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**Teaching for a deep
understanding in
*MATHS***

**Adult numeracy
in Australia:
*a call for change***

**Trust in our schools:
*the missing part of
school improvement?***

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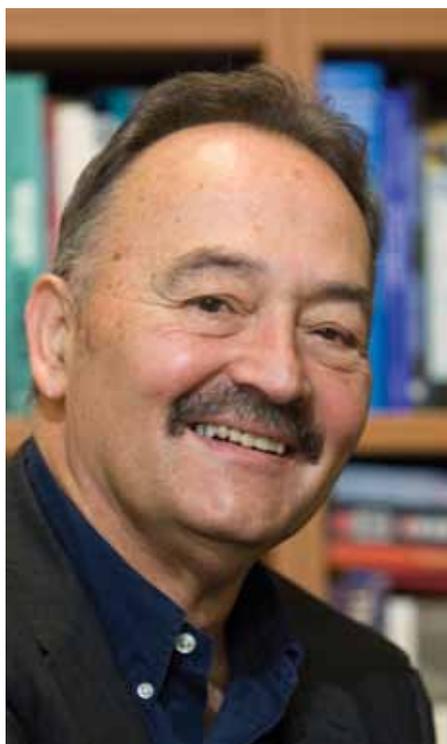
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Concerns about numeracy



The importance of being numerate in modern society cannot be overestimated. Numeracy, the ability of an individual to apply mathematical skills in everyday situations, enables people to make sense of the world around them and participate fully in society. Benedict Anderson wrote about how universal literacy produced by mass schooling ensured the production of the imagined community that was the nation and of national citizens. I would also want to argue that universal numeracy serves these functions as well.

As Keith McNaught notes in his article in this edition of *Professional Educator*, 'In a society like Australia, numeracy is... intrinsically involved with an individual's ability to engage actively with media, government, community, educational and financial institutions and their respective mechanisms, regulations and standards.' By contrast, 'An innumerate person not only lacks the necessary skills to apply mathematics to life, but they fail to realise their full potential as a productive and informed citizen.'

In this the International Year of the Mathematics of Planet Earth (MPE) we are devoting this edition of *Professional Educator* to discussion of some of the trends and issues in mathematics education and numeracy. Our contributors present some concerning facts.

James Flynn notes that the 'mathematical competence of populations across the Western world is barely increasing or even going backwards, at a time when other intellectual skills have shown considerable growth.'

According to a recent discipline profile of mathematical sciences prepared by the Australian Mathematical Sciences Institute (AMSI), despite a strong need for graduates in mathematical sciences, domestic enrolments in higher degrees wane, the number of qualified mathematics teachers in schools is in decline, and the number of students enrolling in advanced mathematics courses at Year 12 has dropped by 30 per cent.

Studies by the Australian Bureau of Statistics and Industry Skills Councils, cited in Keith McNaught's article, indicate that around half of the adult population of Australia has difficulty with numeracy.

What do we do about this situation? Numeracy is centrally important and it is critical to promote competency in the early years of schooling. However, I would not want to see this lead to a narrowing of the curriculum or how we teach mathematics being driven by the content of high-stakes tests.

What do you think needs to be done about mathematics education and numeracy in Australia? Please share your views with us by writing to ace@austcolled.com.au

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your say

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Rupert Dalley's comments (May 2013) about the issues that concern classroom teachers are important. However, I disagree with him on one point. There may well be aspects of 'craft' in what teachers do each day, but teaching is much more than a craft; it is a profession.

Whatever we may think about the AITSL Standards they do aim to 'contribute to the professionalisation of teaching and raise the status of the profession' and the three domains of the AITSL Standards (Professional Knowledge, Professional Practice and Professional Engagement) closely correspond to the criteria generally used to define a professional. Add to this the fact that teachers need to be registered by the statutory body in their state and you have teaching as a profession.

The problem is that many in the wider community do not see teaching as a profession. The relatively low rates of pay don't help! If we don't see ourselves as professionals and talk about ourselves in this way, we will exacerbate the problem and be unable to encourage high quality candidates and university graduates to become teachers. Perhaps classroom teachers need to start referring to themselves more often as 'educators' rather than 'teachers'. I have officially retired but I still see myself as an educator.

Di Russell FACE

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I have just read Geoff Masters' article, 'Education assessment in the 21st century', and found myself agreeing with everything he said. There is nothing more important, or more valuable, to students and teachers as a teaching/learning tool than good assessment. However, we need to ask ourselves two questions: What is good assessment? How can we implement it?

As Masters points out, same year level curricula, and therefore the accompanying means of judging learning is not equitable, and can be a huge disadvantage to those who struggle with a system that may not address their learning needs. As Sir Ken Robinson states in his book *The Element* 'our stratified, one-size-fits-all approach to education marginalises all those who do not take naturally to learning this way'.

The question, then, is how do we ensure that our assessment practices are more meaningful and more appropriate for children in the 21st century? The first way would be to make the curriculum more appropriate, however that is a whole subject in itself.

What we need is for teachers to be able to design their own assessment materials and tasks, to ensure their best possible outcomes for their own students. However, and this, I believe, is a major sticking point at the moment, unless assessment design becomes a significant part of any teacher training course, this cannot happen. Unless teachers truly understand what assessment is and have studied it in a meaningful way, they will not

be able to effectively design the tasks themselves, and may end up doing more damage than good.

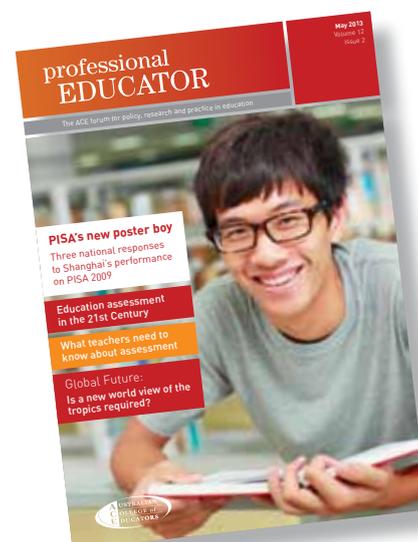
Geoff Masters believes 'it's time for significant reform in educational assessment'. I don't disagree with this for a moment. However, I would add that reformation is not the answer. What education needs is a complete transformation.

Dale Down MACE, MACEL

”

Di and Dale receive a complimentary copy of ACE's publication *Equity and Education*.

To have 'your say' on the articles in this or the previous edition of *Professional Educator*, please email Louise.Reynolds@austcolled.com.au



A year to be number proud

I am surrounded by maths. I work at the Australian Mathematical Sciences Institute — AMSI for short — and am half way through a theoretical physics honours course. I love numbers.

When I talk to people, be it through work, university or socially, I find that many are not ashamed to voice that they are 'not good at maths'. In fact, some take pride in saying so. I always ask these people about their ability in English, or if they would be as open about their lack of reading or writing skills. Almost all of them answer with silence. Many have never thought about it from this angle. And when they do, the conversation that ensues is almost always the same; rather short on their end. '... Oh, but... Maths is different, isn't it?' I would suggest not.

Here at AMSI it is our mission to support the mathematical sciences, from its foundations in our schools to its remarkable ability to innovate and drive us into the 22nd Century. In March, AMSI published its second discipline profile of the mathematical sciences. The intention of these profiles is to provide evidence and inspiration for policy development, for us at AMSI and for various levels of government and governance.

The profile highlights trends that are taking place throughout the education pipeline, from schools to research to careers. It found that:

- the demand for mathematical and statistical skills at all levels outstrips supply
- the number of qualified mathematics teachers in schools continues to decline — especially in regional and low socioeconomic areas
- domestic enrolments in higher degrees wane.

All this while the need for graduates remains immensely strong. One of the striking things reported in the discipline profile is that 94.4% of Year 6 students believe mathematics to be important to their futures. Yet over the last 15 years the number of students enrolling in advanced mathematics courses at Year 12 has suffered a 30 per cent reduction.

