Student achievement in mathematics and science

International data: PISA and TIMSS

Queensland Government | QCAA Queensland Curriculum & Assessment Authority

For all Queensland schools

Learning goals

To develop understanding of:

- the main positions around international testing data (specifically PISA and TIMSS)
- Queensland's data and how it compares with other Australian jurisdictions
- future considerations that may positively impact student learning.

Structure of presentation

- approaches to data
- positions on international testing data
- comparisons with national testing (e.g. NAP-SL)
- Queensland data
- considerations for Queensland schools

Why discuss international testing results?

- increased focus in the media
- can influence educational and policy debates
- need to approach data in a considered way in order to lead informed discussions about next steps
- presents opportunities for reflecting on practices that lead to improvement for students at
  - national level
  - state level
  - local levels

What is PISA?

- Programme for International Student Assessment (PISA)
- triennial international study
- measures knowledge and skills of 15-year-olds in
  - scientific literacy
  - reading literacy
  - mathematical literacy

What is TIMSS?

- Trends in International Mathematics and Science Study
- conducted every four years
- assessments are conducted in mathematics and science for students in Year 4 and Year 8
  - content dimension (domains/subject matter)
  - cognitive dimension (expected thinking processes and sets of behaviours)

Limitations with international testing data

- The assessments are point in time measures.
- They only represent a sample of students.
- Different forms of sampling are used for different assessments and for different purposes within assessments.
- Only a limited set of skills is assessed.

Data presented within the media

Two approaches:

1. comparison of country ranks
2. comparison of country mean scores over time.

Problems with country ranks

- Countries do not have comparable demographic and sampling processes.
- Number of possible ranks is not stable.

Problems with country mean scores

- Iterations of each assessment may not be equally comparable or be testing the same thing.
- National average may not be a fair representation of each jurisdiction.

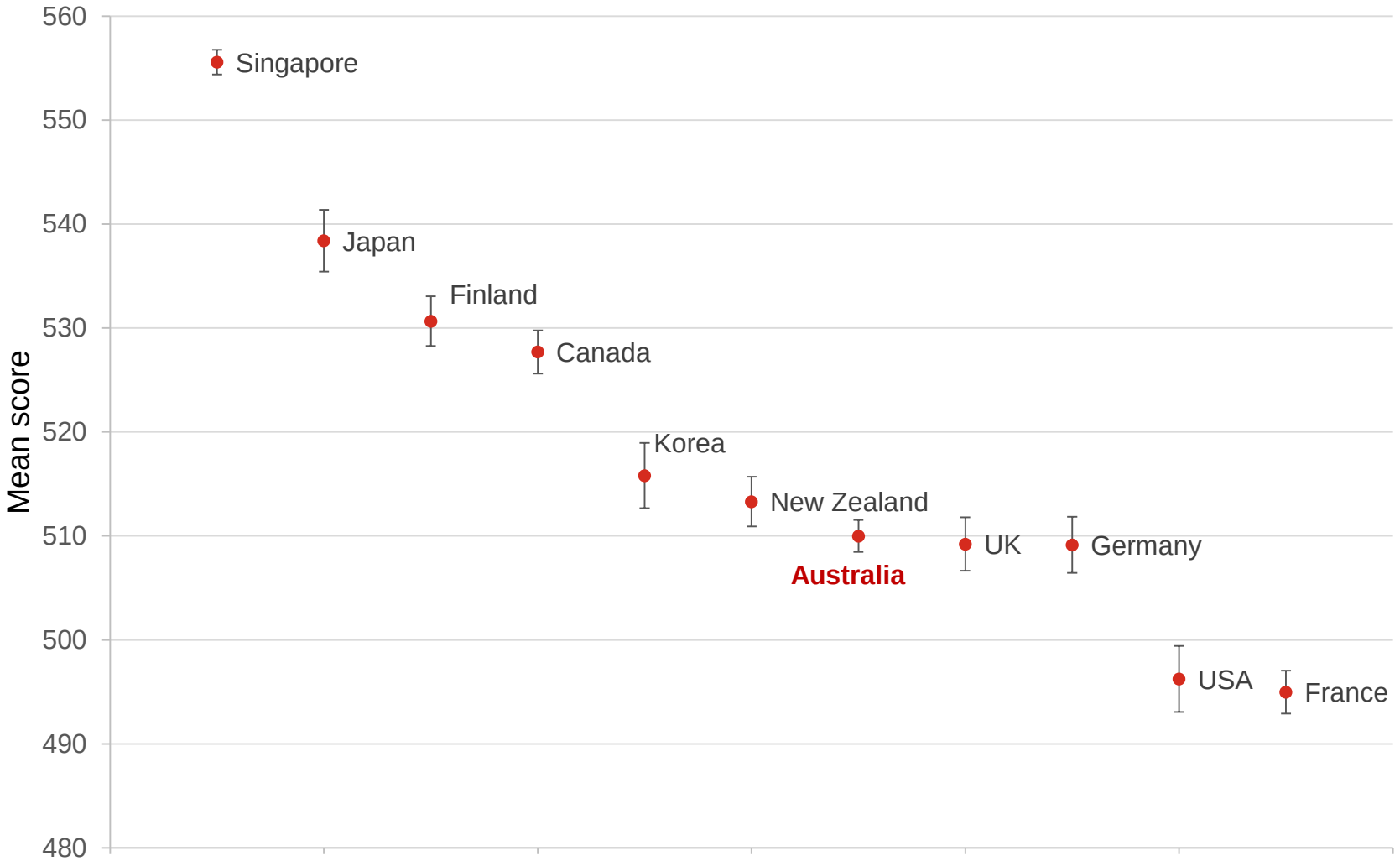
Comparing countries

- Countries have societal, cultural and contextual variations.
- The preferred comparison option is within-country variations.

Uncertainty in results

- standard errors
- confidence interval

Average scores with standard error
PISA 2015 (scientific literacy)



Data from Thomson, S, De Bortoli, L & Underwood, C 2016, *PISA 2015: A first look at Australia's results*, Australian Council of Educational Research, Melbourne.

