of teacher support (as defined by caring relationships and exposure to high expectations messages) and greater numbers of

Disadvantaged students – attitudes and engagement

Disadvantaged students

- **Value science and mathematics less** – at Year 4 the difference is not significant, but it becomes significant by Year 8 (TIMSS, p.207, p.216).

- **Are less confident** – significant differences between socioeconomic groups.

- **Less likely to report engaging teaching** - Disadvantaged students were more likely to report lower levels of very engaging teaching at Year 8. But there is no difference at Year 4 (TIMSS, p.231)

- **Lower aspiration**s - 75% of students from an advantaged background expected to attend university compared to 28% from a disadvantaged background.

- 52% of disadvantaged students only planned to go as far as upper secondary or less, compared to 10% of advantaged students. (TIMSS, p.232)

students who report receiving higher grades and being strongly connected to school, and fewer students who report skipping school and feeling unsafe at school

These results provide interesting information about the achievement gap between disadvantaged and advantaged students. Ways of teaching, amount of homework, and even student attendance do not have a major impact on academic performance.

However, engaging and supportive teachers who can build student confidence and aspirations will make a difference. And it is evident that this is more likely to occur in advantaged than in disadvantaged schools.

ACER summarises this by stating t*he good news is that when they [disadvantaged students] do experience very engaging or supportive teaching, they – and their advantaged peers – have higher achievement than those students who face less engaging or supportive teaching.*

Dockery's (2017) longitudinal study looked at a Connection to Kinship measure, and found that where parents place a high priority on fostering a strong sense of identification with their Aboriginality in their children – pride, respect, knowledge of their family networks and family history – then those children display better outcomes. This measure of parents is higher in major cities – suggesting that in remote areas, students are already embedded in their kinship networks, and also suggesting that for Aboriginal and Torres Strait Islander children living in mainstream Australia, maintaining a strong identity is important.

In remote areas, where parents place a high emphasis on traditional knowledge their children's maths and reading scores are higher, but their school attendance is lower. Dockery says this suggests that the schools are not catering for students learning needs – and education in remote schools will be most effective with local-based curricula designed to combine traditional and mainstream learning.

Resilience

The PISA report, and a 2011 OECD report (using data from the 2006 PISA study) both look at resilient students – i.e. those who do better than their socio-economic background would predict. The OECD report found that resilient students are more motivated, engaged and self-confident than other disadvantaged students.

However, boosting self-confidence and engagement is more beneficial for advantaged students than for disadvantaged, which the OECD report suggest may come from an additional positive boost from supportive households. The OECD report suggests that schools have an important role to play in targeted strategies for disadvantaged students, to provide that extra support to, for instance have discussions about why science matters, when their families may not be equipped to have these discussions at home. These need to be strategies to build student confidence, foster positive approaches to learning and motivation. Schools may need to provide disadvantaged students with higher quality experiences and work hard to improve students' motivation and confidence.

Schleicher (2017a) says that this shows that *'deprivation is destiny is a myth or a false assumption that can stand in the way of educational improvement.*

He says the PISA results show that education systems where disadvantaged students succeed are those that are best able to moderate social inequities. *They tend to attract the most talented teachers to the most challenging classrooms and the most capable school leaders to the most disadvantaged schools, thus challenging all students with high standards and excellent teaching.*

Resilience

PISA classifies students as 'resilient' if they are in the bottom quarter of the PISA index of ESCS in their country but perform in the top quarter of students in the focus subject among all countries (PISA p.216)

Across Australia, 33% of low-quartile of socio-economic background students are considered to be as resilient (p.212)

▶ Student self-confidence is the strongest predictor of resilience. (OECD, p.65) These self-confident disadvantaged students are 1.95 times more likely to be resilient than disadvantaged students who are not confident, even when accounting for student and school background factors, including how many hours they spend learning science at school per week.

▶ Motivation, positive learning approaches and learning time are also predictors of resilience

What will make a difference?

A OECD (2016) report, *Low-Performing Students: Why They Fall Behind and How to Help Them Succeed*, provides suggestions for success for low-performing students. Andreas Schleicher, who is the Director for Education and Skills with the OECD has also provided a couple of useful summary pieces.

Areas for consideration include

Engagement, motivation and self-confidence

▶ Students self-beliefs will impact on their well-being and motivation. When students feel they belong at a school they are more motivated (OECD 2016, p.117).

▶ Schleicher (2017a) reports that the countries that do better are those where students believe they will success if they try hard and trust their teachers to help them succeed.

School characteristics

▶ Effective schools are led by individuals who community clear goals and define plans, promote a positive school climate, collaboration among teachers and professional development for teachers. Effective leaders welcome and encourage teacher participation in school decisions and involve parents in school life. Effective leaders set high expectations for student achievement while nurturing students' well-being. (OECD, 2016, p141).

Expectations for students

▶ School leaders and teachers sometimes respond to low-performing students by lowering their expectations and reducing the scope of curriculum – this type of response can turn into a self-fulfilling prophecy whereby lower expectations lead to poorer performance (OECD, 2016, p.141).