So if we are mindful of its importance, why the lack of interest? Firstly, mathematics is an elective. What kind of message does this send to school students? That having a grasp on the English language is more valuable than having a grasp of mathematics? (Which, as described to me by a mentor, is 'the common language of all science'.)

“ ...94.4% of Year 6 students believe mathematics to be important to their futures. ”

Secondly, there is a lack of awareness of the career paths linked with higher degrees in mathematics and statistics. If career advisors, teachers and parents aren't acquainted with the diverse fields — finance, business, computer science, psychology, the modelling of just about everything — how can our kids choose wisely?

In fact, the data shows that mathematics and statistics departments across Australian universities provide 'service subjects' to a staggering thirteen different faculties.

We must ensure that the mathematics concealed between all layers of modern existence is clear and visible. Are people savvy to the fact that text messages are converted to binary and back to letters in the nanoseconds it takes for them to travel from fingertips to the correspondents phone? Beautiful, sophisticated mathematics.

Thirdly, our society. An emphasis on material things, good looks and athleticism is rampant in today's media. Whether it be a broadsheet, online, on our small screens or in a magazine, we are more likely to hear about so-and-so's botched plastic surgery job than who is the most recent recipient of the million-dollar Clay Mathematics Institute Millennium Prize.

Engaging people in mathematics and statistics is tricky — I wonder if we have any stats on just how tricky. We must stop, and ask: 'Why?' Actually, I withdraw that question. It is far too difficult to answer. Instead, let us be proactive and do something about it.

2013 is the International Year of the Mathematics of Planet Earth (MPE). AMSI and its partners have taken on the responsibility to dazzle Australians with the varied influences that the mathematical sciences has on all aspects of life. And we aim to do it in a fun — engaging — accessible way.

Of course in today's world the lynchpin is a blog, which is both interactive and informative. We have puzzles and competitions, with prizes, classroom and dinner table activities and an array of interesting posts from an array of interesting people.

We have a dedicated and passionate team working on the schools section of the website. Here teachers, and anyone else



AMSI's schools program. Photograph courtesy of AMSI

“ 2013 is the International Year of the Mathematics of Planet Earth (MPE). ”

for that matter, can find material to use in the classroom to engage (there's that buzzword) their students with mathematical applications in the tangible world.

There isn't much I can do to make mathematics a core subject at Year 12. However, to combat the second issue — lack of career advice — I run a special blog: *A coffee with...* In this blog I ask an assortment of people five simple

questions about their relationship with mathematics and / or statistics. It illustrates that whether you're a personal trainer, journalist, climate change scientist, Google technician, aspiring statistician, accountant or political history major you'll use some form of mathematics or statistics in your daily life — at work and at play.

In July this year, Melbourne will be host to MPE: The Conference. A week long event designed to instigate interdisciplinary conversations and collaborations in a bid to address pressing global matters.

This event will also cater to those in the public whom wish to expand their horizons and knowledge in the Mathematics of Planet Earth with public lectures, workshops and round tables.

So while we all know that the mathematical sciences are integral to our modern way of life, the fact needs to be at the forefront of the public consciousness.

I cannot do this on my own, the task falls to us all — and is a little easier than changing the Australian curriculum. Although, if we do a good job of banding together in 2013 — that means jumping together online, on your soap box, spreading the numbers and being proud of it — who knows, public outcry just might get our polities thinking: '... If we want to be the clever country, we need more innovation to improve productivity. And vital to every step of that process is the language of mathematics. So we need to invest in education, for our maths sake.'

Stéphanie Pradier works in media and communications at AMSI, and is completing her honours year with the ARC's Centre of Excellence in Coherent X-ray Science. She has a passion and knack for communicating tricky ideas in layman's terms. Stéphanie's *A coffee with...* blog can be found at <http://mathsofplanetearth.org.au/category/a-coffee-with/>

Further information on the International Year of the Mathematics of Planet Earth, including classroom resources and activities, is available from <http://mope.org.au>



Adult numeracy in Australia: a call for change

THERE IS A LACK OF CLARITY ABOUT THE DIRECTION FOR ADULT NUMERACY IN AUSTRALIA ACCORDING TO KEITH MCNAUGHT

It has been acknowledged that high levels of innumeracy and illiteracy not only have a direct impact on a nation's GDP, but have far-reaching consequences on an individual's ability to participate in a modern technological society.

Examinations of research papers and reports since the 1990s indicate that studies of numeracy are inherently linked with those of literacy. While the two areas are closely related, research projects with a specific focus on numeracy levels are less common. In the common coupling together of literacy and numeracy, the attention given to literacy is frequently disproportionate and to the detriment of numeracy.

The lack of detailed investigations into innumeracy in Australia represents a gap in the current policies of educators and governments. If the issue is to be addressed a concerted effort must be made to develop accurate and relevant methods for describing the current

problem. Moreover, determining which institutions will provide for numeracy research and education initiatives will be of primary concern.

Defining numeracy

In 1997, the Australian Association of Mathematics Teachers described numeracy as 'the disposition to use, in context, a combination of: underpinning mathematical concepts and skills from across the discipline, mathematical thinking and strategies, general thinking skills; and grounded appreciation of context' (AAMT, 1997). Diana Coben summed up numeracy elegantly when she stated 'To be numerate means to be competent, confident, and comfortable with one's judgement on whether to use mathematics in a particular situation and if so, what mathematics to use, how to do it, what degree of accuracy is appropriate, and what the answer means in relation to the context' (Coben, 2000, p. 10).

Numeracy is not just a basic proficiency with mathematics (for example, the ability to add, subtract, divide and multiply), but the propensity of an individual to apply those skills in his/her everyday life to interpret, calculate and make sense of the world around them. In a society like Australia, numeracy is also then intrinsically involved with an individual's ability to engage actively with media, government, community, educational and financial institutions and their respective mechanisms, regulations and standards. An innumerate person not only lacks the necessary skills to apply mathematics to life, but they fail to realise their full potential as a productive and informed citizen.

The notion of context can make definitions of numeracy problematic. What standards apply when we categorise people as 'numerate' and 'innumerate'? How do we set benchmarks in testing whilst considering cultural, social, economic,

technological contexts in an individual's real life application of mathematics? A socially and culturally responsible approach to education and research implies that a 'universal standard' for numeracy is inherently problematic and that methods of testing will always be limited in scope.

Measuring numeracy

The *Adult Literacy and Life Skills Survey* (ALLS) was first conducted in 1996 by the Australian Bureau of Statistics. The most recent available iteration of the survey, run in 2006, revealed 'the proportion of Australians below minimal competence was 44.5% for numeracy and 64% for problem solving' (Athanasou, 2012, p. 175). A paper titled *No More Excuses – An Industry Response to the Language, Literacy and Numeracy Challenge*, published in 2011 by Industry Skills Councils, stated that 'approximately 53% of working Australians have difficulty with numeracy skills' (ISC, 2011, p. 1).

Most studies of numeracy are focused on measuring numeracy while individuals are still in the classroom, at the primary and secondary school levels. NAPLAN (National Assessment Program for Literacy and Numeracy), PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) provide the majority of data on a national and international scale, but each of these studies comes with its own set of limitations and difficulties.

A comparative look at NAPLAN results from 2008-2012 on a national level provides little insight into whether literacy and numeracy levels are improving on a whole. The percentages of students in grades 3, 5, 7 and 9 able to meet benchmarks in reading, writing, spelling, grammar and punctuation and numeracy have varied between 84.8% and 95.4%; with no pattern of significant improvement or decline between years since 2008 (NAPLAN Summary Report 2012, 1). Numeracy results have remained in the 90% range throughout all grades since 2008. In addition, due to the recentness of NAPLAN as a testing method, we cannot accurately determine

the nature of the relationship between poorly performing students in NAPLAN and adult innumeracy levels on a national scale. Although we can assume that students who perform poorly in NAPLAN throughout their school life will translate into becoming innumerate (within the Australian context) as adults, this assertion remains a point for speculation. NAPLAN results appear to be more about identifying schools that are underperforming, rather than innovating in numeracy policy and practice on a national level.