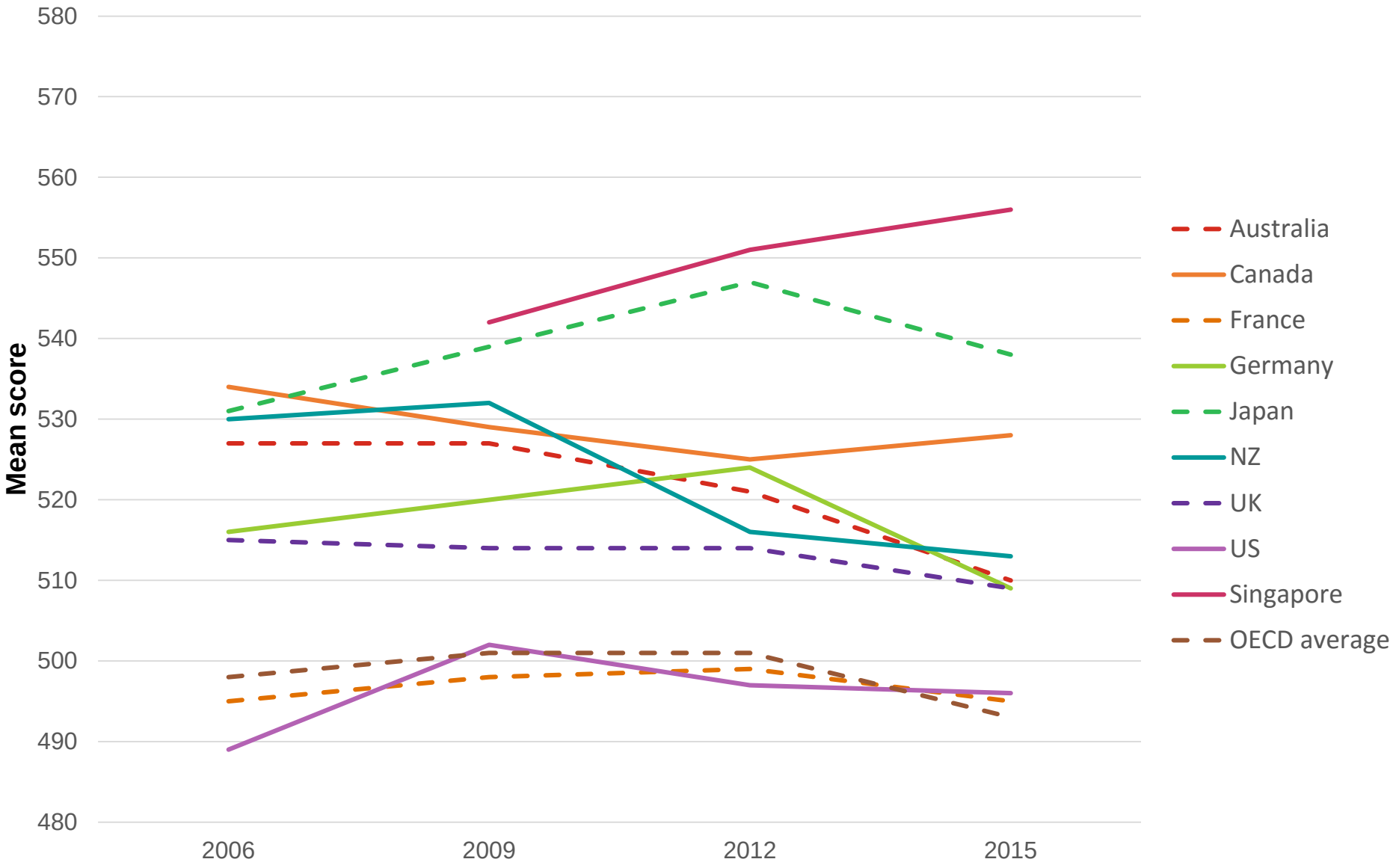
Two dominant positions

Position 1: Australian performance is declining

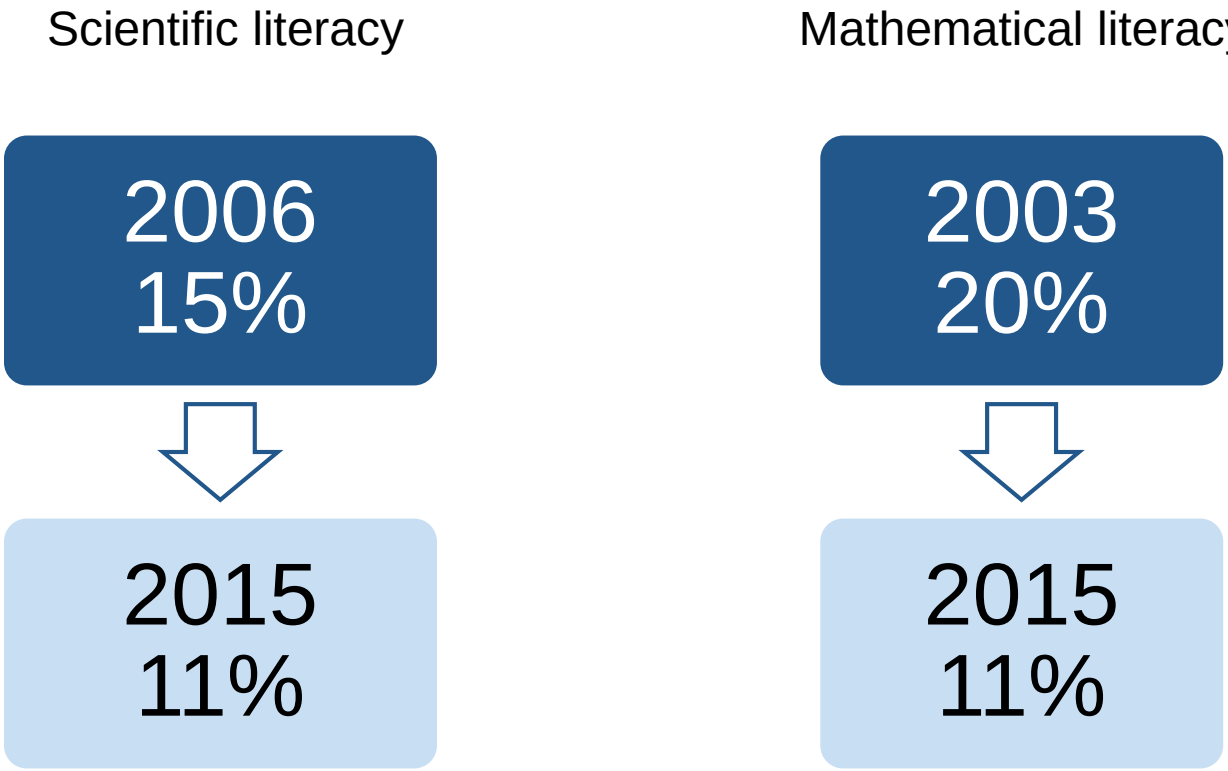
Position 2: Australia’s performance is stable

Position 1: Australian performance is declining

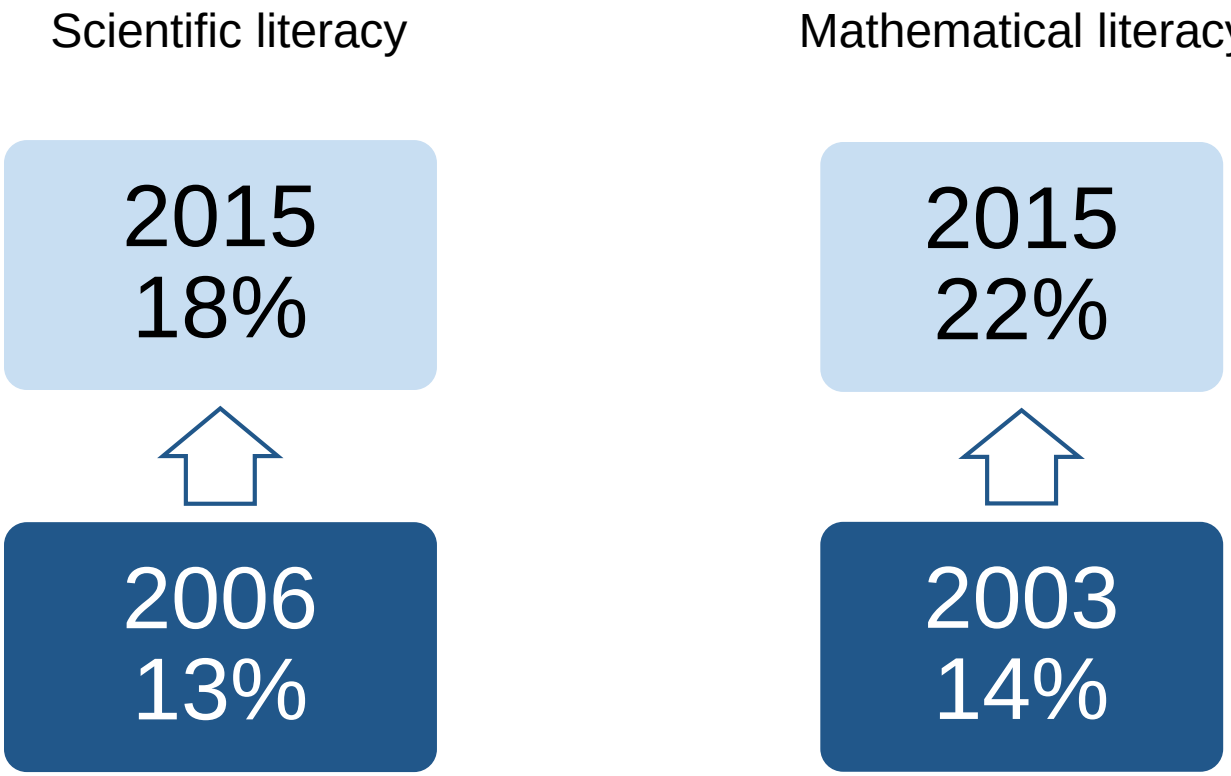
PISA scientific literacy 2006–2015



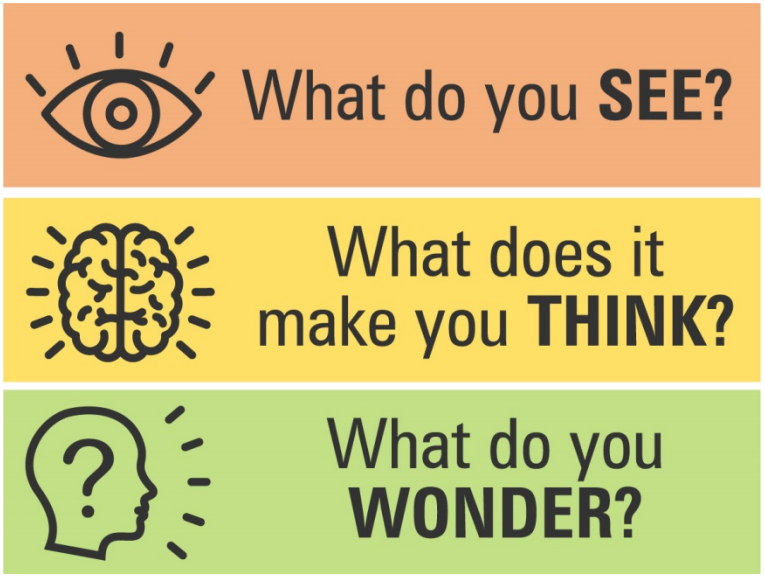
PISA: Australia's proportion of high performers is declining



