

Does Queensland need an inquiry into falling school student performance in maths and science?

Dr John Ridd



ABOUT THE AUTHOR

John Ridd is a retired secondary schoolteacher and co-author of a series of maths textbooks for years 8, 9 and 10. He is a former member of the Moderation Committee of the Queensland Board of Senior Secondary School Studies. He was awarded his Doctorate in 2004, with a thesis on the topic *Participation in Physics and rigorous Maths and a consideration of educational, economic and political influences.*

Two of Australia's Chief Scientists, Ian Chubb recently and Robin Batterham some years ago expressed concern over the condition of "maths, science and other vital disciplines" - the "enabling sciences" - in Australia, as they foreshadowed the prospect that we would be overtaken by more competitive education systems.

An examination of data from the International Trends in Maths and Science Studies (**TIMSS**) reveals a deplorable weakness in the condition of maths and the numerical sciences in Queensland. As you consider the data below, keep in mind that the average result for TIMSS is a score of 500.

MATHS, GRADE 4	MATHS, GRADE 8	SCIENCE, GRADE 4	SCIENCE, GRADE 8
HIGHEST PERFORMERS			
Hong Kong, 607	Taiwan, 598	Singapore, 587	Singapore, 567
UNITED STATES OF AMERICA			
529 (11th)	508 (9th)	539 (8th)	520 (11th)
UNITED KINGDOM			
541 (7th)	513 (7th)	542 (7th)	542 (5th)
AUSTRALIA			
516 (14th)	496 (14th)	527 (13th)	515 (13th)

A clear picture of the effect of recent Australian education policy is painted by change in these scores: in the period from 1995 to 2007 the USA gained 17 points, the UK gained 16, but Australia *lost* 13 points.

The TIMSS tests award a rating of 'Advanced' to students who score highly. It provides an indicator of those countries who develop higher numbers of students into top performers. Australia and Queensland also under-perform by this measure:

MATHS, GRADE 4	MATHS, GRADE 8	SCIENCE, GRADE 4	SCIENCE, GRADE 8
Hong Kong, 40%	Taipei, 45%	Singapore, 36%	Singapore, 32%
Australia, 9%	Australia, 6%	Australia, 10%	Australia, 8%
Queensland, 3%	Queensland, 3%	Queensland, 4%	Queensland, 6%

The implications of these feeble performances for our more gifted children are severe.

Algebra, considered the "gateway to further mathematics" because of the crucial work it plays in more advanced mathematics. Weak results in algebra inevitably cause trouble for students as they are expected to build upon that knowledge later. TIMSS results for algebra in Grade 8 were:

TAIWAN (TAIPEI)	USA	UK	AUSTRALIA
617	501	492	471

All of the five top performing countries were East Asian, with scores of greater than 558. Those countries are Australia's local and global competitors, both in the education industry and in the economy as a whole. In that context Australia's performance is embarrassing.

Queensland had predictably weak National Assessment Program – Literacy and Numeracy (known as **NAPLAN**) results, ranking second last, just above the Northern Territory. It was a shock to many. Then Premier Anna Bligh described the results as "a wake-up call". She requested the Australian Council for Educational Research (known as **ACER**) to examine the situation. ACER's report, titled "A Shared Challenge" (2009), analysed the situation and made a series of recommendations.

A 'flavour' of the document can be gained by looking at these graphs and quotations.

“ We must accept and implement as soon as possible Jensen's recommendation that "the current measures of school performance published in the *My School* website should be replaced with value added measures of school performance, given their greater accuracy and fairness to schools serving poorer communities.”