PISA (Programme for International Student Assessment) assesses 15-year-old students in literacy, numeracy and life skills every three years (OECD, 2012). The latest PISA tests (2009) ranked Australia above the OECD average in all areas (reading, mathematical and scientific literacy). However, in mathematics, Australian students achieved a result similar to that of 2006 but down on the 2003 result (ACER, 2010). The reason for the slight differences in student performance between the years remains unclear, although we can infer that the results show Australia's education system has not yet implemented policies or practices on a national level to improve significantly or impact numeracy scores, at least for the period from 2006-2010. The nature of PISA as a random and anonymous testing method also means that we cannot use results as a basis to measure improvements in the numeracy skills of the members of a cohort as they enter adulthood and the workforce.

However, PISA succeeds in offering data that allows us to compare results between different states within Australia, providing us with a picture that considers gender, race and socioeconomic context. In the area of mathematical literacy, the 2009 results revealed the lowest performing states to be the Northern Territory and Tasmania, although at a level not significantly different from the OECD average (ACER, 2010). The 2011 NAPLAN results echoed these findings, showing Northern Territory and 'indigenous schools' as performing below the national average, despite an improvement in performance over the previous years.

“ Numeracy is not just a basic proficiency with mathematics (for example, the ability to add, subtract, divide and multiply), but the propensity of an individual to apply those skills in his/her everyday life to interpret, calculate and make sense of the world around them.

”

Identifying 'at-risk' groups within Australian society is less about concerns regarding location, race and ethnicity, but more about recognising the effect of disadvantage on the social norms and expectations of parents and teachers. As part of a new approach to LLN (language, literacy, numeracy) culture within education, numeracy should be properly valued and its true importance emphasised within vulnerable Australian communities and the schools educating their children - it needs to be promoted – in a practical and easy to understand manner – as a key to a higher quality of life for everyone.

The message from all LLN stakeholders is clear - in the 21st century, the career trajectory of an individual is often varied, changing jobs more often is becoming the norm, and broad skill sets based on solid foundations will be crucial to sustaining employment over the course of a lifetime. Numeracy skill gives a person the ability to adapt to changing circumstances and economic environments. With this fact in mind, in order for Australia to continue on a path of social and economic growth, policy makers need to move away from rhetoric and towards action. Current policy and funding targets fail to layout how numeracy education practices can improve, but it is obvious that significant changes need to take place in the culture and practices within Australian schools, training organisations, and higher education providers.

“ As part of a new approach to LLN (language, literacy, numeracy) culture within education, numeracy should be properly valued and its true importance emphasised within vulnerable Australian communities...”

Current government, education and industry responses

In May 2012, the Australian Council for Educational Research (ACER) conducted the first National Adult Language, Literacy and Numeracy Conference (NALLNAC) providing a platform for discussion of adult literacy and numeracy education, the extent of the problem, the socioeconomic impacts of illiteracy and innumeracy, and the desperate need for a concentrated response.

The conference yielded positive results in the form of 10 major insights. For the purposes of this paper, with its focus on adult numeracy, the five most crucial ideas are:

- Research shows that numeracy is a critical predictor of educational, workforce and lifelong success. We need to talk about literacy and numeracy.
- We need to continue to increase our knowledge of the issues and implications of low LLN skills both within VET and outside VET, particularly in business and industry.
- No single sector – public education, private education, industry or government – can address the issues in isolation. It requires a shared response and a collective responsibility.
- Assessment is a vital tool for gathering evidence to improve teaching and learning, and to inform educational and business administration. Learning, training and assessment are not separate activities but essential partners.
- We need properly funded research to provide us with an evidence base for policy and planning, rather than relying solely on local and anecdotal information (ACER, 2012).

On 26 June 2012, the South Australian government announced a \$3.25 million Adult Community Education initiative, which will fund in excess of 7000 training places to be offered by community-based, not-for-profit training providers. This initiative will provide adults with education in basic job skills with a focus on numeracy and literacy (Government of South Australia, 2012). On a longer-term, national level, training in literacy and numeracy for adults is organised by government via the Department for Employment and Workplace Relations' *Language, Literacy and Numeracy Program* (LLNP). The program has been in operation since 2002, in which Registered Training Organisations (RTOs) are contracted by the Department of Industry, Innovation, Science, Research and Tertiary Education; \$143.1 million has been allocated to improve entrance to the program. The LLNP targets jobseekers from non-English speaking backgrounds, but also caters for other disadvantaged groups including Indigenous people and those with disabilities.

Teaching numeracy

A 2011 paper, authored by Stephen Black and Keiko Yasukawa, titled *Beyond deficit approaches to teaching and learning: Literacy and numeracy in VET courses* explored a more holistic approach to LLN education – a method that integrates LLN study within a larger context of vocational training and seeks to avoid targeting students/individuals that 'don't make the grade'. The paper summarised the current approach to teaching LLN:

L&N support provided to students in VET falls within a 'deficit' approach, that is, learners are perceived to have problems which are primarily located within them, and that they need support to overcome these problems in order to succeed in their studies. This approach is so engrained in VET practices that there is very little debate over it in Australia, either in the research literature or in practice. (Black & Yasukawa, 2011, p. 1).

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The paper addressed the issue of context and the role of the school/institution as an environment that either facilitates learning for the whole student group, or places fault/inadequacy upon the individual. It is possible that this dominant discourse, which specifically targets students that are having LLN problems, is pervasive not only within higher education, but also within primary and secondary schools. It is a dominant understanding which amounts essentially to the process of blaming the victim.

Furthermore, Black and Yasukawa highlighted a lack of standards in LLN testing and screening within VET providers, stating:

Nearly all TAFE systems have testing mechanisms, though again, they vary considerably, and they can be seen to fit along a continuum ranging from formal, decontextualised testing at one extreme, to informal chats with students at the other (2011, p. 6).

The arrival of an *Australian Core Skills Framework*, as a national standard for LLN skills is a positive step forward. While the dominant understanding of LLN education (e.g. one-on-one support, general workshops, and tutoring) is not without its merits, the approach to teaching numeracy should avoid singling out failing individuals. That is, the content and support is best effectively embedded

in to discipline-specific subjects. The standards of numeracy being taught must be based on a joint understanding between all parties – a flexible understanding that is informed by personal/cultural/vocational context and practical application; the skills must be discipline-specific. In terms of both VET and Higher Education programs, general numeracy workshops are of little, if any, value. However, tailored discipline-specific programs can have significant benefit.

Conclusion and recommendations

The current set of PISA and NAPLAN test results provide a narrow view of national numeracy. Moreover, our key sources of data on adult numeracy are extremely limited [e.g. the Australian Bureau of Statistics' ALLS]. The recentness and infrequency of the present assessment methods also serves to limit a long-term perspective and in addition, many concerns have been raised about their fairness in relation to students' context. Our sources of information are inadequate. Therefore, research methods that provide us with an accurate, considered and broad view of numeracy will be vital to formulating effective policies and practices.

“ Current policy and funding targets fail to layout how numeracy education practices can improve, but it is obvious that significant changes need to take place in the culture and practices within Australian schools, training organisations, and higher education providers. ”

National agreed standards for numeracy need to be commonly understood. This paper echoes the findings of the 2012 NALLNAC – all sectors of Australian society need to share responsibility and determine collectively exactly what the nation needs to do to improve numeracy levels. In 2010-2011, the Australian Government spent approximately \$725 million on programs to improve 'foundation skills'; an effective return on inputs is essential.