PISA: Australia's proportion of low performers is increasing

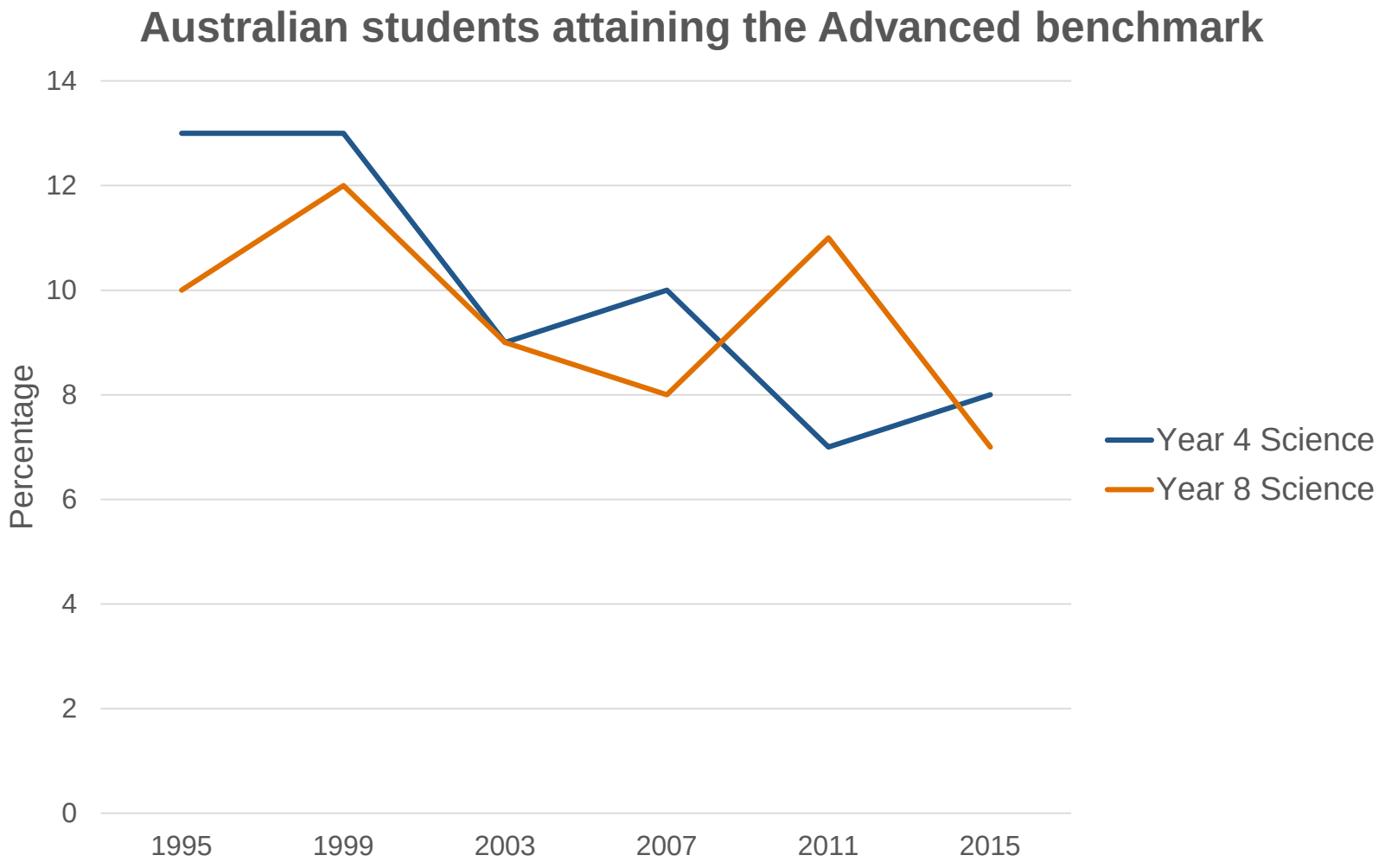


Activity 1: Data for discussion



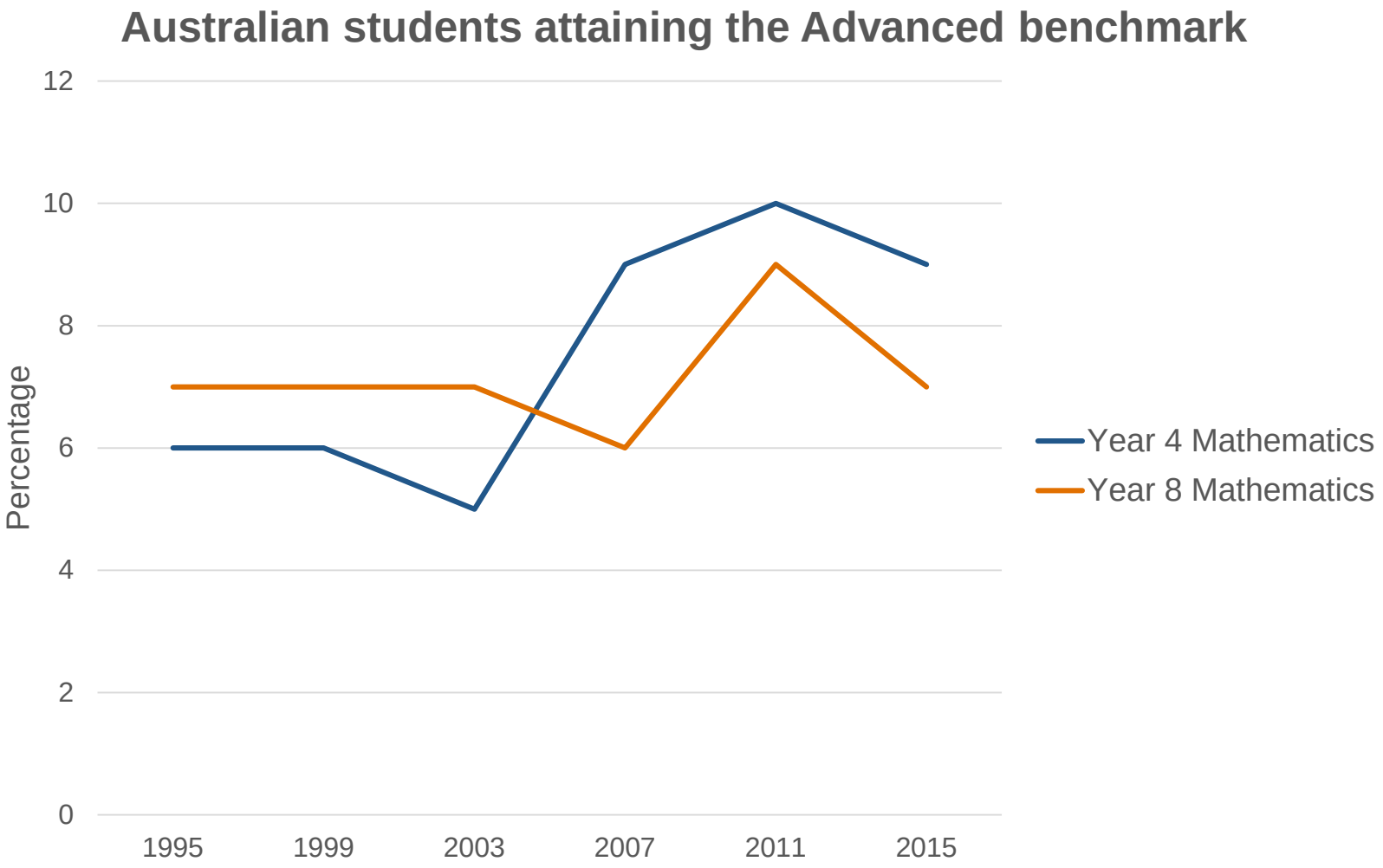
Examine Figures 1 to 5 on the Activity 1 handout and discuss your conclusions.

TIMSS: Science 1995–2015



Data compiled from http://research.acer.edu.au/timss/

TIMSS: Mathematics 1995–2015



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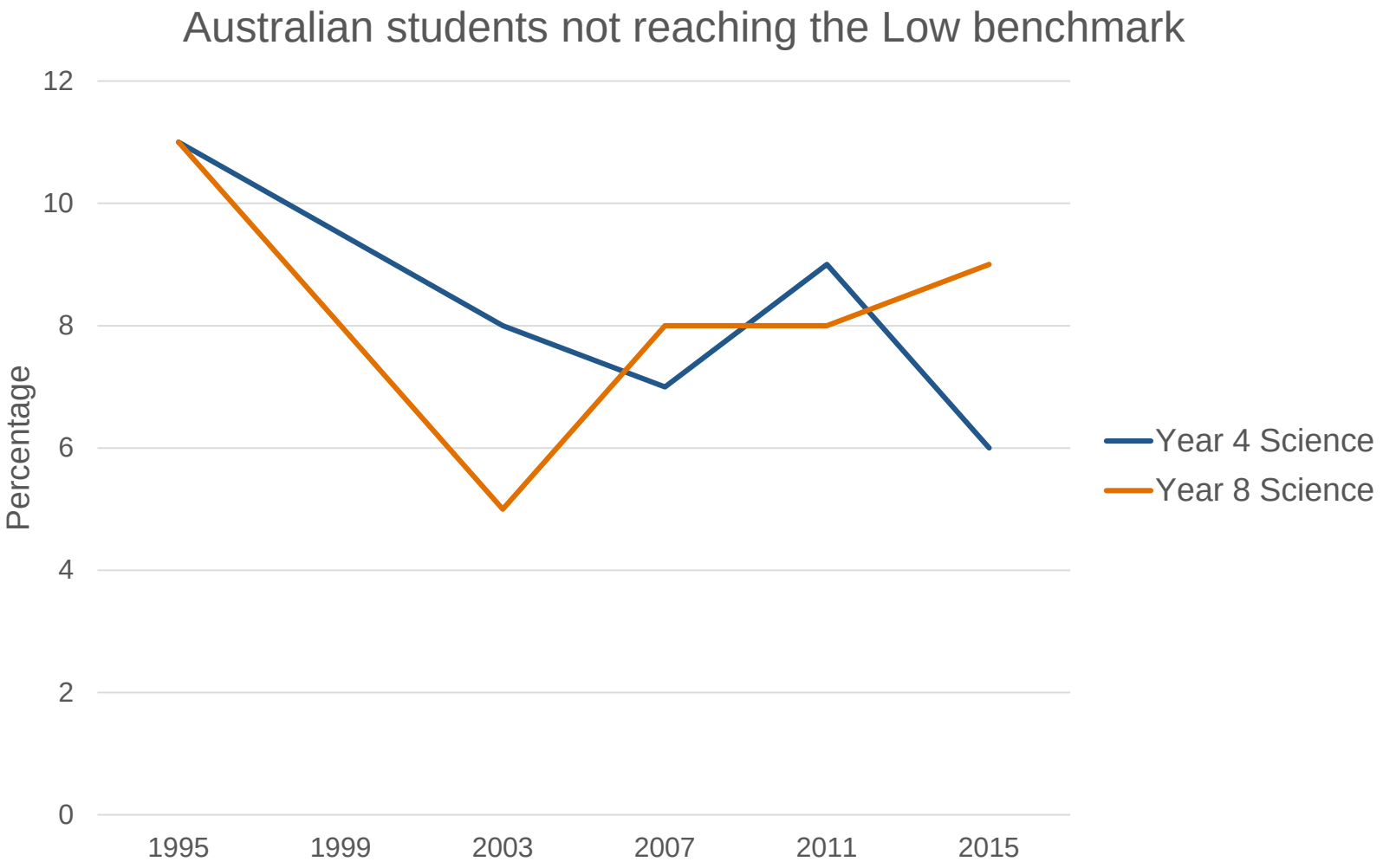
TIMSS: Science 1995–2015