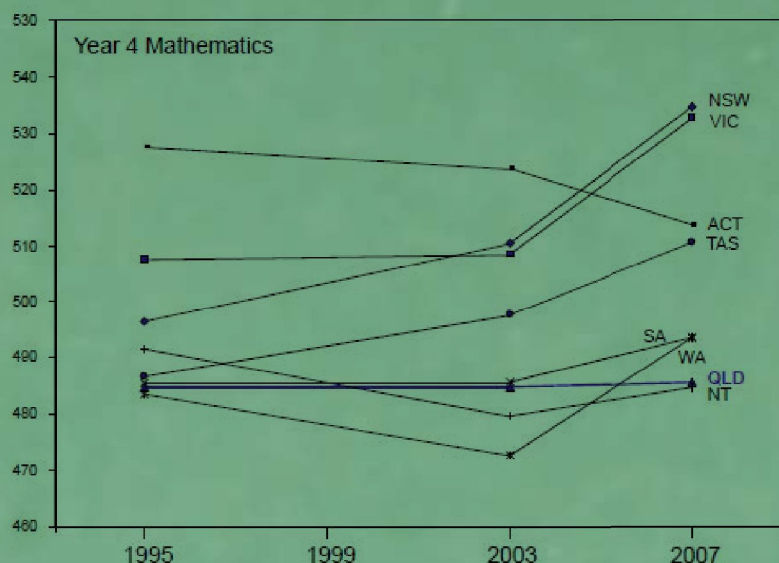


Figure 2.9 Trends in Year 4 mean scores in mathematics TIMSS 1995 to 2007

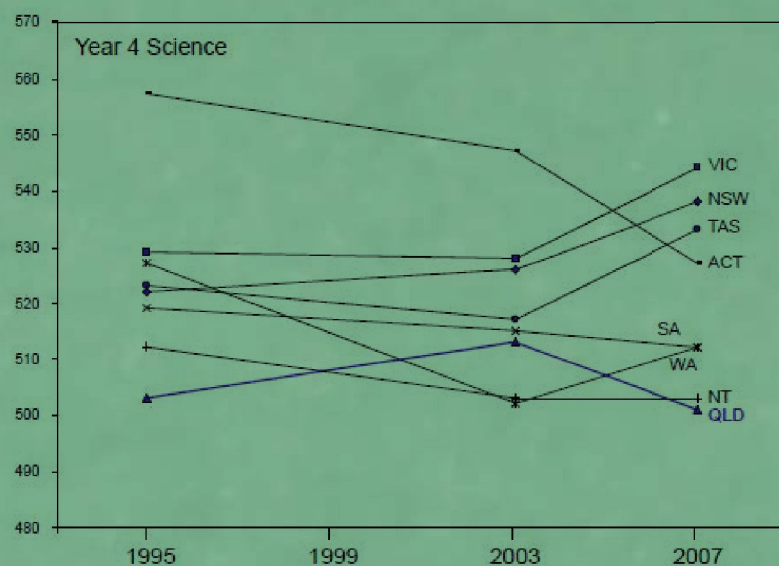


Figure 2.10 Trends in Year 4 mean scores in science TIMSS 1995 to 2007

The data showed that education in Queensland at year 4 is not improving, and in science, standards are falling.

ACER's accompanying remarks included:

- "...at Year 8 also, the absolute performances of Queensland students were unchanged or declined non-significantly between 1995 and 2007."
- "...Australian primary school students, and particularly students in Queensland, perform well below world-best standards in mathematics and science."
- "...there has been a decline in the relative performance of Queensland students in mathematics and science over several

decades.' From '...1964 to 1995, the absolute decline in lower secondary mathematics achievement appears to have been greater than in any other state, and to have been the equivalent of about two years of schooling."

- "In the mid-1960s, Queensland junior secondary students outperformed students in all other Australian states in mathematics. ...From the late 1970s, there was a significant decline in levels of junior secondary mathematics performance in Queensland."

So what is the cause of these problems?

The Longitudinal Survey of Australian Youth (known as **LSAYR 20**), proved that school type (that is, whether it is public or private) is *not* the driver of these results. Individual schools influence outcomes. School types do not.

It is *not* class size: there is no evidence anywhere of a relationship between class size and results.

It is *not* money: in the 1970's I taught at Innisfail State High School. There were no lights in the classrooms, no fans, class sizes were much greater than nowadays, and we produced maths and science outcomes far higher than happens nowadays.

The problem is "The Education Establishment"; the two main wings of which are University education faculties and the Queensland Studies Authority (known as the **QSA**).