Allowing students who need support to engage on a voluntary basis is an issue that also needs to be addressed; it simply compounds disadvantage and ignores the wealth of long-term research which identifies the phenomenon that those who most need support are the least likely to engage. Change is essential for personal-good and common-good. There's a message of importance for both VET and Higher Education in challenging current approaches to improving student numeracy, to address the broader national problem of innumeracy.

This article is based on a discussion paper prepared by the Academic Enabling and Support Centre, University of Notre Dame Australia; the work of Ray Leemans is acknowledged.

Professor Keith McNaught is the Director of the Academic Enabling and Support Centre (Fremantle & Broome campuses) at the University of Notre Dame Australia and has a long background in Mathematics Education. keith.mcnaught@nd.edu.au

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JAMES FLYNN

Mathematics at school: Raven's versus Shayer

In America and other Western nations, there is a wealth of data that helps track, explain and understand children's intellectual growth. The results of IQ tests such as the Wechsler tests and Raven's Progressive matrices show some interesting and surprising developments. In addition, America uses the Nation's Report Card, which describes the mathematics and reading levels of school children aged about 7, 12, and 17.

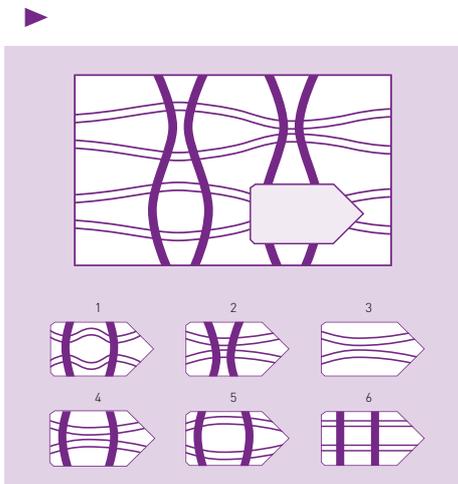
For many decades, average scores on the Wechsler IQ tests – there are versions for pre-schoolers, school age children and adults – and Raven's Progressive Matrices have steadily increased. The population seems to be getting more competent at the sorts of intellectual skills that these tests assess. A closer look at results reveals that competence is not increasing at the same rate in all domains however. Of concern is that the mathematical competence of populations across the Western world is barely increasing or even going backwards, at a time when other intellectual skills have shown considerable growth.

The Wechsler Intelligence Scales

For the last 70 years the Wechsler Intelligence tests have been in wide use worldwide. The tests are 'individual tests', that is, they are administered

to the test taker by a trained psychologist. There are three forms the WPPSI (←6 years), the WISC (6-16 years) and the WAIS (→16). The three forms have two sub-scales: verbal and performance, each of which is composed of several items. Results on these are combined to give a full scale score.

The score obtained on a Wechsler IQ test is a 'deviation IQ'. This number is derived by comparing an individual's score with those of others of the same age. The process of using results from a sample of individuals to construct scores is also called 'norming'. The Wechsler tests have a mean of 100, thus average IQ as measured by these is 100. Scores are normally distributed (a bell shaped curve). Around 66% of people have a Wechsler IQ of between 85 and 115, thus scores in this range equal a 'normal IQ'.



Raven's Progressive Matrices

Critics of intelligence testing have been quick to point out that the content of IQ tests draw heavily on the experiences of a sub group of people, that is, educated white Westerners. Efforts were subsequently made to develop tests that were purer measures of IQ, unaffected by learning. These were sometimes referred to as 'culture free' or 'culture fair' tests. A well-known and widely used culture fair IQ test is the Raven's Progressive Matrices, an example of a non-verbal IQ test because the problems are expressed in pictures rather than words.

The Wechsler IQ tests are composed of a number of subtests that measure competence in domains of great interest to educators: the Arithmetic, Vocabulary, and Information subtests. The Raven's test, on the other hand, is a 'non-verbal' IQ test. It measures the ability to perceive logical relationships that connect symbols of an abstract nature, shapes that show a progressive tendency to alter over a sequence, all in the context of a matrices design so that one must compare sequences along multiple dimensions.

Raven's and math test scores are highly correlated, which might seem to signal that they require similar cognitive skills. Therefore, it appeared sensible to teach young children Raven's-type problems in the hope that they will become better mathematics problem solvers. US schools have been doing that since 1990.

However, prior to 1990, between 1950 and 1990, people made huge gains on Raven's Progressive Matrices. I have estimated these gains at an average of at least 20 IQ points. These gains, of course, were not the product of deliberate tutoring, as they occurred before tutoring was introduced. During the same period, US schoolchildren showed virtually no gains on the Arithmetic subtest. In sum, Raven's gains do nothing to promote mathematical reasoning gains. Raven's-type tutoring was doomed from the start. And indeed, in the decade after its introduction, schoolchildren, at age 17, made no mathematics gains on the Nation's Report Card.

Note that I stress age 17. From 1973 to 2000, the Nation's Report Card shows 4th and 8th graders making mathematics gains equivalent to almost 7 IQ points. These put the young children of today at the 68th percentile of their parents' generation. But the gain falls off by the 12th grade, to literally nothing, and the content of the WISC Arithmetic subtest suggests why.

The Arithmetic subtest and the NAEP mathematics tests present a composite picture. An increasing percentage of young children have been mastering the computational skills the Nation's Report Card emphasises at those ages. However, WISC Arithmetic measures both computational skills and something extra. The questions are put verbally and often in a context that requires more than a times-table-type answer. For example, take an item like: 'If four toys cost six dollars, how much do seven cost?' Many students who can do straight paper calculations cannot diagnose the two operations required: that you must first divide and then multiply. Others cannot do mental arithmetic involving fractions. In other words, WISC Arithmetic also tests for the kind of mind that is likely to be able to reason mathematically.

My hypothesis is that during the period in which children mastered calculating skills at an earlier age, they made no progress in acquiring mathematical reasoning skills. Reasoning skills are essential for higher mathematics. Therefore, by the 12th grade, the failure to develop enhanced mathematical problem-solving strategies begins to

bite. American schoolchildren cannot do Algebra and Geometry any better than the previous generation. Once again, although the previous generation was slower to master computational skills, they were no worse off at graduation.

“ ...it appeared sensible to teach young children Raven's-type problems in the hope that they will become better mathematics problem solvers.”

The US is not the only place to exhibit signs that mathematical skills are not growing at the same rate as other skills. Research by Michael Shayer, an English educator, has highlighted that in Britain from 1975 to 2003, performance among schoolchildren on the Piagetian tasks of conceptualising Volume and Heaviness declined by 0.8 standard deviations (12 IQ points). I analysed British Wechsler Intelligence Scale for Children data covering the latter half of that period. From 1990 to 2003, British children lost 6 IQ points on the WISC Arithmetic subtest. The rates of loss are of course identical.

Michael Shayer is breaking new ground using teaching techniques based on self-discovery within small groups. The results of a new method of teaching mathematics are often impressive when the inventor and his disciples communicate it to teachers and teachers are excited about something new and promising. But perhaps Shayer's method will continue to pay dividends when it becomes part of classroom routine. It is worth a try.

Professor James Flynn is Emeritus Professor in the Department of Politics at the University of Otago, New Zealand and Distinguished Associate at the Psychometrics Centre of the University of Cambridge. He is author of *Are we getting smarter? Rising IQ in the twenty-first century* (2012) published by Cambridge University Press.

Successful Science Education Practices

Exploring What, Why and How They Worked

Christine Redman (Ed)

There seems to be a flood of generalist research-based education books on the market at present, often marketed as 'the solution' to any and all education/schooling problems in Australia and more widely in the West.

Yet schools become better for each student one classroom at a time, one subject at a time, one teacher at a time. We know that classrooms vary enormously, and that the tasks facing Science, Mathematics, English, Drama, Art and PE teachers differ considerably.

This book, then, is very welcome indeed. It is thoroughly research-based, contemporary, international in scope and deals with real situations in real classrooms where Science (in one chapter, ICT) is being learned and taught. In 'student' age range it moves between young children and experienced graduates.

