Mathematics and Science Achievement in Australia's Schools

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How well are Australia’s schools preparing students in mathematics and science?

two international surveys of school mathematics and science achievement:

PISA (OECD) programme for international student assessment

TIMSS (IEA) trends in international mathematics and science study

PISA (2003)

- 15-year-olds
- 276,000 students in 41 countries

surveys:

- mathematical literacy
- scientific literacy
- reading literacy

PISA looks at how well students are able to apply basic understandings and skills in mathematics and science to everyday situations.

eg,

- are they able to perform currency conversions?
- read tables and graphs in newspapers?
- use basic understandings of science to make sense of magazine articles about topics such as genetically modified foods and animal cloning?

One of the more difficult PISA questions asked students to calculate the average speed in kilometers per hour of a person who walks 89.6 metres in a minute.

(not a high level of mathematical ‘knowledge’ but a high level of mathematical ‘skill’)

mathematical literacy (PISA:15 year olds)

1. Hong Kong SAR
2. Finland
3. Korea
4. Netherlands
5. Liechenstein
6. Japan
7. Canada
8. Belgium
9. Macao-China
10. Switzerland
11. **Australia**
12. New Zealand
13. Czech Republic … 41

scientific literacy (PISA:15 year olds)

1. Finland
2. Japan
3. Hong Kong SAR
4. Korea
5. Liechenstein
6. **Australia**
7. Macao-China
8. Netherlands
9. Czech Republic
10. New Zealand
11. Canada
12. Switzerland … 41

Conclusion:

Relative to students in other OECD countries, Australian students perform well in mathematical and scientific '*literacy*'.

TIMSS (2002-03)

Year 4

117,000 students in 25 countries

Year 8

220,000 students in 46 countries

surveys:

- mathematics knowledge
- science knowledge

TIMSS looks at how well Year 4 and Year 8 students have mastered the factual and procedural knowledge taught in school mathematics and science curricula.

eg,

- do students know how many legs an insect has?
- which animals lay eggs?
- what happens when light passes through a prism?
- what the angles of a triangle sum to?
- how to convert 7/10 to a decimal?
- what congruent triangles are?

mathematics (TIMSS: Year 4)

1. Singapore
2. Hong Kong SAR
3. Japan
4. Chinese Taipei
5. Belgium (Flemish)
6. Netherlands
7. Latvia
8. Lithuania
9. Russian Federation
10. England
11. Hungary
12. USA
13. Cyprus
14. Moldova, Rep of
15. Italy
16. **Australia**
17. New Zealand
18. Scotland … 25

mathematics (TIMSS: Year 8)

1. Singapore
2. Korea
3. Hong Kong SAR
4. Chinese Taipei
5. Japan
6. Belgium (Flemish)
7. Netherlands
8. Estonia
9. Hungary
10. Malaysia
11. Latvia
12. Russian Federation
13. Slovak Republic
14. **Australia**
15. USA
16. Lithuania
17. Sweden
18. Scotland
19. England
20. Israel
21. New Zealand … 46

science (TIMSS: Year 4)

1. Singapore
2. Chinese Taipei
3. Japan
4. Hong Kong SAR
5. England
6. USA
7. Latvia
8. Hungary
9. Russian Federation
10. Netherlands
11. **Australia**
12. New Zealand
13. Belgium Flemish
14. Italy
15. Lithuania … 25