▶ Schleicher (2017b) says that while all teachers care about positive relationships with their students, some may not be sufficiently prepared to create a learning environment that facilitates and supports active engagement in learning. *Schleicher says "Teachers should also be better supported to collaborate and exchange information about students' difficulties, character and strengths with their colleagues, so that they can collectively find the best approach to make students feel part of the school community.*

Resources

▶ Improving the quality of a school's resources and ensuring that every child has access to quality school buildings, teachers and educational material is important for low-performing students. However, once principals report that the quality of their school resources is satisfactory, additional or better-quality resources have little additional impact on low performance. (OECD, 2016, p.175).

Summary of Key Points

▶ In Australia, Indigenous students have significantly higher awareness of environmental issues, slightly higher level of environmental optimism, and significantly more knowledge of how science beliefs are constructed compared to non-Indigenous students. And yet, when it comes to performance in standardised testing, Indigenous students achieve at lower levels than non-Indigenous students.

▶ The data provides some clues about why there are achievement gaps (between Indigenous and non-Indigenous students and between disadvantaged and advantaged students). There are multiple risk factors (OECD, p.191)

  o Students of low socio-economic status, and students is schools of low socio-economic status achieve at lower levels
  o Students with lower self-confidence, lower expectations or themselves and lower aspirations will perform at lower levels
  o Attendance does make a difference, but the impact is only significant at the levels of extreme non-attendance
  o Parent involvement can make a difference
  o Teacher support and expectations make a difference

▶ The socio-economic status of the school is likely also to correlate with low teacher and student expectations and potentially with low parent involvement (due to their own lack of resources or value of the schooling system).

▶ Disadvantaged students are more likely to come from an immigrant background and attend schools where there are larger concentrations of other disadvantaged students, greater teacher shortage, poorer quality educational resources and where teachers have low expectations of their students (OECD, 2016, p192).

▶ In Australia, many Indigenous students may be in schools of low socio-economic status, and we need to look at these multiple factors when considering policy for Indigenous education. Even for Indigenous students in metropolitan or high-advantaged schools, there is evidence that the issues around a sense of identity and belonging, recognising the worth of mathematics and science as taught in schools, and seeing relevance to their own lives and future aspirations, may all still be relevant.

▶ In low socio-economic schools, supportive teaching, engaging curriculum all become more important to make up for the opportunity gap left by lack of parent resources and low student expectations.

▶ As shown in Bruce Torff's work (see SSI Reading Review), in low socio-economic schools it is more likely that there is a 'rigor gap' where teachers inadvertently use lower critical thinking activities for low-advantage students, resulting in a watered down curriculum. If this is also resulting in a loss of student engagement and feeling of belonging in schools, then we will continue to see an achievement gap.

Stronger Smarter Recommendations and Provocations

Implications for policy makers and educational systems

It is time to stop talking about the achievement gap and to start understanding and addressing the underlying causes. The OECD report, p.191 suggests that policy makers should design a policy strategy that addresses the multiple risk factors faced by low performers. Innovative school models are needed to provide education that is relevant and recognises the diverse learning needs of students.

Stronger Smarter Metastrategies and Approach

We suggest that the evidence from TIMSS and PISA clearly shows that many of the underlying causes of low achievement are around student identity, high expectations and belonging. If policy strategies for Indigenous education and low-advantage students include all elements of the Stronger Smarter Metastrategies and the Stronger Smarter Approach, then they can start to address these causes.

Metastrategies 1 and 2: Positive student identity and embracing Indigenous leadership

PISA data suggests Indigenous students have a high understanding and value of environmental and scientific issues. Indigenous parents value cultural education for their children. And yet, Indigenous students are not attending school, perhaps because they can get a better cultural education with their families. When they do attend school, they lack motivation because they don't see the relevance of studies to their future lives. They don't expect to go to university, or to get jobs that require maths and science.

If our education system is always trying to address the 'gap' with remedial, watered-down curriculum, then it will not deliver for our Indigenous and disadvantaged students. The research tells us that what is needed is to address student engagement, teacher support, positive student identity, and culturally-responsive pedagogies, and working with local Indigenous communities to provide the best support for students.

Metastrategy 3: High-expectations relationships

Schleicher (2017a) says that the PISA study suggests that teachers often expect less of students from lower socio-economic background even if the students show similar levels of achievements. And those students and their parents may expect less too. Schleicher says it is unlikely that school systems will achieve performance parity with

the best-performing countries until they accept that, with enough effort and support, all children can achieve at very high levels.

The 2016 OECD report says that training and development programs for school leaders need to emphasise the type of leadership that fosters expectations of high academic achievement for all students in their schools (OECD, 2016, p.193).

Metastrategies 4 and 5: Innovative school models and staffing models

There are significant implications for how we use school funding. The 2016 OECD report suggests that providing quality resources for all students is important, but once these reach a certain level, additional resources do not make a difference. Peter Adams, senior manager at PISA at the OECD, (interviewed by Chelsea Attard in Education HQ Australia) says that more teachers with the aim of smaller class sizes may not necessarily help, but providing more support, giving teachers more preparation time, and more professional development is more likely to help. Schleicher (2017a) agrees that the highest performing education systems in PISA focus resourcing on attractive teacher working conditions and careers, ongoing professional development and working balance, rather than on smaller class sizes. Riddle (2016) says that resourcing needs to go to more teacher aides, counsellors and community liaison, whole-school pedagogical approaches, parent engagement, targeted interventions and programs, as well as adjusting curriculum for the diverse learning needs of different students.

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See also the Institute's Reading Review of Bruce Torff's research on folk beliefs and the rigor gap.

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