Positioning theory, Wittgensteinian perspectives, constructivism, communities of learners and practice, narrative research (and more) all feature, and there is no shortage of reference to the influential theorists in the field.

Despite the opening apologies of some of the contributors, the classroom approaches and technologies feel very contemporary. This includes the ICT material – no mean feat, given the pace of change in that area!

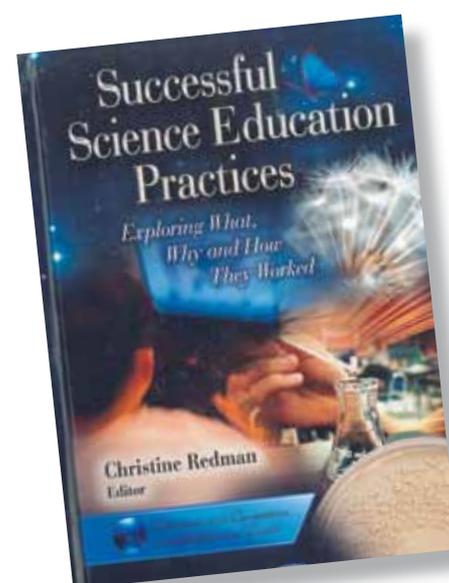
Many of the chapters left me inspired to learn more about.... and to incorporate more of.... in my own teaching.

There are chapters on giving effective feedback to students (very practical, with the lessons of constructivism firmly in mind), incorporating effective use of ICT in a range of settings and technologies, international perspectives on primary science education from China and Iran, reflective personal perspectives on teamwork, perspectives on the role of dot drawings as a powerful learning approach for young children, using models, simulations and demonstrations, teachers learning Space science (full of creative ideas and leads with a well-designed learning process) and a careful examination of the difficulties involved in teaching Newton's Third Law. The scientific fields cover Biology, Chemistry, Environmental science, Earth and Space science and Physics.

I don't imagine that the book will be read 'cover to cover' by busy classroom teachers – though it is hard to imagine a thoughtful practitioner not finding several chapters of interest and stimulation, and it would certainly be valuable in a school science department and teacher education libraries. Researchers in the field, however, will undoubtedly find much of interest in the book.

We should be thankful to Christine Redman for drawing the project together, and Nova publishers for their part.

Dr Syd Boydell



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DAVID TRIPP

Principles of practice in teacher education and performance standards

DAVID TRIPP PROVIDES AN ACCOUNT OF HOW TEACHER PROFESSIONAL KNOWLEDGE CAN BE CAPTURED AS 'PRINCIPLES OF PRACTICE'



In my previous opinion piece (*Professional Educator* May 2013) I explained why professional practice cannot be broken down to sets of competencies as in trades training, which is why we speak of teacher education rather than training: the number of variables and context means we can never be sure of the outcomes of any strategy; but this does not mean that it is not possible to identify and teach sets of strategies that teachers can apply according to their professional judgement of what will work best in any given instance. What is surprising, however, is that teacher professional knowledge has never been systematically researched and packaged for teacher education courses and performance assessment, in spite of much having been developed, recognised and explained here and there in the literature over the years. What follows here is a brief account of how teacher professional knowledge can be captured as principles of practice; it ends with two major implications of this for the profession.

Constructing principles of practice

Something I've learned from both my own teaching of beginning teachers and watching experienced teachers mentoring them, is that we mainly talk and think about teaching practice in terms of what are generally referred to as 'tips for teachers'. Here are some of these 'tips' for curriculum and classroom management that I've used with student teachers:

- Break instructions down into manageable chunks.
- Start new learning from what the students already know (and can do).
- Avoid escalating minor incidents into major power struggles.
- Get the student's account of what happened (and their understanding of your response to it).
- Be clear about your expectations and their responsibilities.

For some time I've been looking for ways to develop such 'tips for teachers', and have recently settled on seeing them as having four components: strategies, functions, theories, and educational values. Take for example the tip to 'be consistent'. That involves:

- A *strategy* to use to be consistent (e.g. '3-strikes': warn, warn, consequence).
- The *function* of consistency is to establish 'normality' through routines.
- Psychological *theory* validates consistency by explaining the need for routines and how reinforcement works, and how an emotionally safe learning environment assists learning.
- The *educational values* in being consistent are that it is efficient, socially just, and helps to reduce stress.

When tips for teachers have been developed in such a way, I refer to them as 'principles of practice' because they are principled guides to action; that is, they are general recommendations for action, and they are also 'principled' in the sense that they are validated by experience, theory and educational values.

Analysis of critical incidents in classroom interaction shows that a teacher may be following several principles of practice in a single exchange. In this incident the teacher was using a '3-strikes' strategy with a child who was annoying her neighbour. After two warnings the teacher told her to move, but the child pleaded, saying, 'I won't do it again', and the teacher responded with:

It's too late for that now, Jill. I did tell you twice, didn't I? So you can either move to the other end of the table for the rest of this lesson; or if you don't want to do that, you can leave the classroom now and finish your work after school tomorrow. It's your choice.

This is not just an example of consistency in discipline; whether the teacher consciously knows it or not, it also shows the implementation of several other tips for teachers:

- Listen to the child's view
- Show you've heard
- Explain your decisions
- Give children some autonomy
- Demonstrate desirable behaviour

This is the anatomy of a teacher's professional practical knowledge, and all such tips can be analysed to become principles of practice in the same way as 'be consistent'. Taking the first two as further examples:

Principle of practice	Implementation strategy	Function	Validating theory	Educational Value
Get the child's view	Listen to the child	Informs professional judgement	Evidence informed decision making (Reflective practice)	Justice Maintain safe learning environment Socialisation
Show the child she's been heard	Respond to content of utterance	Treats child as a worthwhile person	Child development (self-regard)	Mutual respect



One can see here how components of different principles often overlap in a single classroom interaction. One might need to refer to these as 'specific principles' because they are some of the principles involved in more 'general principles' such as, *Avoid power struggles*. So too, the tip 'listen to the child's view' is one strategy for implementing the general principle: *Get the child's view*.

That analysis of the incident shows how easily teachers' professional knowledge can be expressed as principles of practice, and also that these do not so much link theory and practice as incorporate them in a single superordinate entity. Principles of practice treat teachers' professional knowledge as a combination of facts, explanations and skills, or 'knowing that', 'knowing why' and 'knowing how'. For example, they need to know that it's important to avoid power struggles and why that's so, and they also need to know how to avoid them.

“ Principles of practice treat teachers' professional knowledge as a combination of facts, explanations and skills... ”

Note also that principles of practice do not displace the role of context and the need for professional judgement: there are times when long-term outcomes will be better achieved by not consistently imposing a consequence after two warnings for a misdemeanour. For instance, if a child already has had a consequence for poor behaviour that morning, then it might be better to respond with a further warning or asking

the child to explain their behaviour. That is why it is essential to consider both theory and values in the making of appropriate professional judgements.

Implications for teacher standards

The Federal Government's Australian Institute for Teaching and School Leadership (AITSL) has been charged with improving teacher education, and part of their work has been to annotate their 'illustrations' of the national teaching standards with 'Features of Practice'. For example, a feature of practice identified in an illustration of a teacher selecting content for a Year 9 Mathematics program (unpublished), is that the teacher is seeking to, *Organise content in an extended teaching program in which all parts are related and coherent*, and one can see how it could be re-worded as a general principle of practice:

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The different parts of the content of a teaching program should be coherently related. This principle is derived from learning theory: psychological concepts such as 'big picture', chunking and sequence in learning, and the value is to make it easier to understand.

Two *principles of practice* were not identified as *features of practice* by AITSL in that illustration. One is to: *Work from the known to the unknown*, which is implicit in the teacher's strategy for the children to, *Describe known shapes*, and that's informed by the Vygotsky's theory of the zone of proximal development. The other is to, *Consolidate learning through immediate application*, which is implicit in the teacher's strategy for the children to, *Use the learning to solve problems*, and is informed by theory about learning from experience.