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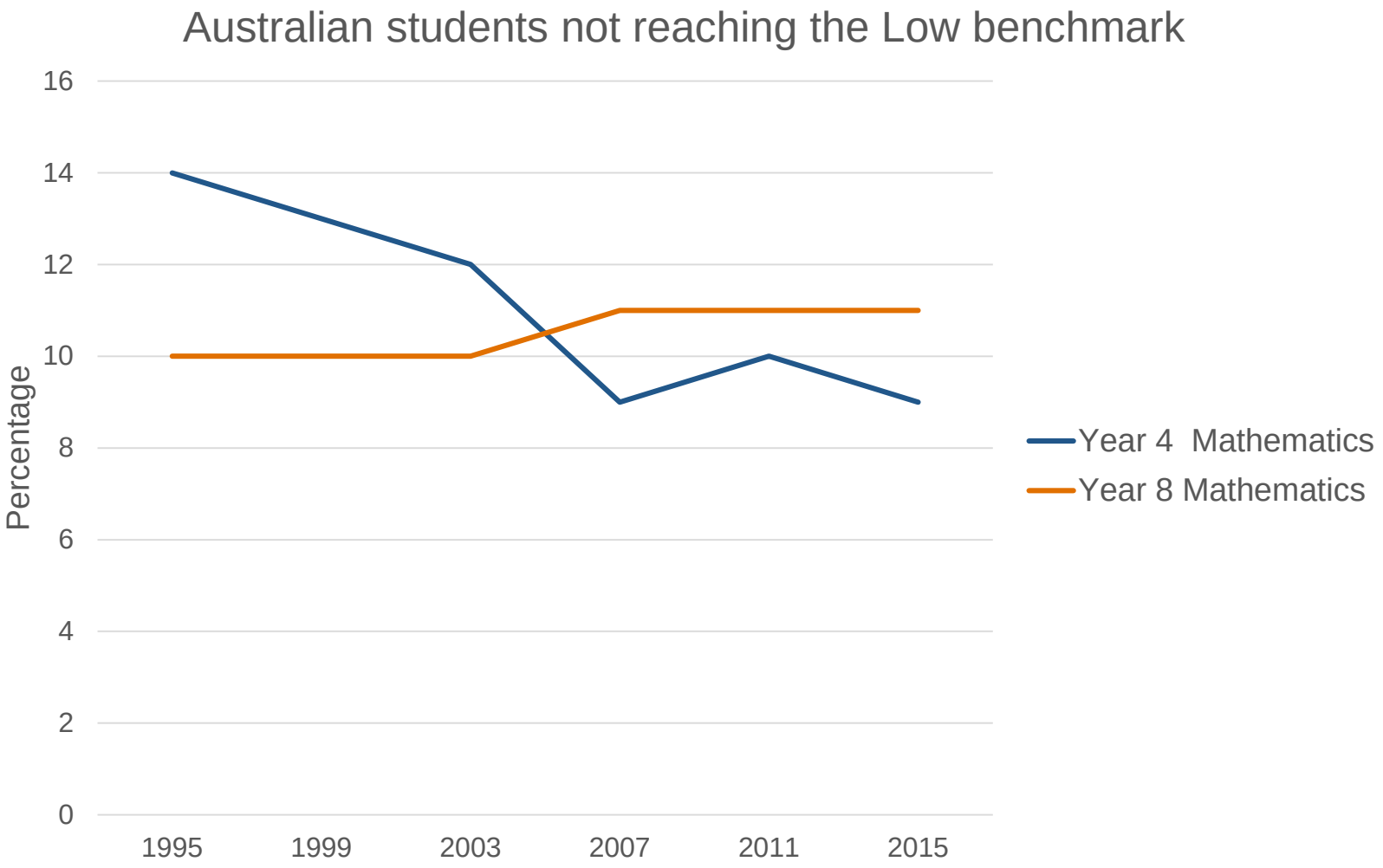
TIMSS: Mathematics 1995–2015



Data compiled from http://research.acer.edu.au/timss/

TIMSS: Large tail of underperformance

	Low benchmark	Did not reach Low benchmark	Total
Year 4 mathematics	21%	9%	20%
Year 4 science	19%	6%	25%
Year 8 mathematics	25%	11%	36%
Year 8 science	22%	9%	31%

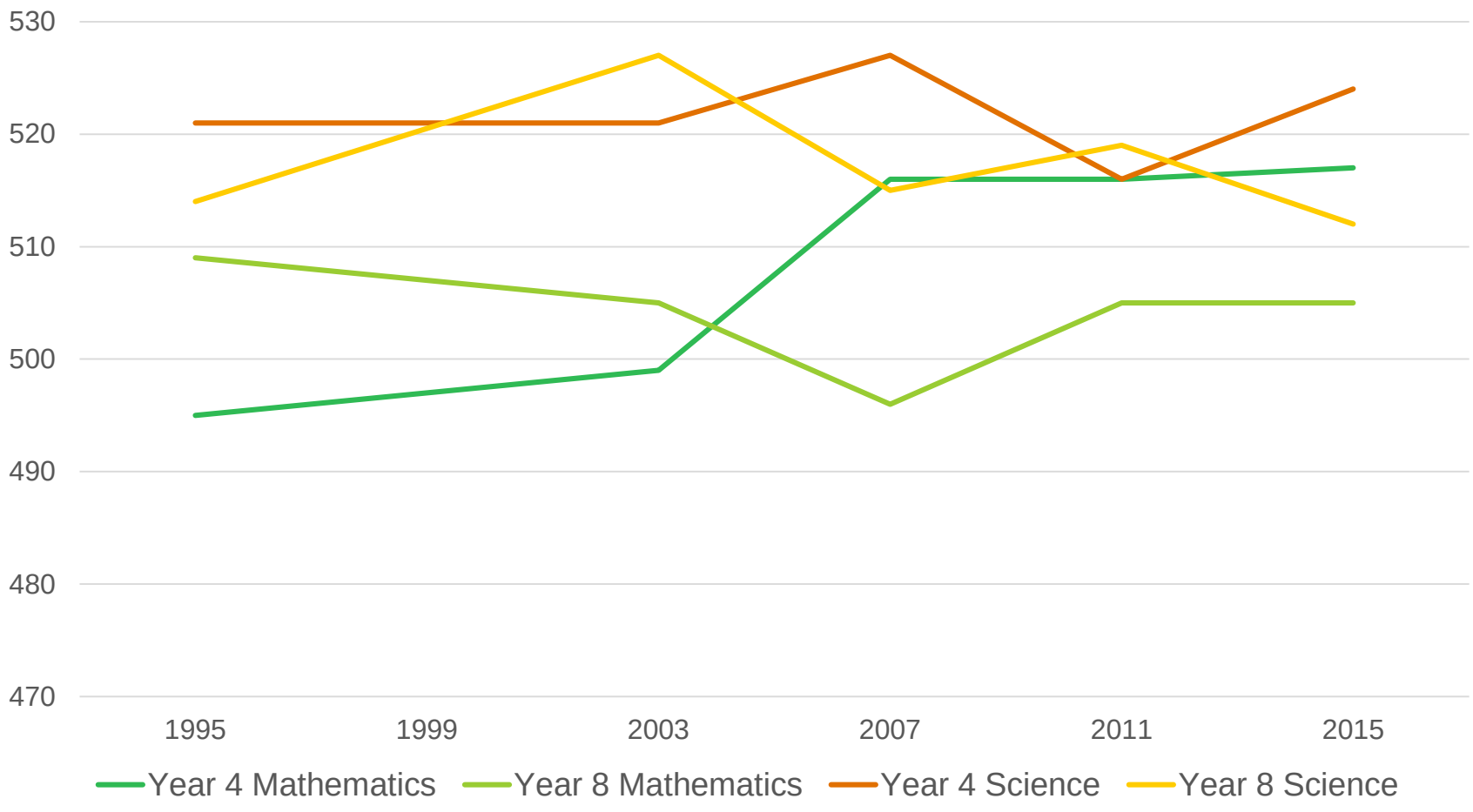
Position 2: Australia’s performance is stable

Position 2: Australia's performance is stable

- Australia's performance is higher than the OECD average — this reflects a successful education system.
- Australia's proportion of high achievers is higher than the OECD average.

PISA domain (2015)	Australia — proportion of high achievers	OECD — proportion of high achievers
Scientific literacy	11%	8%
Mathematical literacy	11%	11%

TIMSS: Mathematics and science achievement scores 1995–2015



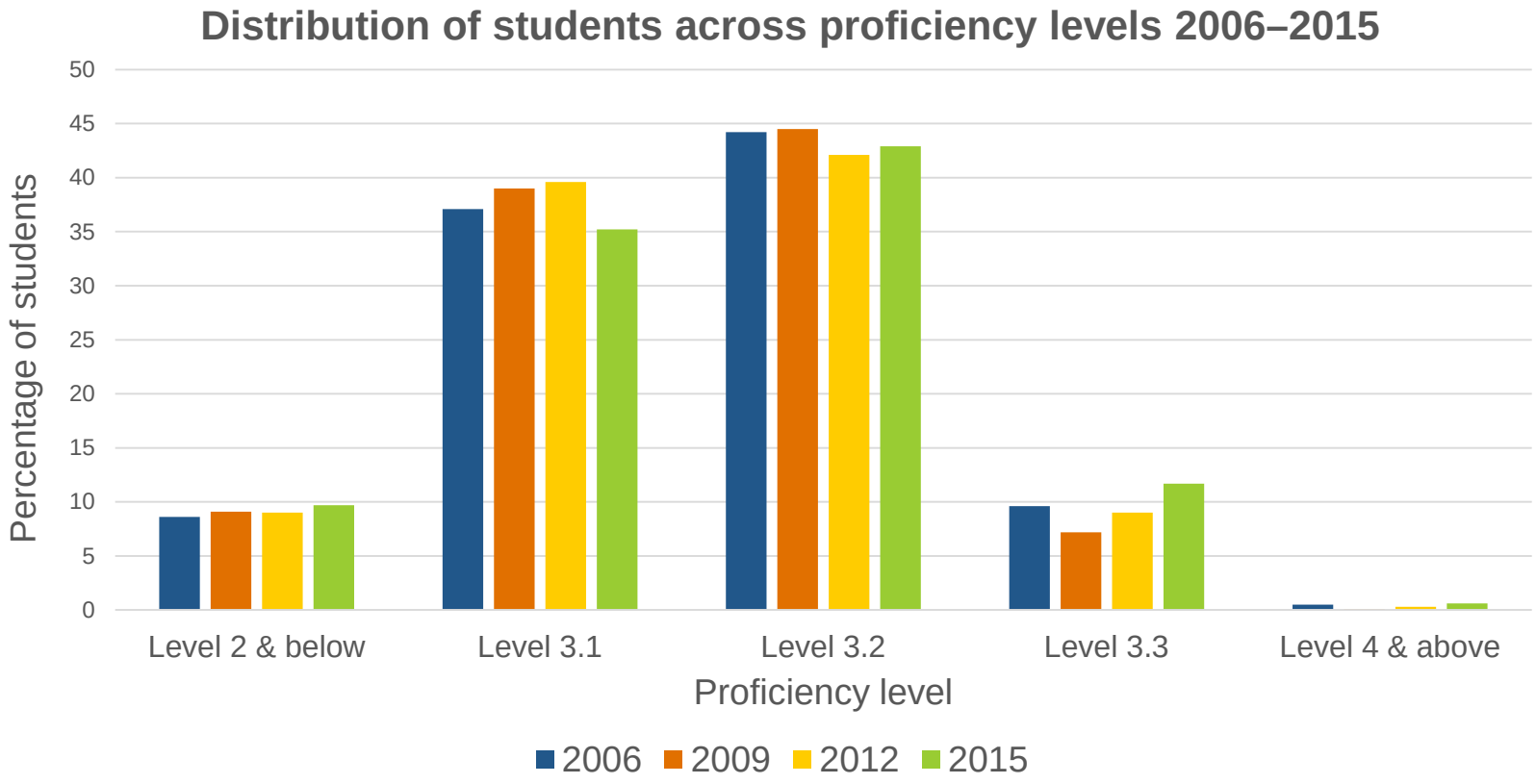
Data compiled from http://research.acer.edu.au/timss/

What is NAP-SL?