Education faculties are the source of the background theories on how to educate. As the TIMSS data shows, the theoreticians' ideas have palpably failed. As university education faculties are also responsible for teacher training, their influence permeates widely throughout the school system.

The action wing is the powerful Queensland Studies Authority. They produce *all* syllabi and assessment systems for *all* subjects in *all* schools of *all* types throughout the State. They have strong authoritarian tendencies, and their assessment systems are laid down with absolute rigidity. In Years 11 and 12 sciences, there *must* be Extended Experimental Investigations (known as **EElS**) and Extended Response Tasks (known as **ERTs**) that go on for months at a time, allowing pupils to obtain the assistance of others (parents, tutors, siblings) such that the final product is often of dubious provenance, and facilitates minimal real learning. But it is

not just that EElS and ERTs use up a vast amount of time for little learning outcome. Because the process drives at the production of long reports they teach habits that are contrary to the practices and skills of real scientific method. It is bad science to reward waffle. Science is about cogency, precision.

The QSA's assessment structures are complex, non-numerate, opaque, furtive and have unclear rules and systems. A matrix of results must be completed with letters, not scores, and then the teacher uses those letters to come to an overall assessment using an unclear technique. Exam papers are never available to anyone for examination and comment. Fear of reprisal silences criticism.

Because of the authoritarian nature of the assessment systems, QSA effectively control the pedagogy, that is, the way things are taught. The National Curriculum syllabi will *not* help much either, because the States control assessments and the QSA has already stated that such things as EElS and ERTs will stay.

So, what is to be done?

Some pointers were revealed by ACER in "A Shared Challenge":

- "All top performing schools recognise that they cannot improve that which they do not measure".
- "Top performing schools are relentless in their focus on improving the quality of classroom instruction"
- "All of the top performing and rapidly improving systems have curriculum standards which set clear and high expectations of what students should achieve." In this writer's opinion, no QSA syllabus meets that standard.

Schools need "well developed systems for evaluating and monitoring performances."

ACER recommended "That all aspiring primary teachers be required to demonstrate through test performance, as a condition of registration, that they meet threshold levels of knowledge about the teaching of literacy, numeracy and science and have sound levels of content knowledge in these areas."

ACER also recommended "That standard science tests be introduced at Years 4, 6, 8 and 10".

ACER observed that in high performing Victorian schools, "Each of the schools has been particularly active in identifying tests and other assessments which contribute to an objective picture of student achievement and to the determination of the value that the school itself adds, through analysis of trends over time."

Valuable as NAPLAN is, it requires development. Dr Ben Jensen of the Grattan Institute, in his work "Measuring what Matters: Student Progress", states that "the 'My School' website is considerably better than having no information published on school performance. However, problems still exist because ...[it] can produce biased results for schools in low socio-economic areas." He argues that there needs to be a process of "value adding" in education.

Value adding can be defined as "...models that estimate the contributions of schools to student progress ...measured at at least two points in time (OECD 2008)".

Jensen states that value adding is more accurate and that "greater accuracy resulted in head teachers in England favouring the introduction of a system of value-added [teaching]...". He explains that it is preferred in Europe for the same reason, and that "Teacher unions and school associations in a number of countries have also supported the introduction of value added modelling as the greater accuracy creates a fairer system, particularly for schools serving more disadvantaged communities."

NAPLAN is already having a positive effect on teaching in many schools. A value added system would have an even greater impact.

Only Parliament can institute the drastic changes needed to syllabi, assessment systems, teacher training and school attitudes, because at present the QSA and university education faculties think everything is either fine or minimally imperfect and will resist the change required.

So, what should the new Queensland Government do?

Five steps are worth consideration and action:

- Form a permanent standing committee of Parliament for *school* education. The committee should, *inter alia*, examine assessment systems, causes of weak performance to Year 10 exit, and obtain opinions from parents and students under as part of a parliamentary inquiry.