Clearly those are all principles of learning that can be taught so that teachers know and use them in lesson planning, thus producing more illustrations of those principles being put into practice.

In 2011 I pointed out to AITSL that features of practice were close to principles of practice, though the two are constructed differently: the features are descriptions of good practice, whereas principles are prescriptions for good practice, which I thought might be more useful in regard to standards.

Although AITSL's overall approach has much to recommend it, I believe it needs to flesh out its current standards with relevant principles of practice. For instance, at the Graduate level, Focus 1.5, states that teachers should be able to: 'Demonstrate knowledge and understanding of strategies for differentiating teaching to meet the specific learning needs of students ...'. Exactly what that means could well be best expressed as a set of principles of practice under the general principle: *Differentiate teaching to meet the specific learning needs of students*. The advantage of that is that those principles would combine the 'knowing that', 'knowing why', and 'knowing how' of that standard into single sentences for easy categorisation, communication, teaching and performance assessment. And as I have demonstrated here, it is also very

easy to show how they work in practice by annotating AITSL's illustrations of the standards with them.

Implications for teacher education and professional development

The recent *Education Workforce Schools Report (2012)* had little positive to say about teacher education. It found that teachers do not feel well prepared in a number of essential practical skill areas such as classroom management; they find theory and practice links weak, and some theoretical components simply irrelevant (p. 123). To make good professional judgements, teachers need the theories and values that inform effective strategies, but theory's relevance to, and presence in practice, is missed or seen as irrelevant when it's not taught as informing teaching and learning strategies and professional reflection on practical experiences.

“...teachers do not feel well prepared in a number of essential practical skill areas such as classroom management; they find theory and practice links weak...”

It is obvious that teacher educators need to be able to work with students' observational and trial teaching experiences throughout their course, but universities have put this into the too hard basket for too long. They have yet to come to terms with the fact that teachers learn their profession more through school mentors and reflection on experience than they do from largely theoretical courses in the psychology, sociology or philosophy of education; yet they continue to prepare students to teach principally through such courses.

Universities teach the importance of situating academic learning in the context of use, but for mainly financial reasons they continue to separate the two contexts by having different teachers, dealing sometimes with different learning, sometimes with the same learning, but always in different locations and usually after long intervals. These factors are mainly responsible for the notorious theory/practice divide experienced by student teachers, and any improvement will require radical structural changes.

First, the current demand on students to 'learn the theory at university, then apply it to practice in a school', must be reversed to: 'experience applying the practice in school, while learning the theory of it at university'. They can then use the theory to inform judgements about when, where and how to use which strategy.

Second, that process requires in-school placements of at least half a day per week throughout the initial training course, because it's then very easy to tell students in a lecture to look for an example of a strategy or principle of practice, and have them do so and report back very soon. This focuses their classroom observation, analysis and reflection, and the examples produced then contextualise explanations of strategy, function, theory and value in recently experienced and documented practical incidents. Melbourne University's Master of Teaching has such a pattern of continuous in-school experience.

Third, it also requires a complete repackaging of undergraduate teacher education courses. This must involve shifting the context of teaching the 'why' of teaching practices that's currently taught in separate courses in academic disciplines such as the sociology, psychology, history and philosophy of education, to courses in the principles of practice in curriculum, classroom management, treating students with respect, catering for cultural and individual differences, diagnosis of learning difficulties, group learning, collegiality, professional development,

“ ...teachers learn their profession more through school mentors and reflection on experience...”

school-community liaison, literacy and numeracy throughout the curriculum, and so on.

The real difficulty for teacher education will be to shift academics' content knowledge, practical experience, and research interests from the application of one of the '... of Education' disciplines to the principles of practice in teaching and learning.

Conclusion

Working mostly with the outline standards and illustrations that AITSL has already generated, it should be possible to produce comprehensive sets of principles of practice that can be used to assess teacher knowledge and performance. These would also serve as the content of a new and more effective teacher education curriculum.

AITSL is now in the unprecedented position of being able to determine the structure and content of teacher education nationally and thus to change both its curriculum and teaching and learning processes; the question now is whether it will simply normalise the somewhat chaotic status quo, or have the long term vision and courage to explore and develop a radical improvements.

Dr David Tripp is an educational consultant and Adjunct Associate Professor at Murdoch University. He is currently developing a website to involve classroom teachers, school leaders and university academics in the documentation and utilisation of principles of practice. For more information go to: <http://prinsofprac.com>.

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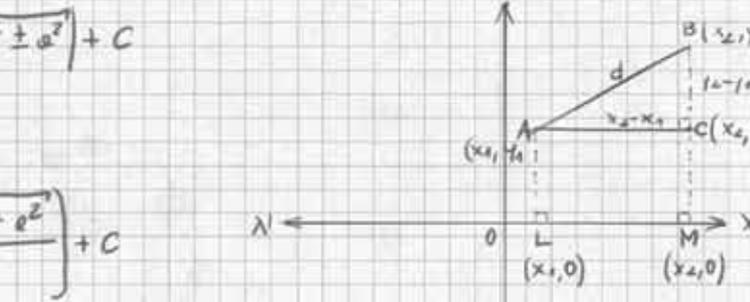

Teaching for deep understanding in Maths: taking our students from “*you haven’t taught us this*” to “*I get it!*”

CASE STUDY

SCOTT MARSH AND LORRAINE DREDGE PRESENT SOME RECENT ATTEMPTS TO IMPROVE THEIR INTENTIONALITY AS TEACHERS OF MATHEMATICS

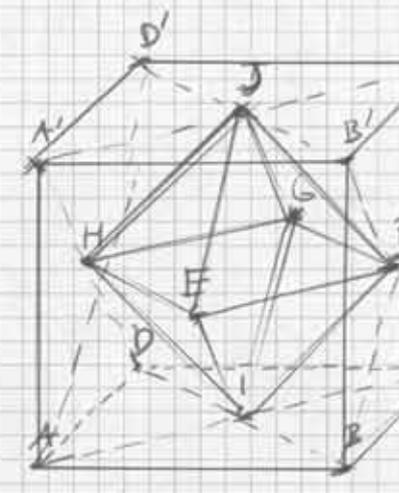
In being intentional, we have sought to scrutinise more regularly why we teach what we teach. We have asked ourselves questions such as: Why is algebra important? What are the big ideas underlying the content and skills we teach? What is it I love about Mathematics? What does teaching for understanding or teaching for transfer/application in our subject area look like?

This article seeks to provide a brief summary of how we have commenced answering these questions. Importantly the article outlines how we have gone about rethinking our teaching of maths and how we have become more explicit in our practice. Before looking at some maths programs, some background may be helpful in contextualising our journey within the overarching goals of our school.