- National Assessment Program – Science Literacy (NAP-SL)
- One of three sample assessments conducted on a triennial basis
- Year 6 students only
- measures scientific literacy of primary students in Australian schools

National Assessment Program – Science Literacy (NAP-SL)

- Results reflect a relatively consistent Year 6 science literacy performance from 2006–2015.



Data from http://www.nap.edu.au/results-and-reports/national-reports#NAP_sample_assessments

Comparisons to like countries

Position in mathematics

Position in science

PISA participants affect rankings

Number of participating countries — OECD and non-OECD (2000–2012)

Year	2000	2003	2006	2009	2012	2015
Number	43	41	58	74	65	72

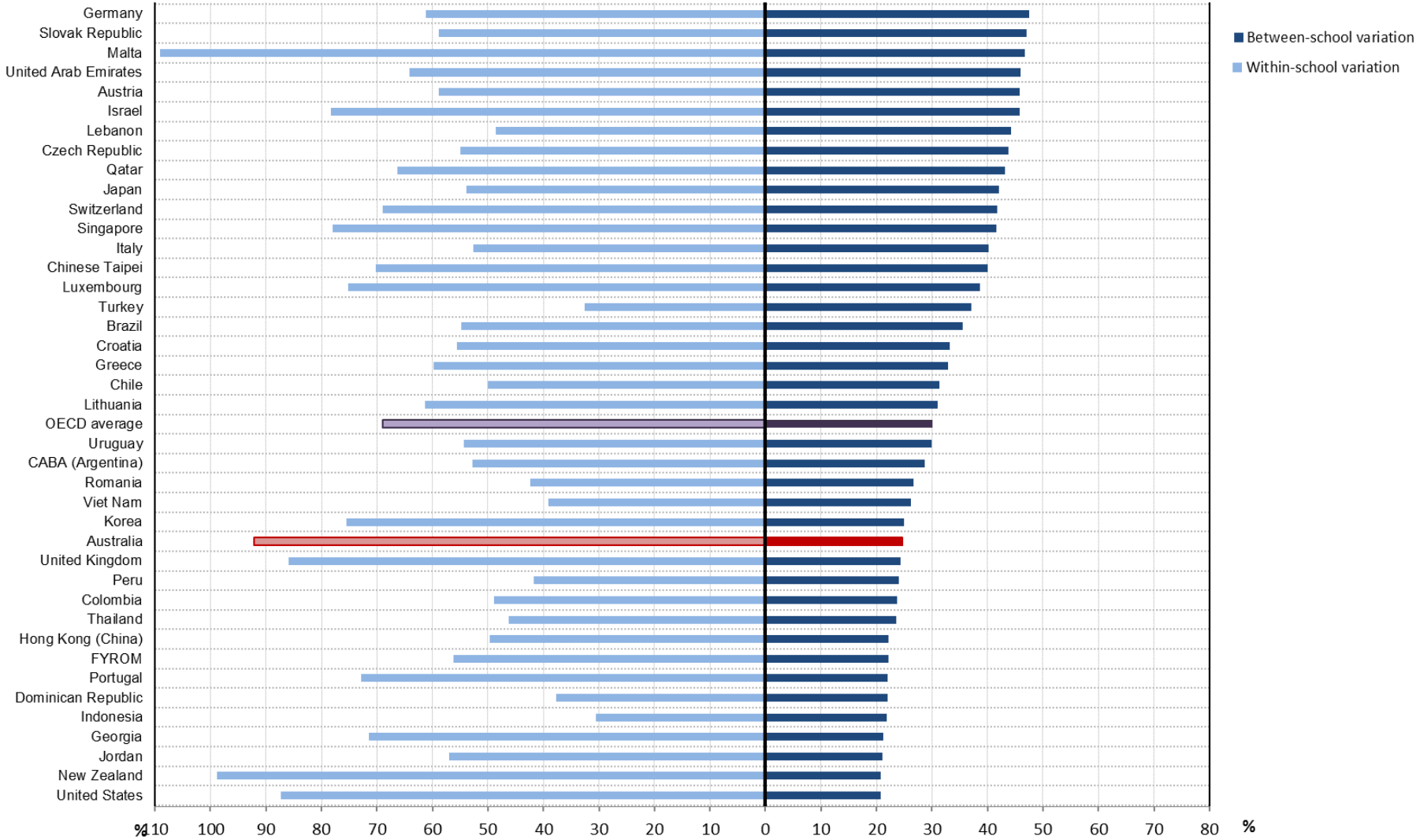
Source: OECD PISA participants (www.oecd.org/pisa/aboutpisa/pisa-participants.htm)

The impact of disadvantage

- national inequality highlighted
- large variations by region, state/territory, gender, SES, language background and Indigenous status
- widening gaps as learners progress from stage to stage
- relatively high rates of non-completion of school
- poor outcomes for disadvantaged students
- questions about the equity in the Australian education system

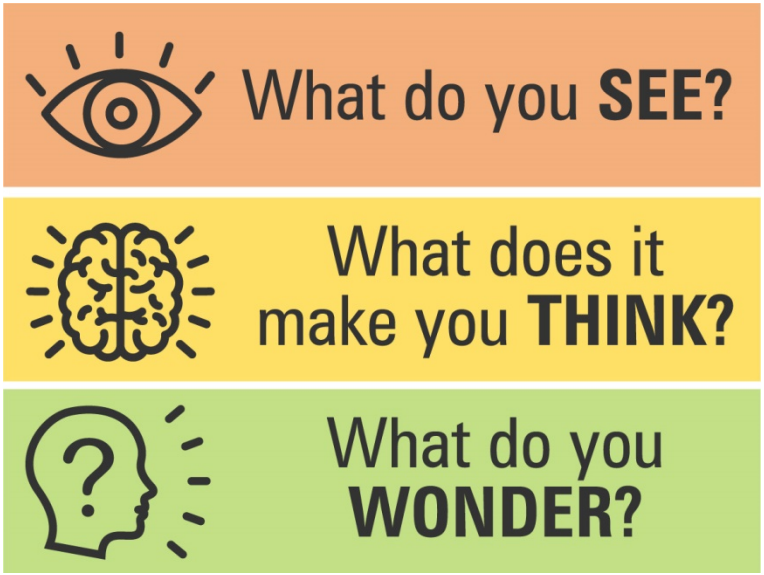
Within-school variation

PISA 2015: Variation in science performance within and between schools



Data extracted from PISA 2015, www.oecd.org/pisa, accessed 4 March 2017

Activity 2: Within-school variations



Examine the graph *PISA 2015: Variance in science performance within and between schools* and complete the activities on the Activity 2 handout.

Queensland’s performance

Queensland's performance — 2015 PISA scientific literacy

- performed better than the OECD average in scientific literacy
- had the smallest decline across the states between 2006 and 2015

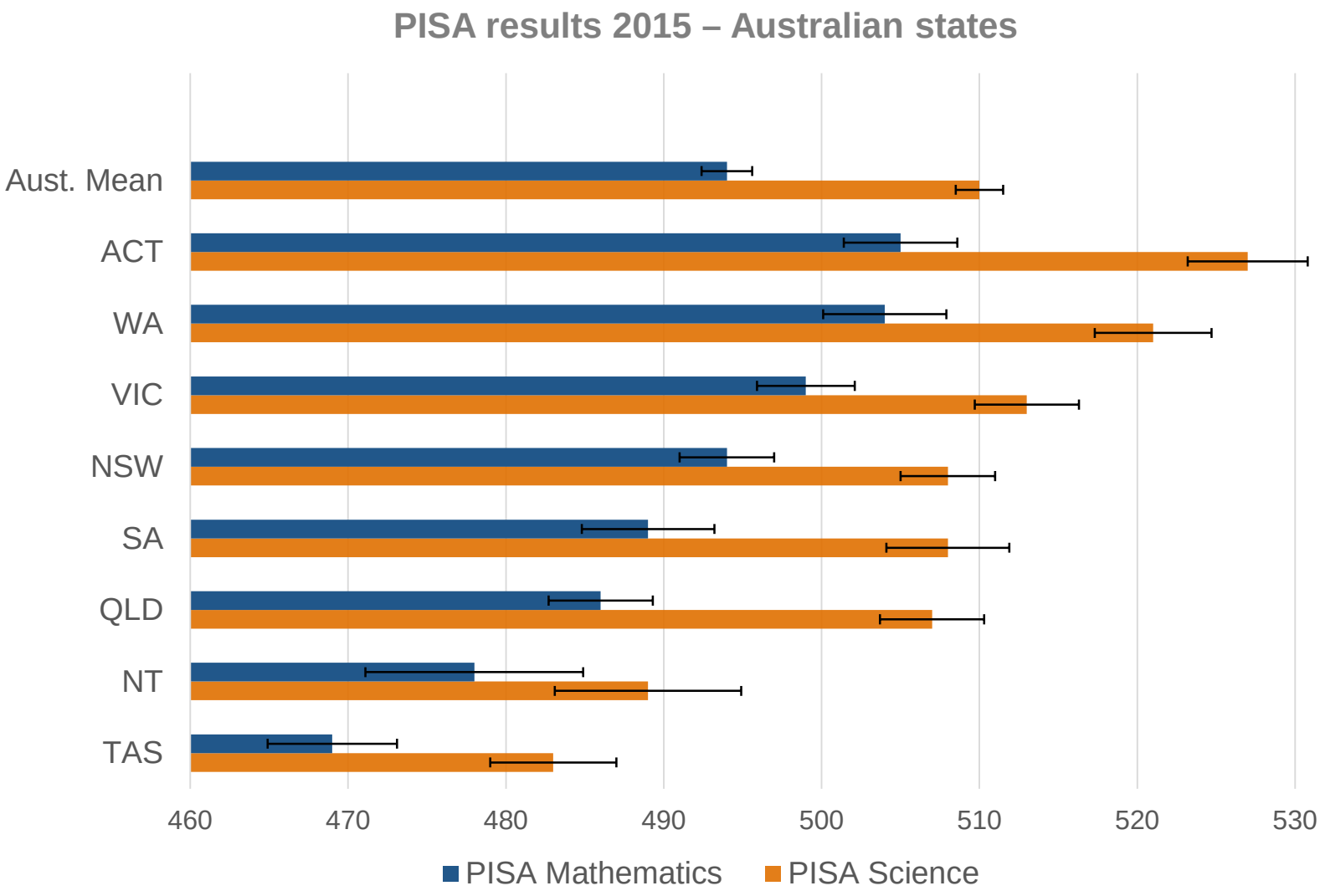
Scientific literacy	OECD PISA 2015 average	QLD PISA 2015	Variation in proportion of Qld's high performers since 2006
High performers	8%	10%	decline of 3%
Low performers	21%	18%	increase of 5%