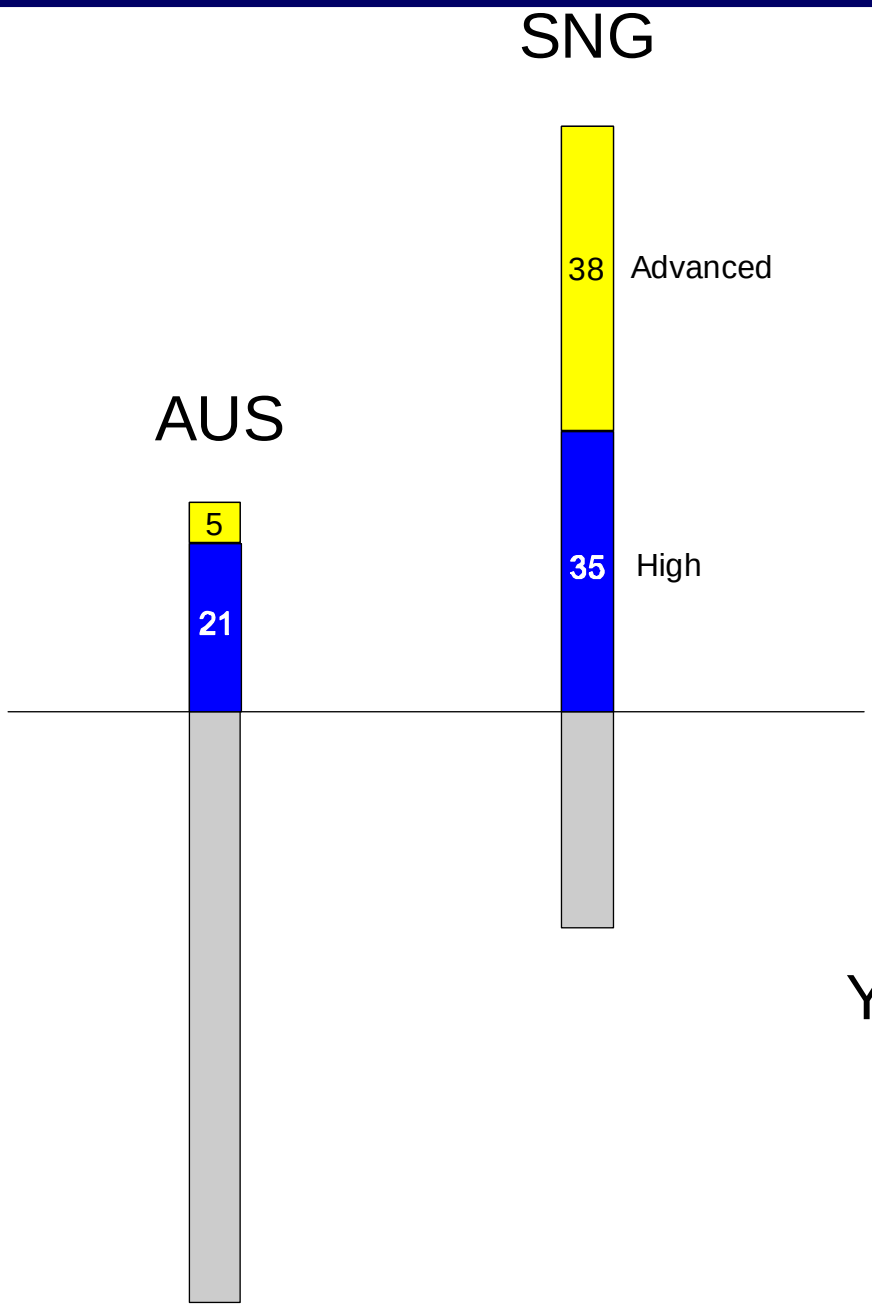
science (TIMSS: Year 8)

1. Singapore
2. Chinese Taipei
3. Korea, Rep of
4. Hong Kong SAR
5. Estonia
6. Japan
7. England
8. Hungary
9. Netherlands
10. USA
11. **Australia**
12. Sweden
13. Slovenia
14. New Zealand
15. Lithuania … 46