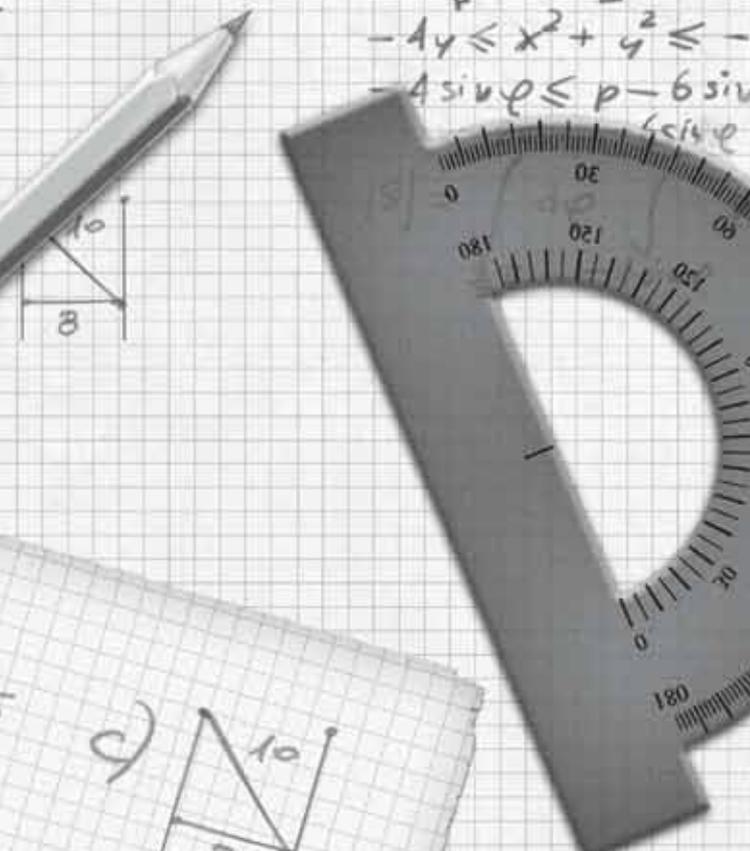


$$\frac{e^2}{8} \ln |x + \sqrt{x^2 \pm a^2}| + C$$

$$\frac{3a^4}{8} \ln |x + \sqrt{x^2 \pm a^2}| + C$$



$$\begin{cases} x = p \cos \varphi \\ y = p \sin \varphi \\ |z| = p \\ p \in \left[\frac{3}{2}, 2\pi \right] \\ -4y \leq x^2 + y^2 \leq - \\ -4 \sin \varphi \leq p - 6 \sin \end{cases}$$



Background

Our journey commenced in light of a review of our student data by an external researcher. Whilst our academic results were ok (there are always ways we can improve), qualitative data revealed that we could do more to engage our students; particularly in the middle years. More broadly, as a school we were exploring how we could engender a more intentional focus on developing deep understanding and the notion of a schoolwide, shared language for learning.

In addition to the student data, the decision to develop our focus on understanding and pursue a shared language for learning arose from reviewing a range of studies into improving student learning; particularly the work of Professor Steve Dinham and his analysis of high performing schools in the state of New South Wales. Dinham's research (see Dinham, 2008) identified that high performing schools in the Higher School Certificate (HSC) cultivated:

- whole or cross-school approaches to curriculum and pedagogy (p. 25)
- whole-faculty approaches to programming: with staff sharing responsibility for curriculum development (p. 26)
- teachers commitment to teaching 'beyond' the HSC, indeed teaching for understanding as opposed just to pass an exam (p. 31)
- teachers who emphasised the application of knowledge during class times, using reasoning, independent thinking and group work (p. 32).

In identifying the notion of a whole or cross-school approach to teaching and learning, this concept is well explored in a range of forms by scholars (Andrews et al., 2009; Robinson, 2011). Indeed the benefits to teachers from schoolwide approaches to teaching and learning have been well documented by these and other scholars. The Innovative Designs for Enhancing Achievement in Schools (IDEAS) study found that a common pedagogical language facilitated heightened levels of professional dialogue and 'enabled individual teachers, and teams of teachers, to see themselves as creative practitioners' (Andrews, et al., 2009, p. 158). This Australian study alongside other international research clearly demonstrates the power of a shared language for improving learning in schools (for further reading see Bryk, Sebring, Allensworth, Luppescu and Easton – *Organising Schools for Improvement: Lessons from Chicago* or visit the University of Southern Queensland's IDEAS website for further reading about the IDEAS project).

Getting intentional about application

In seeking to enhance the notion of teaching for understanding, we acknowledged that good teachers have always taught for understanding. However, the process of reflecting upon the notion of understanding as an activity characterised or evidenced by application, challenged staff to consider how their lessons promoted understanding. Indeed this orientation of understanding as a transfer-based activity represents a challenge to all teachers as to how they devise learning experiences that carefully and intentionally create opportunities for students to apply their knowledge to new situations or to questions that are presented in an unfamiliar way.

Significantly, the notion of transfer or application speaks right to the heart of the indignant claim that 'You didn't teach us this!' The statement often at a content level is untrue. The content was taught. However at a conceptual level, at an understanding level that demands that students apply their knowledge in a new situation, the statement may in many instances prove to be true. How often do we challenge ourselves as teachers, am I effectively teaching for transfer? What learning experiences have I designed that enabled the students to apply their knowledge? What types of misunderstandings are evident in how my students are applying their knowledge? This level of detail in drilling down intentionally into the act of application is an important activity for all teachers. It is not surprising that Dinham (2008) concluded that successful teachers emphasised thinking and application and were intentional about building understanding.

In seeking to build understanding and establish a shared language for learning, the school adopted the Teaching for Understanding framework (Wiske et al., 1998) from Harvard University. Having researched a number of platforms, this research-based approach to teaching and learning provided a language for learning that seeks to support teachers to further enhance the development of understanding and in so doing, make understanding a central and intentional part of teaching.

Teaching for Understanding framework (TfU)

The Harvard framework is made up of the following 4 core elements:

Generative topic

Communicates in either statement or question form the central concept you are seeking to explore in a topic

Understanding goals

Expose the big ideas or concepts in both statement and question form that underpin the topic you are teaching

Performances of understanding

The learning experiences that require students to transfer their knowledge and skills to new situations

Ongoing assessment

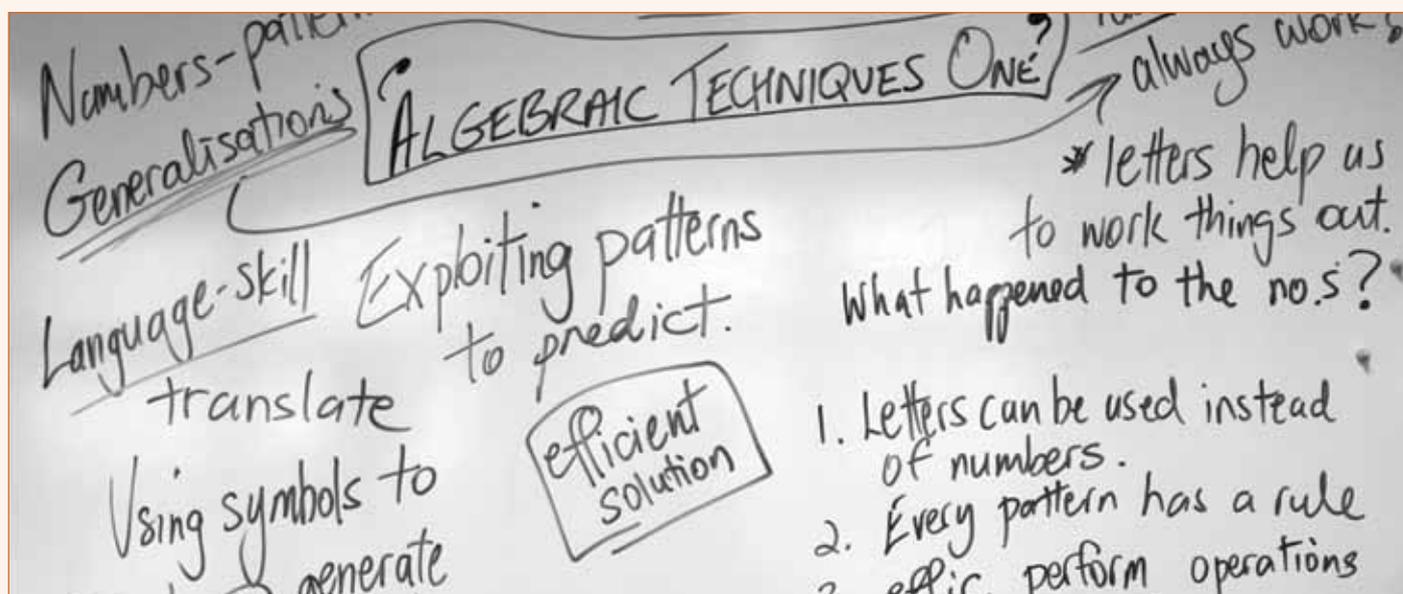
The ongoing strategies used to check for understanding

In seeking to apply these principles in developing teaching and learning experiences in Mathematics, a few challenges did present themselves. Firstly, programming in Mathematics, euphemistically speaking, has often been characterised by a minimalist view of the world. Indeed one might argue that a list of topics, associated syllabus references and textbook chapters would not constitute a program in the scholarly halls of our profession. The attitude that students should engage with the content because of the simple beauty of Mathematics more often than not does not justify a minimalist approach and probably does go some way to explaining the difficulties that some students do experience in seeking to apply their knowledge in this discipline. Therefore, clarifying what was desirable, achievable and useful in a program represented an important first step.