Queensland's performance — 2015 PISA mathematical literacy

- not significantly different to the OECD average
- had the smallest decline across the states between 2003 and 2015

Mathematical literacy	OECD PISA 2015 average	QLD PISA 2015	Variation in proportion of Qld's high performers since 2003
High performers	11%	9%	decline of 9%
Low performers	23%	24%	increase of 8%

Queensland's performance — 2015 PISA



Data from Thomson, S, De Bortoli, L & Underwood, C 2016, *PISA 2015: A first look at Australia's results*, ACER, Melbourne.

Queensland's performance — 2015 TIMSS

Year 4 mathematics

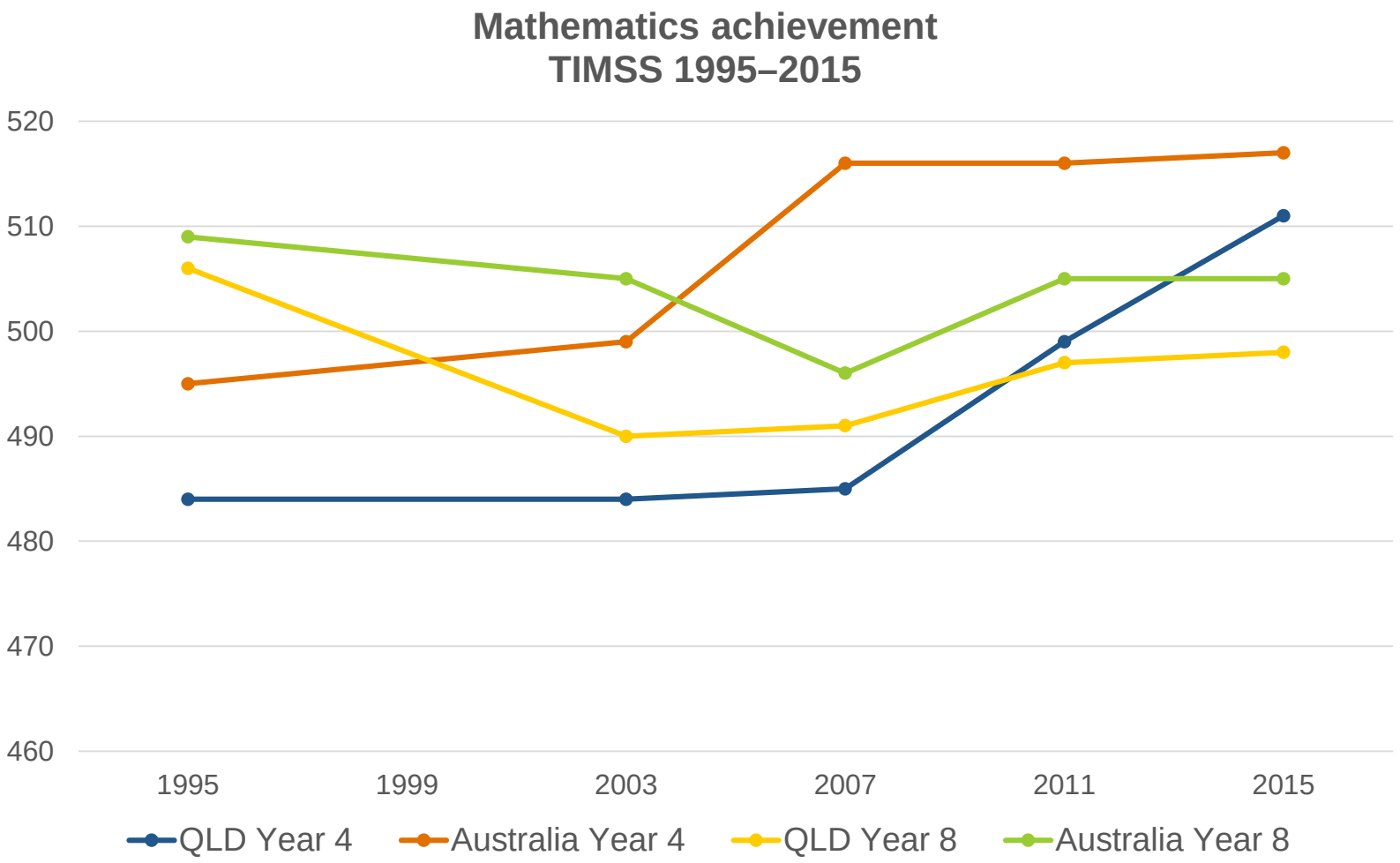
- Queensland was the third lowest performing jurisdiction.
- Performance showed improvement in 2011 and again in 2015.
- Since 1995 there has been
  - a reduction in the proportion of low-performing students
  - an increase in the percentage of students achieving the Advanced international benchmark.
- 6% of students reached the Advanced benchmark.
- 10% of students did not reach the Low benchmark.

Queensland's performance — 2015 TIMSS

Year 8 mathematics

- Queensland was ranked fifth out of eight jurisdictions, equal with South Australia.
- 4% of students reached the Advanced benchmark.
- 11% of students did not reach the Low benchmark.

Queensland's performance — 2015 TIMSS



Data compiled from http://research.acer.edu.au/timss/

(Note: No data available for 1999.)

Queensland's performance — 2015 TIMSS

Year 4 science

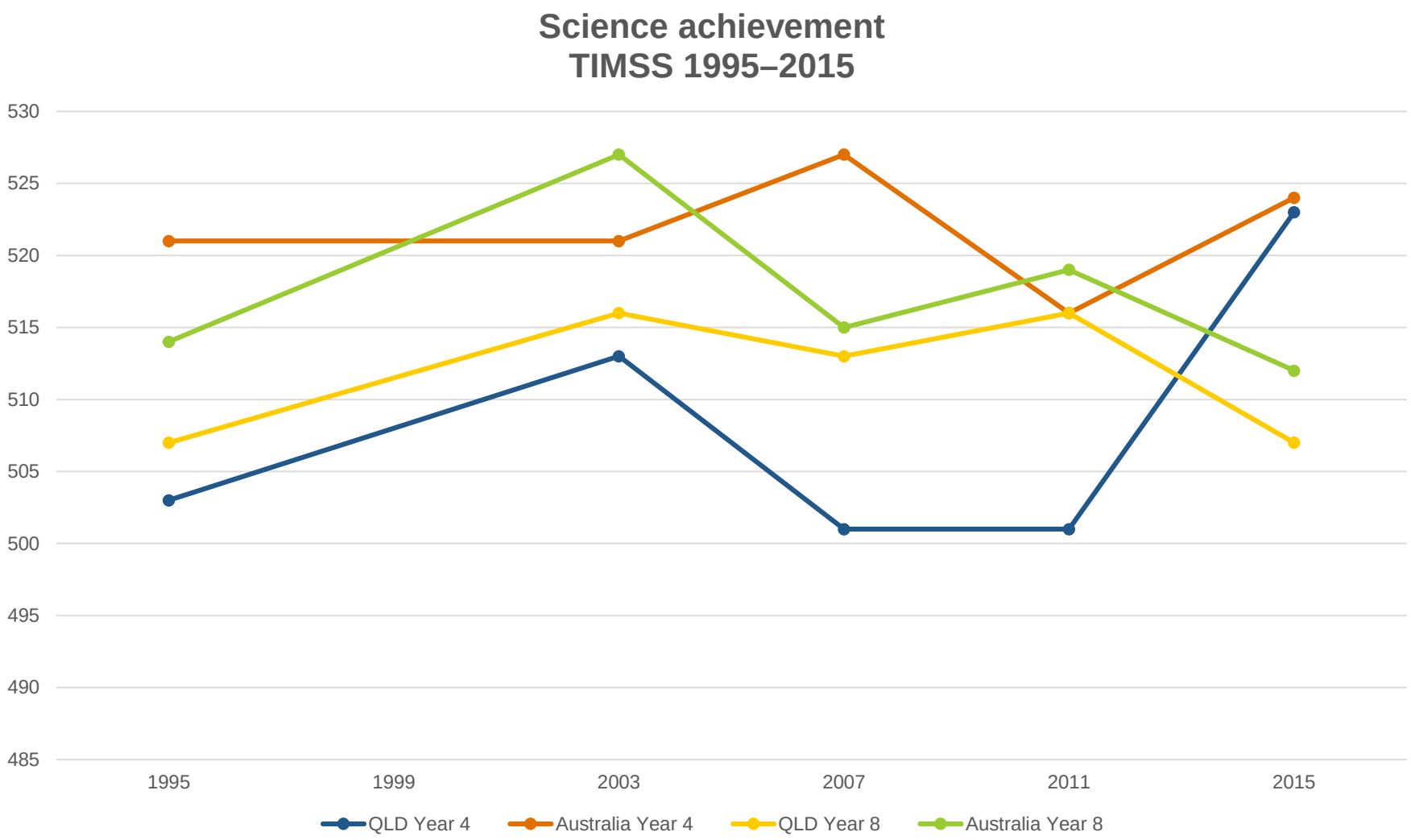
- Queensland was the third lowest performing jurisdiction, although TAS, WA and SA were similar.
- Queensland's performance showed a significant improvement of 23 points.
- There was a statistically significant decline in the number of students not achieving the Low benchmark.
- 7% of students did not reach the Low benchmark.
- 7% of students reached the Advanced benchmark.