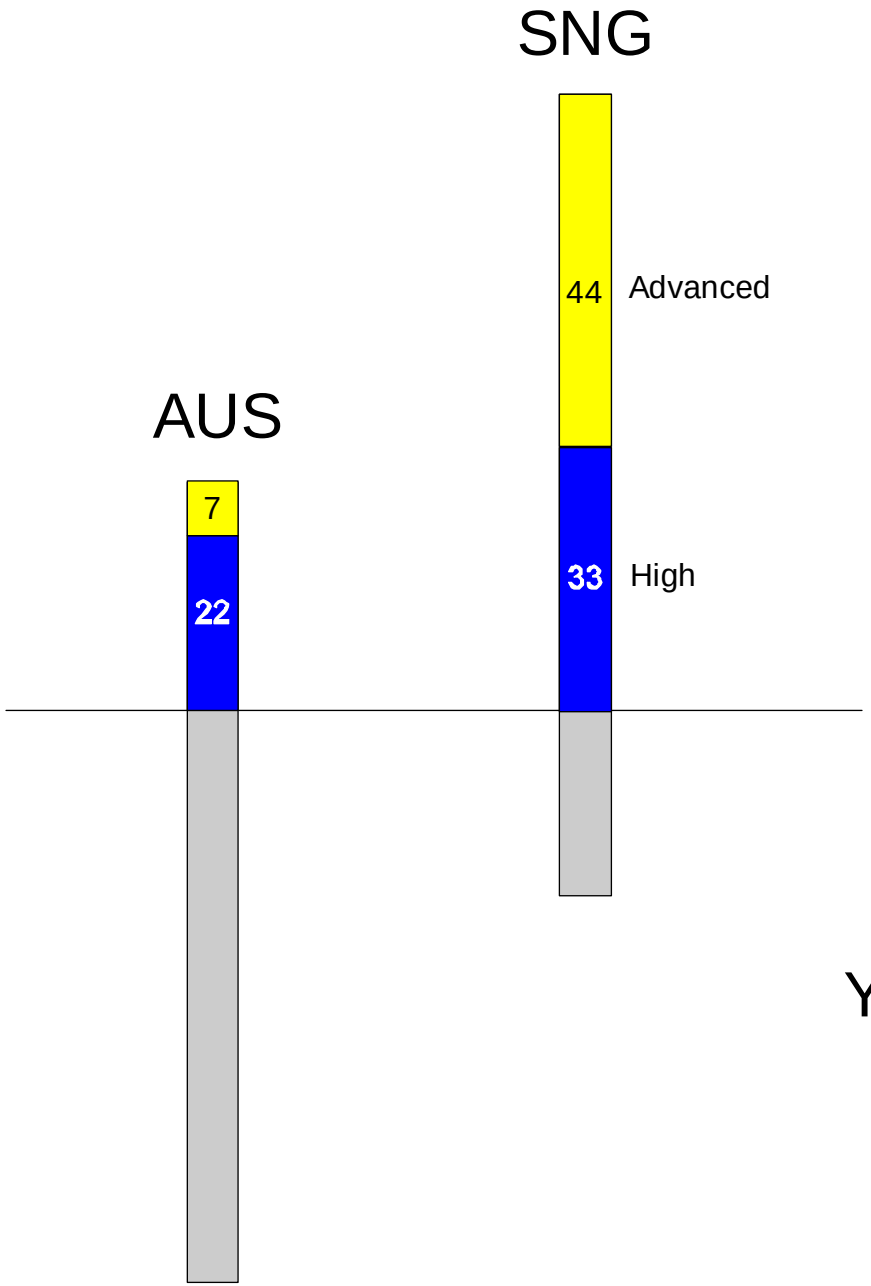
Conclusion:

Australian students perform less well when it comes to mathematical and scientific *knowledge*….