- Accept the ACER recommendation that all aspiring primary teachers must be able to demonstrate a reasonable level of knowledge in maths, science and English. That must occur by formal testing, set externally and supervised in a manner not less rigorous than for the Core Skills Test. Suggested minimal achievement should be at NAPLAN year 9/10 standard and with an 85% pass level. Past papers, marking schemes, pass marks and pass rates should be available for perusal by Parliament and the public.
- Insert in the *Queensland Studies Authority Act 2002 (Qld)* a Regulation stipulating that all assessment systems must be clearly defined, justifiable and produce predictable, measurable outcomes. They must be clearly understandable to students, parents and Parliamentarians and must not discriminate against any student group.
- With the introduction of the Australian curriculum the only remaining activities that QSA *has* to do are Year 11 and 12 assessment, supervision of core skills testing and OP calculation. All other activities, notably enforcement of pedagogy in Years 1-10, are unnecessary, produce even lower standards and are purely "make work". It is now a rump organisation and must be treated and financed as such. Employee numbers and general costs should be reduced proportionately, probably by about 70%. The savings achieved by doing so would be large; far more than the cost of introducing of value added testing.
- Accept and implement as soon as possible Jensen's recommendation that "the current measures of school performance published in the 'My school' website should be replaced with value added measures of school performance, given their greater accuracy and fairness to schools serving poorer communities".

Implementation of these measures will help to turn around the results of Queensland's students. We must act to do so before another generation of students emerges from our education system without the skills needed to compete in the modern world.

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Maths, not “Bloom-in” Education

Dr Matthew Dean

Have you noticed how school graduates generally do not know their times-tables, cannot add fractions or do long division? Even at The University of Queensland, I am finding that the students starting science and engineering degrees are not confident with standard mathematical skills.

Mathematics is the language of the physical world. Science and technology rely on mathematics. Studying mathematics develops sound reasoning, and has been a core discipline pursuing clarity of thought for thousands of years. So why are we presently failing to pass on this gift now?

What is wrong?

Maths' teachers with over twenty years' experience in Queensland, and those teachers who have also taught in other systems, can readily explain what is wrong with our school system: the reason kids do not know their times-tables is because our teachers of maths have been instructed not to have students memorise facts! The reason kids do not know how to add

fractions, and do not know how to do long division, and do not have confidence in doing mathematical procedures, is because teachers of maths, at all school levels, have been instructed to de-emphasize the standard algorithms, and not to use repetition.

No, it's not a terrorist giving our teachers these instructions. It's the recent fashion of educational ideology endorsed by our educational theorists. This ideology is attributed to the 1950s psychologist, Bloom. He regards activities such as remembering and understanding as 'lower order' activities while activities like application and evaluation are considered 'higher order'.

Bloom's theory of 'higher-order-thinking' may have appeal in some sectors, but it is not



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Dr Matthew Dean teaches mathematics at The University of Queensland. He has researched capacitance for silicon chip design, the detonation of mining explosives, symmetrical network problems, highway curvature, and image processing of cells. He has taught mathematics in local schools and abroad. In the course of his career, he has also swung a sledge-hammer, washed dishes, crawled through ceilings, and delivered donuts.

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suiting to mathematics, since mathematics, much like learning to play a musical instrument, requires years of practice and repetition. Following Bloom, our school maths has become instead like one of those 'musical appreciation courses' where students are briefly exposed to a sweeping range of topics, but never really learn how to play. Our students are not asked to do the practice necessary to be able to play a musical instrument. The musical instrument referred to in this analogy is of course the mind.

With our emphasis on so-called 'higher-order' thinking, we have neglected the basics. This has been disastrous for learning maths. Maths is a 'vertically condensed' discipline, building upon itself from one year to the next: Calculus relies on advanced algebra, which relies on simple algebra, which relies on standard arithmetic, which relies on knowledge of the times-tables. Only half-knowing maths one year means only one-quarter-knowing it the next year, and only one-eighth-knowing it the year after that, and so on, until you're having nightmares about arriving at school on the day of the exam, completely unprepared.

I can't help but think that Bloom's followers will not consider maths as 'higher-order' until they have turned it into something it is not. It appears to me that university-level mathematics is still considered a 'lower-order' activity according to Bloom's taxonomy.