Queensland's performance — 2015 TIMSS

Year 8 science

- Queensland and South Australia were equal 5th.
- 5% of Year 8 students achieved the Advanced benchmark.
- 9% of students performed below the Low benchmark.

Queensland's performance — 2015 TIMSS



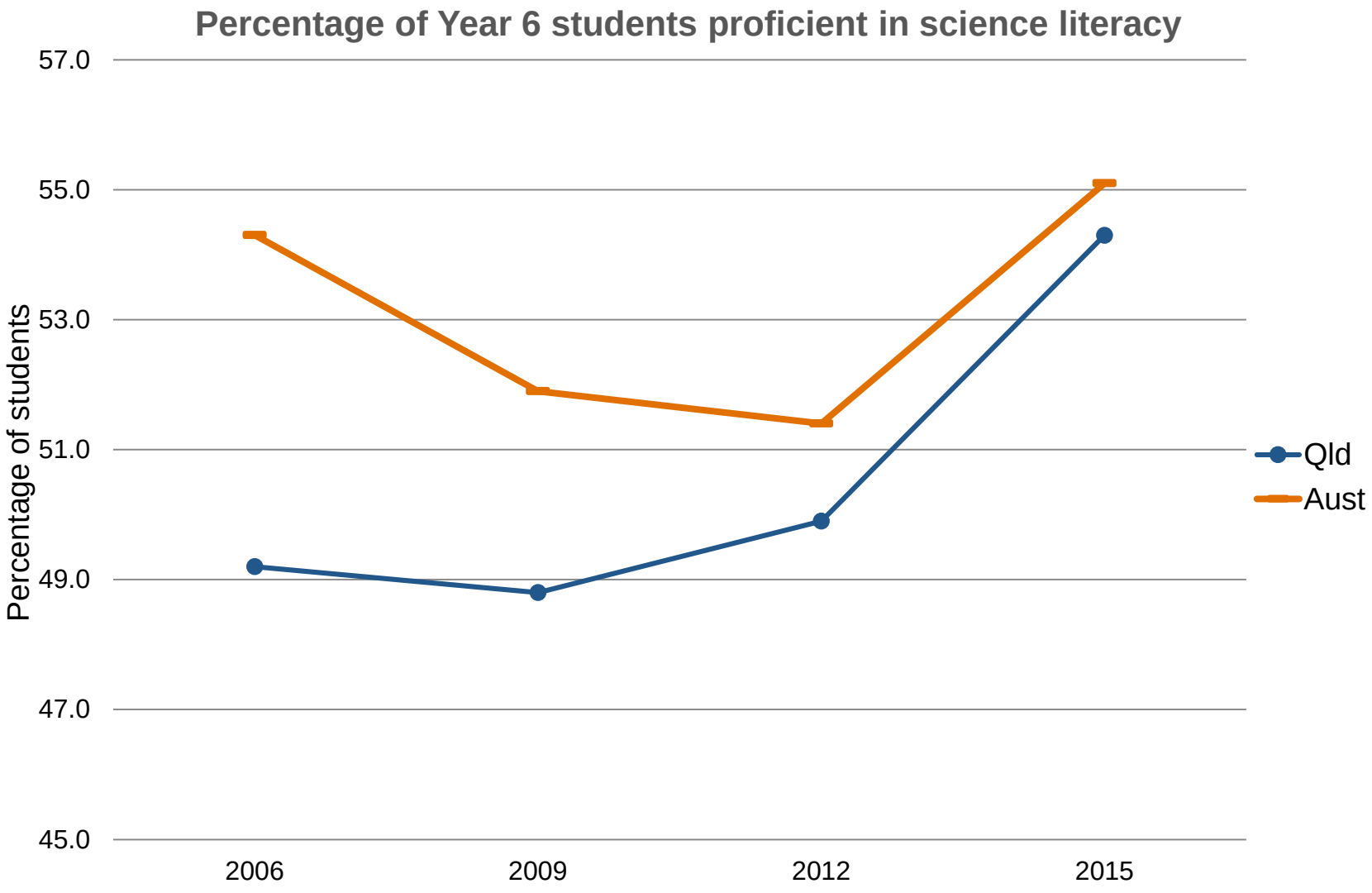
Data compiled from http://research.acer.edu.au/timss/

(Note: No data available for 1999.)

What is NAP-SL?

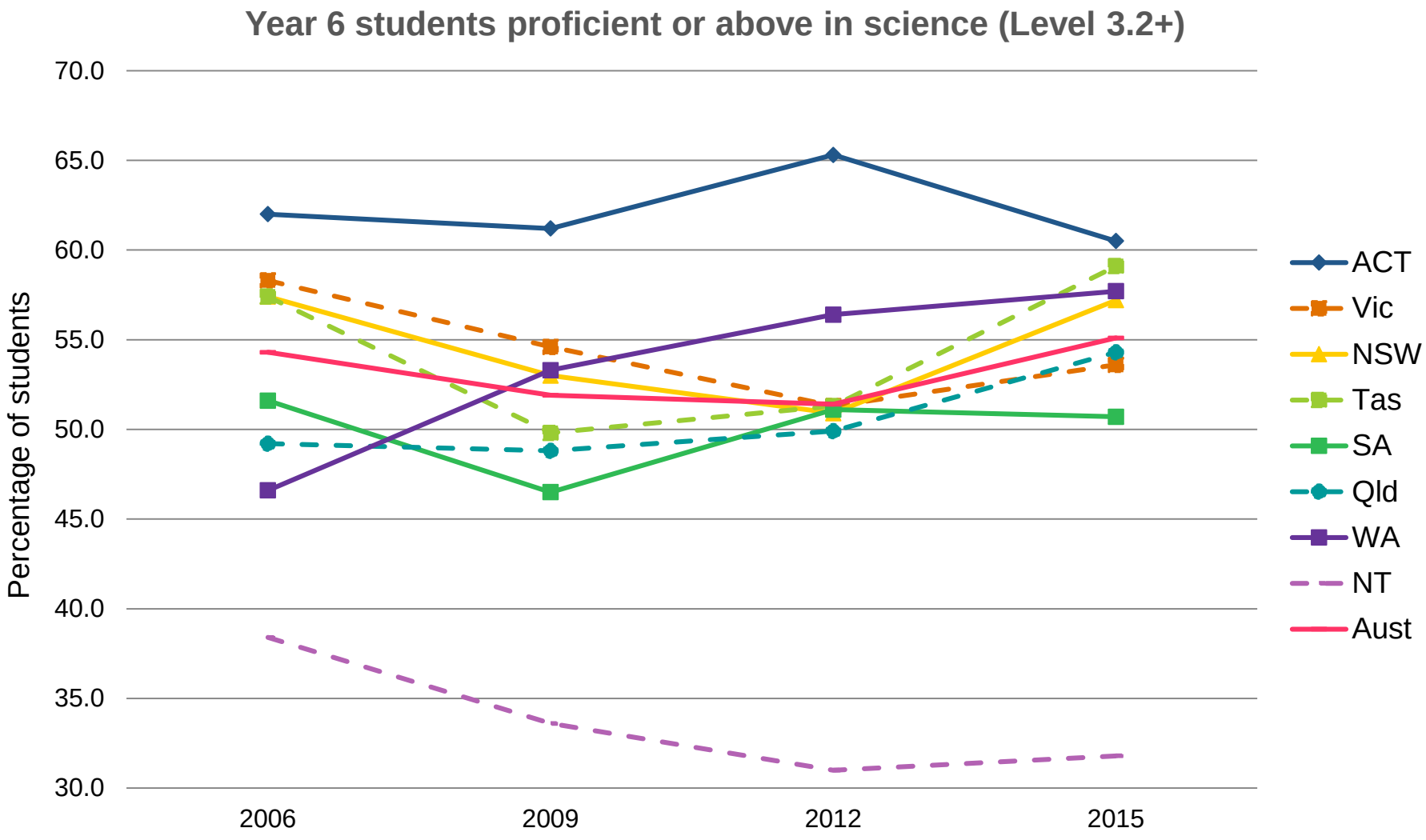
- National Assessment Program – Science Literacy
- NAP-SL is one of three sample assessments conducted by ACARA on a triennial basis.
- It monitors trends in science literacy performance in Year 6 students over time.

Queensland's performance — NAP-SL



Data from http://www.nap.edu.au/results-and-reports/national-reports#NAP_sample_assessments

Queensland's performance: 2015 NAP-SL

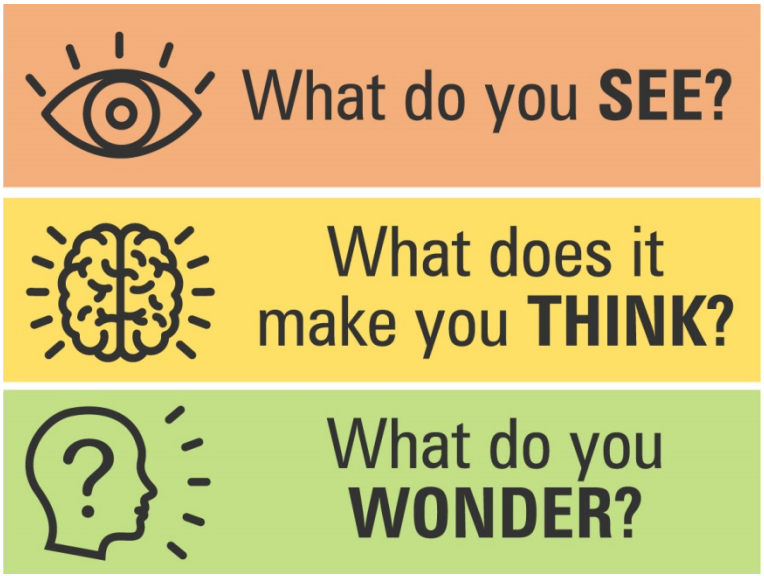


Data from http://www.nap.edu.au/results-and-reports/national-reports#NAP_sample_assessments