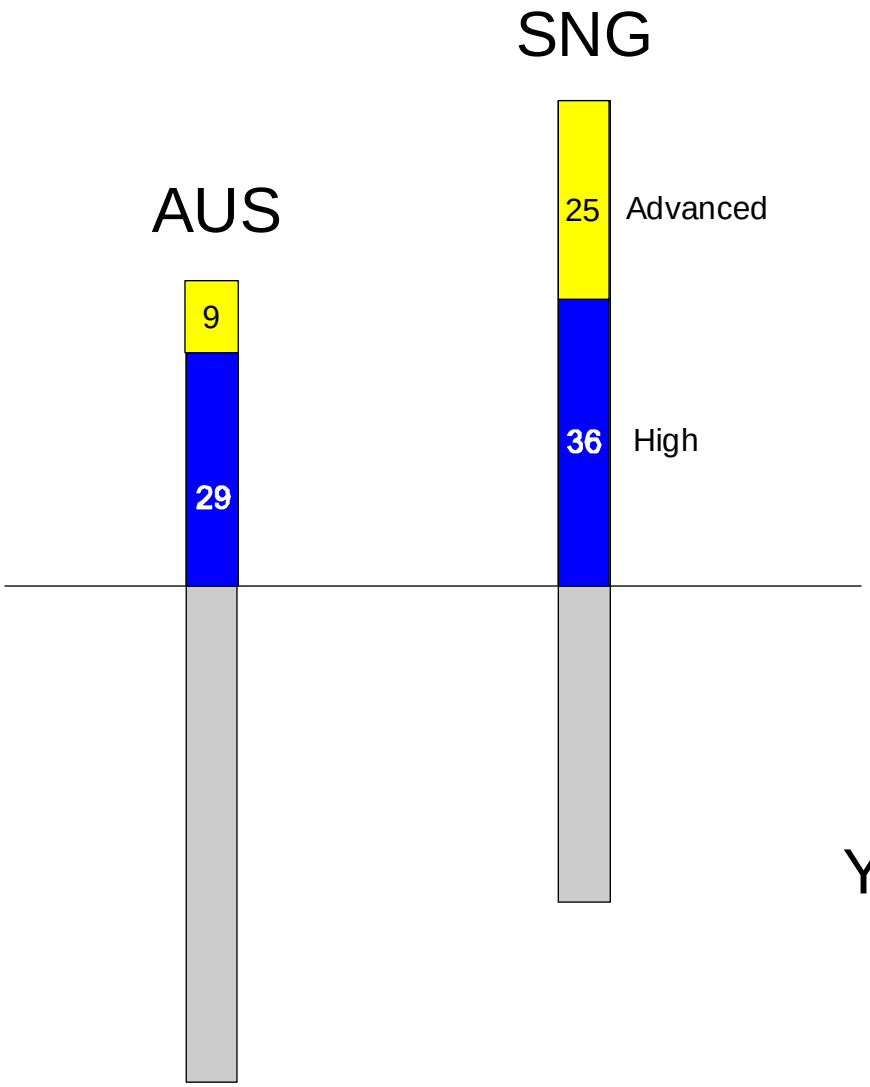
and (except in science at Year 8) we have slipped relative to other countries over the past decade.