“ With our emphasis on so-called 'higher-order' thinking, we have neglected the basics. This has been disastrous for learning maths. ”

Another way that Bloom's ideology inhibits developing maths' skills in our schools is through the introduction of written assignments into mathematics' assessment. Written assignments do not build basic mathematical skills, like regular homework and studying for an exam does. Written assignments belong in English, rather than in maths' class, and they also tend to be

done with the input of parents, tutors, friends or the internet, rather than by the student alone. High school chemistry and physics are suffering even more than mathematics by the inappropriate introduction of very long written assignments.

The imposition of Bloom's ideology also creates much red tape. The paperwork requirements placed on teachers waste so much time that they are obstructive to learning. For example, when a teacher marks a maths' test, he/she is forbidden from awarding a (number) mark for each question and adding these up to get a total score. Instead, for each question, teachers must award letter grades, over three different categories. The appropriate letter is to be chosen by reading and considering up to fifty paragraphs of descriptors. Here is one of the fifty such paragraphs:

“The student work has the following characteristics:

- use of problem solving strategies to interpret, clarify and analyze problems to develop responses to routine and non-routine simple tasks in life-related or abstract situations”

Thus a task which is done by every teacher for every student on every piece of assessment, which should be simple and routine, is in Queensland, not simple at all, but instead a festival of cultural deliberation. After all these festivities, the mystery of how to combine the letter grades begins. Later on, this combination emerges somehow transfigured, on the report to parents, as one of maybe five uncomfortably-worded sentences. The whole process proceeds officially uncontaminated by numbers.

"How is Johnny going in maths?" remains the question on everyone's lips.

How can we fix it?

Education theory and psychology are relatively new and speculative areas of study, with frequently changing ideas. In hindsight, we might question why we ever placed an educational theorist into a position of authority over the process of learning mathematics. It doesn't seem appropriate to subject a whole population to unproven ideas of a speculative nature. People have been learning mathematics for thousands of years. Traditional approaches are safer and more reliable.

The key to fixing this problem is to have experts in the actual discipline of study responsible for the curriculum and assessment of that discipline, rather than appointing education theorists who imagine that every kind of learning is the same. When it comes to mathematics', an appropriate panel of experts might consist of very experienced maths teachers, engineers and mathematicians. Physicists, chemists and economists might also be appropriate.

(Caution: degrees called 'mathematics' 'education' generally consist of only a little or no mathematics, and a lot of 'education'.)

However we decide to restructure, and who ever we appoint, the new body governing mathematics in school must be accountable, unlike the Queensland Studies Authority, which was set up as a statutory body, answerable only to itself.

I feel that we should keep state sovereignty over education as much as possible, even though the proposed national curriculum looks better than our present one. My reason for this is if or when, the national education bodies begin to move down silly paths, then it will be so much more difficult to turn them around. Will the national body appoint people who do mathematics, or people who do education?

There is some good news:

- 1) our current low performance in maths is not due to any intrinsic or innate stupidity,
- 2) this problem can be solved, and
- 3) it is not an issue of needing to spend more time or money.

A good mathematics' course will build a student's confidence in his/her own ability to reason clearly and correctly. After completion, a student may go on to apply this ability to his/her chosen pursuits in life. May we grant this privilege to every generation.

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The 2012 LNP Convention passed this resolution on education:

NUMBER 10 CARRIED LNP WOMEN (HERVEY BAY)

Review teaching and learning in Prep and Primary schools

That this Convention of the LNP calls for the LNP Government to review, as soon as possible, the state of teaching and learning in Prep and Primary schools by:

- a. Conducting an extensive review of the C2C centrally based curriculum with the view (to) allowing teachers to teach and children to learn in a positive environment,
- b. Continuing to closely monitor the implementation of the National Curriculum so that the Queensland teachers and children do not face the stress at the beginning of 2013 that they are currently experiencing in term 1 2012, and
- c. Developing positive communication with practising teachers and valuing their feedback and that adequate time frames be provided for writing the lessons to provide quality education for Queenslanders.