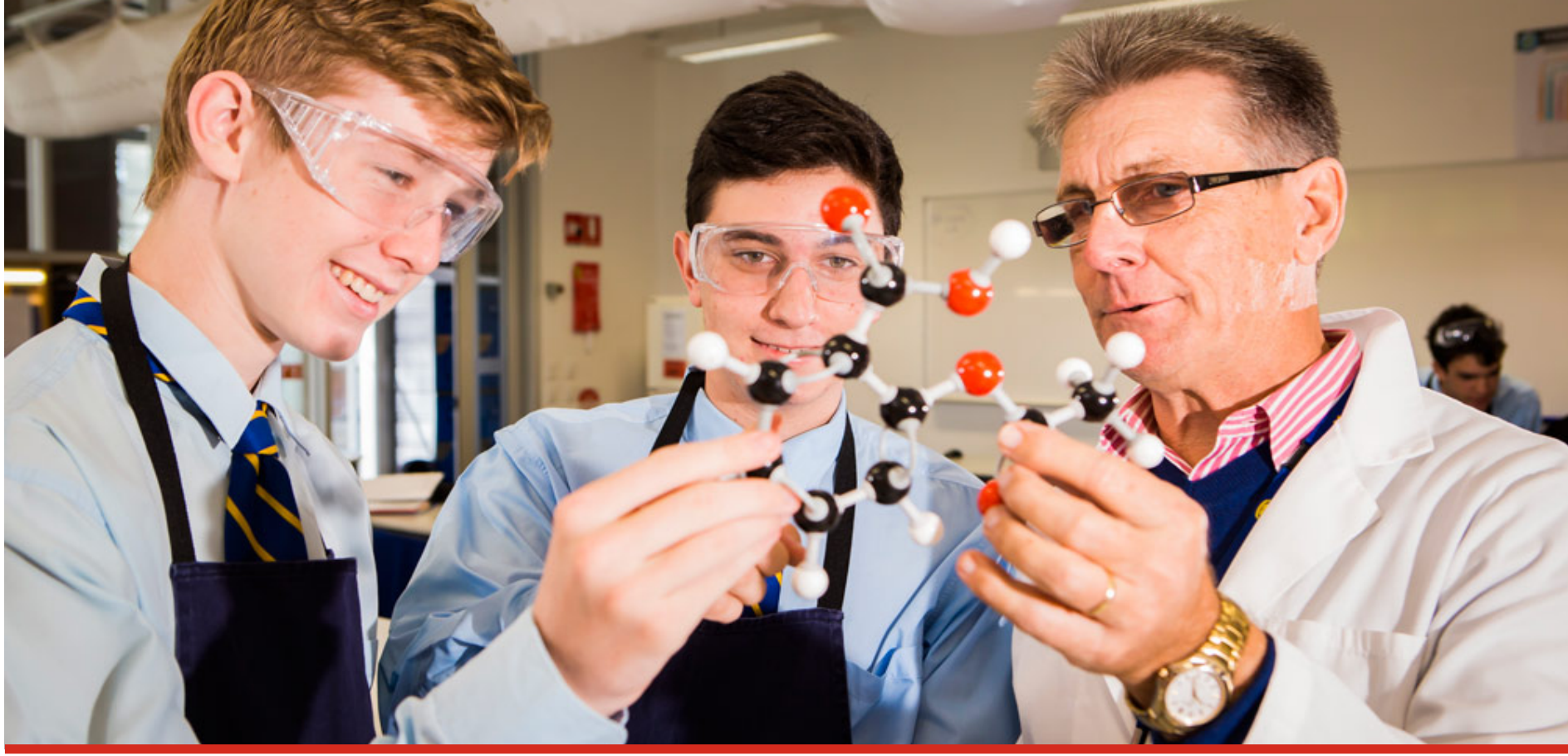
High-performing role models

- National differences, e.g. social, cultural, demographic, geographic and linguistic
- look to high-performing Australian states for improvement strategies
- Western Australia:
  - 2015 PISA mathematical literacy scores would make them comparable to the top 15 performing nations
  - 2015 PISA scientific literacy, WA's mean score places them in 10th rank, statistically similar to Hong Kong

Activity 3: Australian jurisdictional data



Examine the data in Figures 1 to 4 and complete the activities on the Activity 3 handout.



Considerations for targeting improvement in mathematics and science

What can make a difference?

- developing and improving teaching and learning
- encouraging student engagement in mathematics and science
- allocating resources to address individual student needs

Developing and improving teaching and learning

Teachers need:

- high level skills in
  - assessment
  - analysis of data
  - evaluating progress over time
- support to
  - work collaboratively with other teachers
  - target resources at need.

(Hattie 2016)

Encouraging student engagement in mathematics and science

- engagement declines in secondary school
- strong link between outcomes and how students view themselves as learners (self-efficacy)
- subjects for all students, not just high achievers
- student dispositions towards mathematics and science are influenced by the teaching they experience at school
- engagement vital for disadvantaged students

Encouraging student engagement in mathematics

Teachers need to use creativity and vitality to communicate the belief that mathematics is:

- a thinking tool
- a unique and concise language
- a way of investigating patterns and relationships
- a part of everyday life.

Encouraging student engagement in science

Students want stimulating styles of teaching including:

- student-led research
- practical activities
- application of real-world examples.

Students want teachers to:

- explain, discuss or demonstrate ideas
- adapt lessons to address needs
- provide individual help.

Allocating resources to address individual student needs

- public policy responses
- school and sector responses
- teacher responses

Public policy responses

- developing teacher quality
- ensuring mathematics and science classes are taught by qualified teachers
- providing resources to support disadvantaged students
- adequately diagnosing and addressing every child’s needs

School and sector responses

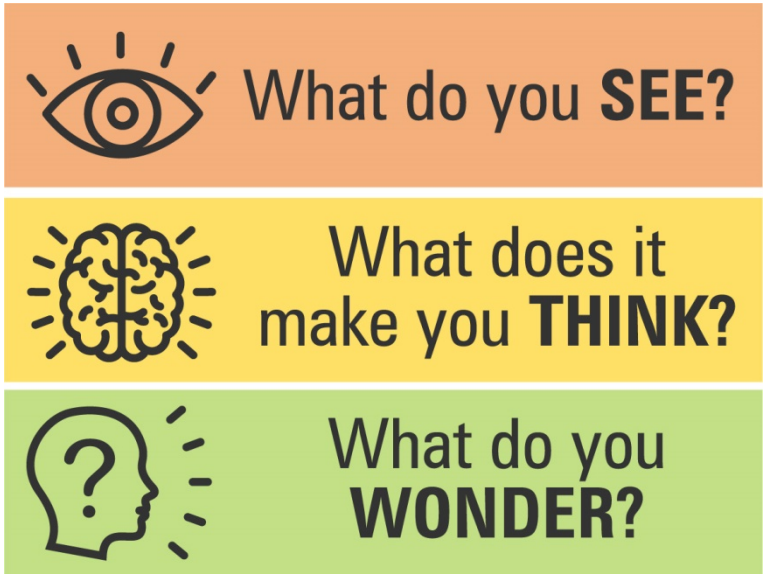
- timetabling sufficient time for the teaching of science
- requiring students to attend science classes
- improving school attendance and retention rates
- extending the range of enriching extracurricular activities (e.g. competitions and clubs)

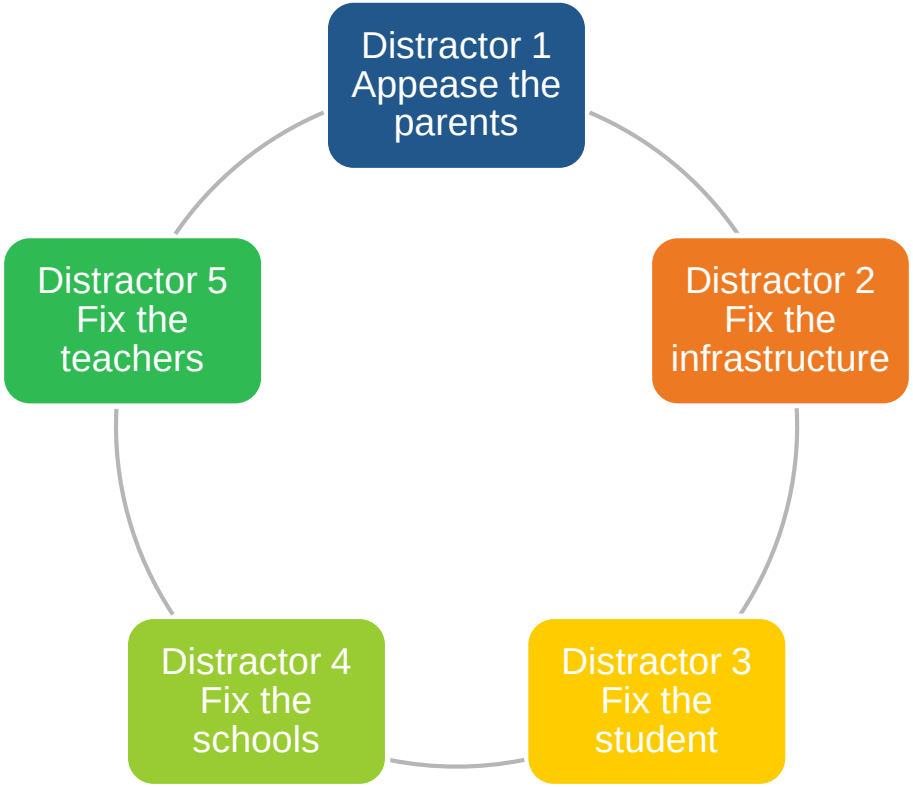
Teacher responses

- encouraging the beneficial effects of peer influences
- treating all students with the same level of attention and respect
- showing interest in the various cultural traditions represented in the student body
- having high expectations for all students

Activity 4: Discussion

Reflect on Hattie's 'distractions from the real problem in education' and discuss the statements on the Activity 4 handout.





Hattie, J. (2015) *What Doesn't Work in Education: The politics of distraction*, London: Pearson.

Conclusion

- Small amount of available analysis has been highlighted.
- It provides evidence-based starting points for schools to target improvements in student outcomes in mathematics and science.

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