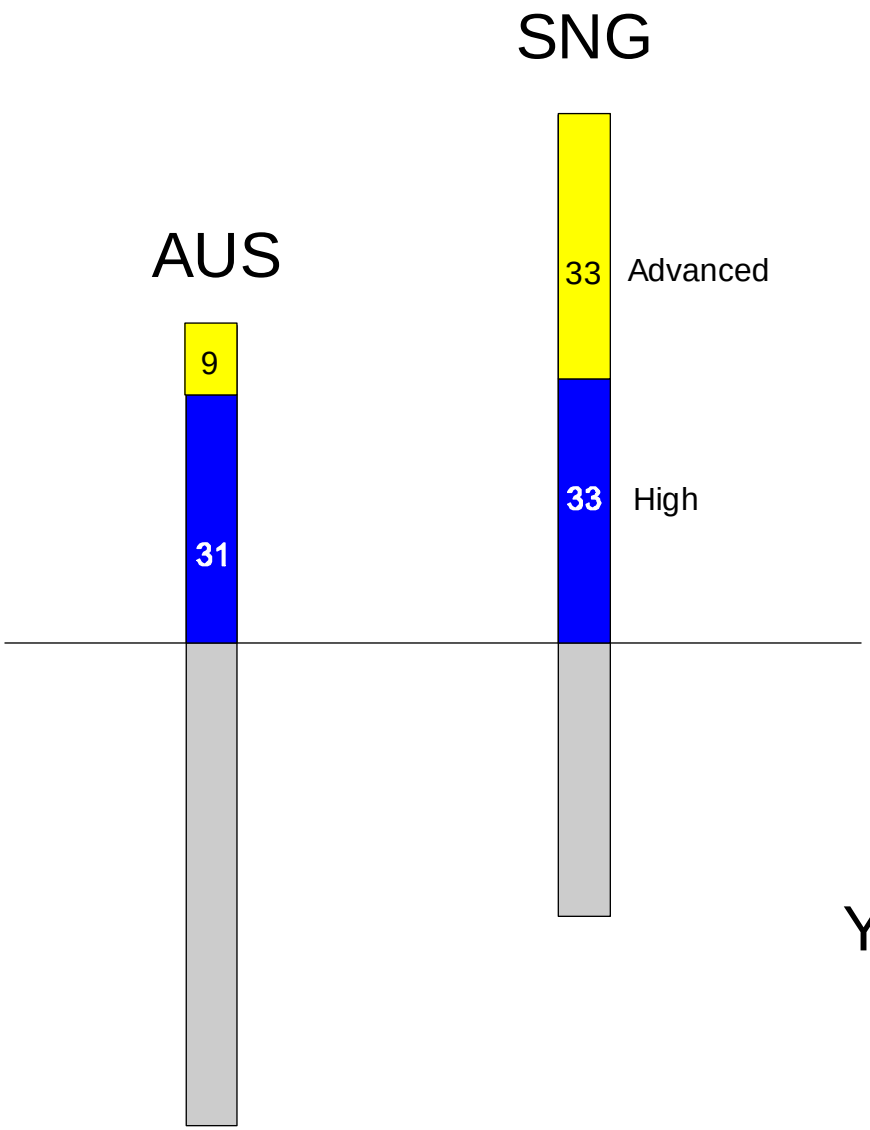
Year 4 Mathematics



Year 8 Mathematics



Year 4 Science



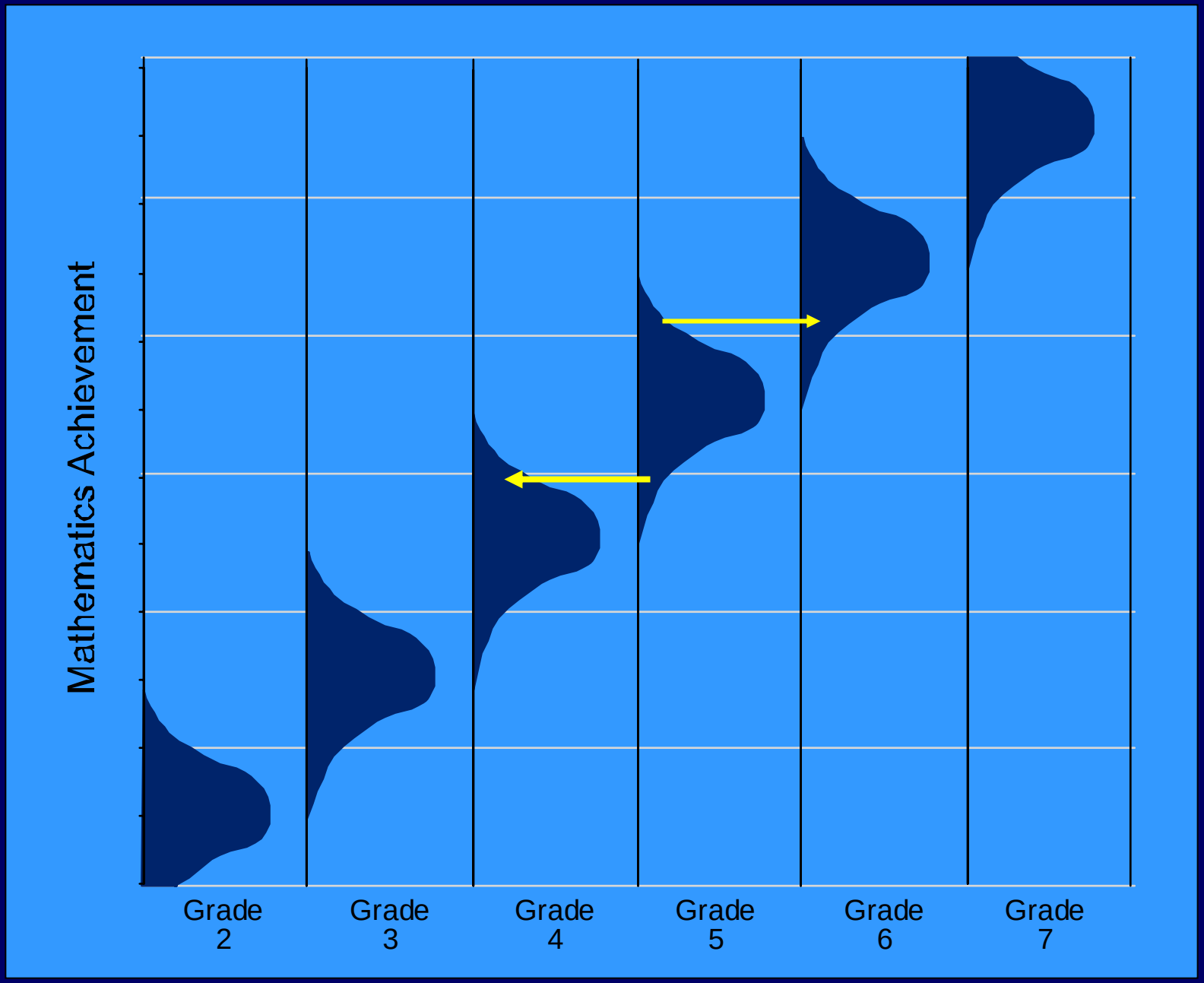
Year 8 Science

policy implications?

- How well are teachers being prepared to teach mathematics and science?
- How much class time is being devoted to mathematics and science learning?
- How explicitly are mathematics and science curricula (expectations) specified?
- How are mathematics and science being taught in schools (pedagogy)?
- How adequate is feedback to students and parents on individual progress?

typically …

- curriculum is divided into grade-based ‘packages’
- most students are taught the curriculum for their grade (in ‘mixed-ability’ classes)


Mathematics Achievement
Grade 2
Grade 3
Grade 4
Grade 5
Grade 6
Grade 7

typically …

- students experience discontinuities between grades and stages of schooling
- each new school year marks a fresh start
- little information is passed across boundaries between grades

“In elementary schools, children move from one teacher to the next every year. Every year we trash a year's worth of relationships built between children and their teacher, and we throw away all the knowledge the teacher has gained about what each child needs and can do. Each year, we tell every child and teacher to start over again.”

(Marshak, 2003, 229)

How consistent is this practice with research findings?

research findings:

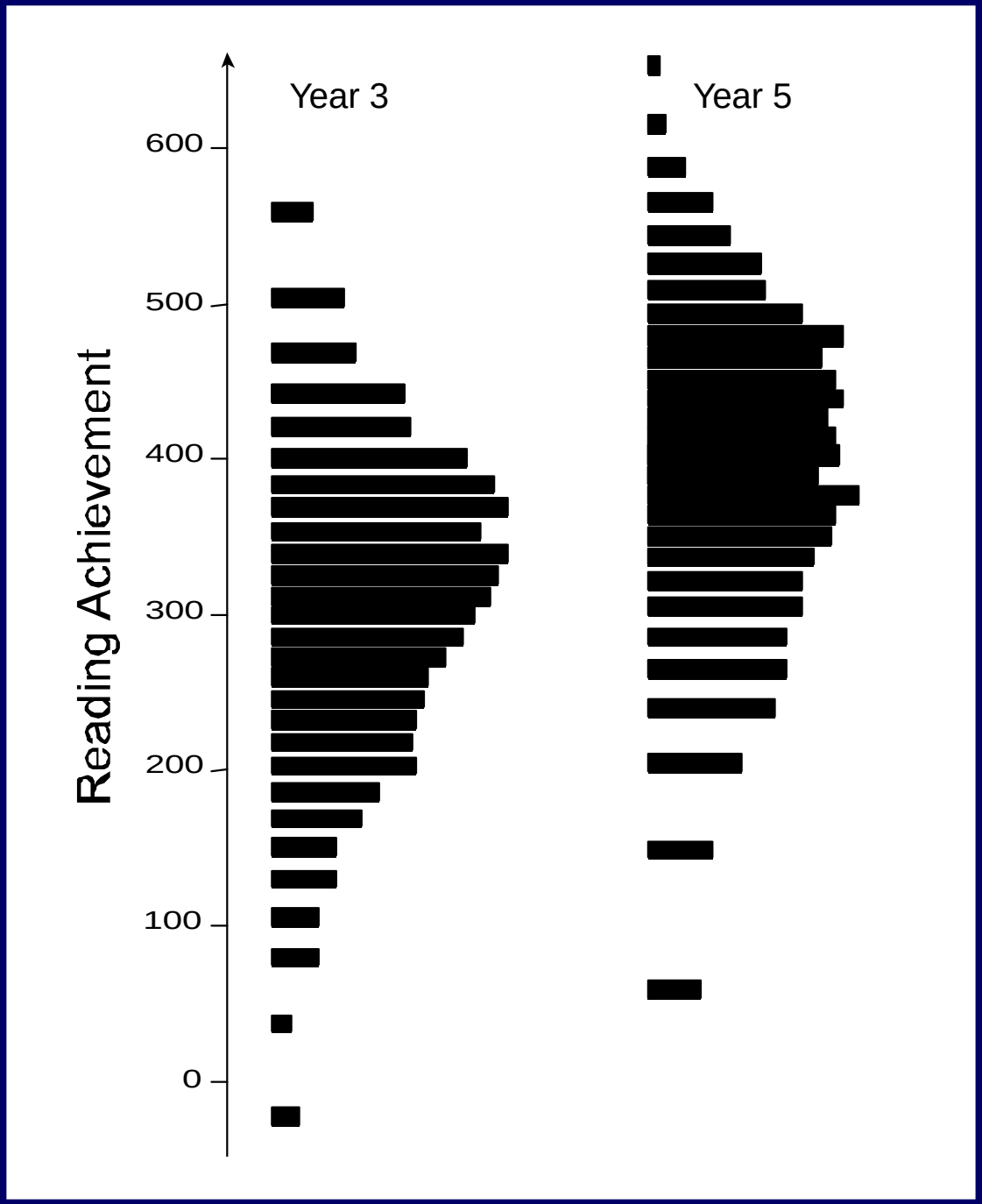
Teaching is most effective when it is targeted at individuals' current levels of knowledge, understanding and skill.

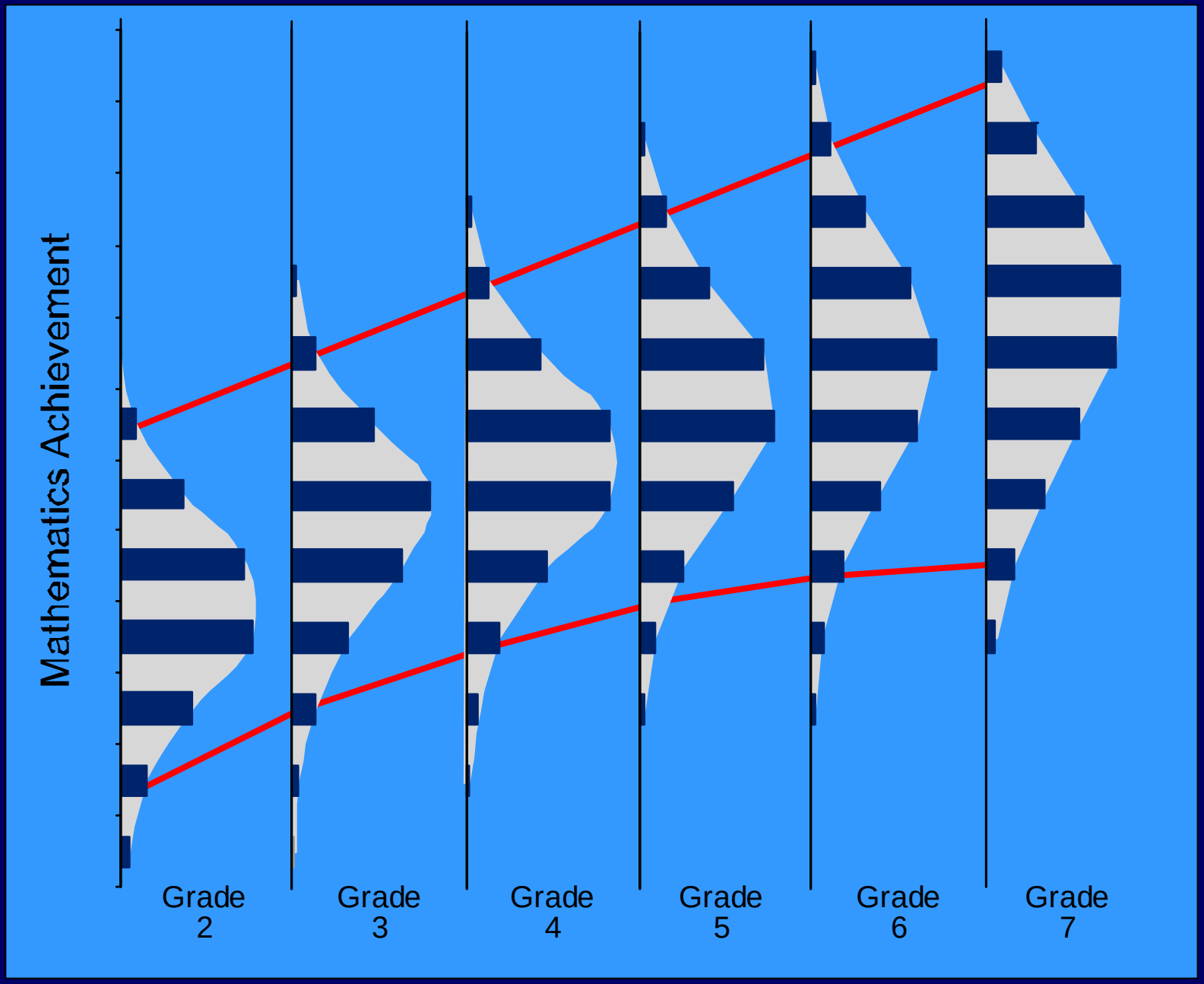
("individualisation")

(Bransford, Brown & Cocking, 2000)

research findings:

Students in the same grade vary considerably in their levels of knowledge, understanding and skill…


Year 3
Year 5
Reading Achievement
600
500
400
300
200
100
0


Mathematics Achievement
Grade 2
Grade 3
Grade 4
Grade 5
Grade 6
Grade 7

research findings (individualise / target):

“Research studies show [primary] pupils of all abilities benefiting from within-class ability grouping in terms of achievement in mathematics.”

(Harlen, 1997)

research findings (continuity):

"Learning arrangements in which students work with the same teachers for more than one year facilitate higher levels of learning. In most high-achieving European and Asian countries, students stay with the same teacher for at least two years, and sometimes three or more."

(Darling-Hammond, 2004: 1079)

to raise mathematics and science achievement levels…

- overhaul ‘one-size-fits-all’ delivery model
- establish where *individuals* are in their learning
- tailor learning experiences to where individuals are
- provide *continuity* to learning (eg, share information about student across grades)

thank you