Secondly, for many mathematics teachers, the writing of program has traditionally been an isolated practice. This practice has either been owned by the Head of Department or, by someone who had been designated by the Head of Department to be responsible for programming a particular year group. The notion of rich collaboration, characterised by discussion, debate, disagreement was not necessarily a process that was pursued when it came to programming Maths lessons. Now this is not to say that Maths teachers do not collaborate; of course they do. However, the practice of programming has not traditionally in some schools been a rich collaborative experience. Although there were other minor challenges, these two represented clear changes to our teaching practice in maths.

In preparing staff schoolwide for the challenges of implementing the TfU framework, we received specific training and support materials with exemplar units. The following example provides an insight as to how we are seeking to be more intentional in our programming and development of engaging units for our students. For the purpose of this article, the notion of engagement is characterised by learning experiences that seek to:

- be meaningful through their ability to connect to other learning areas
- contain an element of real world application thereby further enhancing meaning for students
- provide some form of stimulation whether intellectually or emotionally.



An intentional look at Algebra – What's in the box?

Our first attempt at utilising the TfU framework within our subject area was for a unit on Algebra for Year 7. In seeking to develop a generative topic, we devoted some time in a faculty meeting to debate and discuss the central principles of Algebra. During this brainstorming process we asked ourselves, why is this important for us to teach, why do students have to understand this. To our surprise a broad range of ideas emerged. It was challenging intellectually and did highlight that this process was definitely something new to us, quite creative and stimulating. With the differences exposed, the activity demonstrated that this process was quite important and useful.

In developing a generative topic, our goals were to expose the central concept of algebra and then use this to develop an interesting hook for students and teachers. Further, this first part of the framework seeks to open possible connections to other subject areas and provide ideas for teaching and learning experiences. After much rich debate, particularly around the idea of generalisation, we decided that our generative topic would be "what's in the box?" We believed this question represented an effective generative topic because:

1. The reference to the box spoke directly to the students' prior learning in mathematics – building connections with past knowledge. Students commenced maths in kindergarten with the notion of a box as a symbol and in this way have always done algebra. For example:

$$1 + \square = 4$$

$$\square = 4 - 1$$

$$\square = 3$$

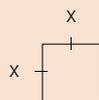
Therefore the notion of introducing a letter such as x can be connected with past learning. For example:

$$1 + x = 4$$

$$x = 4 - 1$$

$$x = 3$$

2. The reference to the box is but one application where algebra supports generalisation. For example:



3. The reference to the box gave us quite a few rich ideas for developing teaching and learning experiences. We thought we could:
 - a. bring a box into the classroom and create some intrigue around its presence – what's in the box?
 - b. develop maths quizzes that lead to cracking some code that could access the box and its contents
 - c. develop puzzles involving surface area and boxes
 - d. develop a real world task about working out how much cardboard a box making company might need to order to be able to supply x amount of boxes thereby engaging students in working out surface area.
4. The notion of the box further enabled teachers to refer to future applications of Algebra in finding perimeter, area, volume or other properties.

We are sure as you read this article you will no doubt come up with many more ideas for rich teaching and learning experiences. Whilst this only represents the first stage of the four part framework, already the process of debating and discussing the notion of algebra has supported us as a team to be more intentional about why we are teaching algebra and how we might go about teaching it. Developing a generative topic is much more than developing a catchy phrase. The process in developing the topic stimulates rich dialogue, challenges thinking and ensures that in a large faculty we are all 'on the same page.' Importantly, this algebra unit is already shaping up as a far more engaging learning opportunity for our students.

Another unit we looked at reviewing for Year 7 was from the recently released New South Wales Board of Studies syllabus titled 'computation with integers'. In developing this unit, the framework was again applied to help make explicit our intentions in approaching this unit. The outcome, including understanding goals is provided below.

Generative Topic: 'The Power of 1'

In discussing the unit, the importance of numbers and their centrality to everything we do quickly emerged. The reference to Bryce Courtney's novel quickly jumped out from the discussion. This generative topic focuses explicitly on the number 1 and has many potential teaching and learning applications such as:

- How could Bryce Courtney order his book without numbers?
- Is maths a language?

In developing the understanding goals, our discussion sought to expose the big ideas or central concepts of numbers. From this discussion the staff identified the following:

Understanding Goals - Students will understand that

1. Numbers work in patterns of ten
2. Numbers provide a system to organise daily life
3. Numbers can be positive and negative and added, subtracted, multiplied and divided to solve problems

Essential Questions

- How do numbers work?
- Why are numbers important?
- How do numbers solve problems?

Notice here that each understanding goal is accompanied by a question. Importantly you will notice that the questions, while seemingly simple are actually quite complex. The questions do not point to answers and support differentiation opportunities as each question could be explored differently by all students at different levels. The understanding goals provide an explicit focus for teachers and the questions can be used to develop learning experiences and engage the students.

The first understanding goal introduces one key fundamental principle of mathematics; that of patterns. Understanding goal 2 introduces the concept of a system. However, again you will notice that the question does not provide any reference to a system. Indeed, the question 'why are numbers important' demands that the students must do the thinking and provides a strong foundation for the development of rich teaching and learning experiences. For example, how would you identify houses in a street without numbers? The final understanding goal provides an opportunity to get into more traditional mathematical application and brings about opportunity to engage in a fundamental principle of mathematics, that of problem solving.

Conclusion

While we are making progress, it is comforting to remind ourselves that real curriculum change takes 5-6 years in schools. This approach to programming has supported us to be more explicit in identifying what we want our students to understand and supported new ways to approach subject content. Significantly, programming maths lessons using the TfU framework has made our teaching more intentional. The language that is offered by the research-based framework guides us in focusing our thinking at a conceptual level and assists us as a team to explore ideas. Significantly, as a K-12 school the language has enabled us to have conversations about maths teaching with stage 3 staff who similarly have received training in the TfU framework. In this way the shared language has enabled us to cross the traditional primary/secondary divide and have rich conversations with our colleagues in other areas of the school.

Ultimately by thinking more deeply about what we do, by being more intentional in our practice, we believe that we are creating better learning experiences for our students. Whilst we have really only just begun our journey, we are wanting to hear less of 'you haven't taught us this' and more of 'I get it!'

Scott Marsh is Deputy Headmaster of William Clarke College, New South Wales. Lorraine Dredge is Head of Mathematics at William Clarke College.

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Q & A

with Professor Ian Anderson

Professor Ian Anderson is the Director of Murrup Barak - Melbourne Institute for Indigenous Development at the University of Melbourne and Co-Chair of the Aboriginal and Torres Strait Islander Higher Education Council.

In 2012, Ian joined the University of Melbourne's senior leadership team as Assistant Vice Chancellor (Indigenous Higher Education Policy) and was appointed to the position of Foundation Chair for Indigenous Higher Education. He had previously occupied the University's foundation Chair for Indigenous Health. Ian has chaired the National Aboriginal and Torres Strait Islander Health Equality Council since 2008.

Ian's background is in medicine and social sciences and he worked in Aboriginal Health for more than 25 years as a health worker, educator, general practitioner, policy maker and academic. He has written widely on Indigenous health and development and maintains an active research portfolio.

His family are Palawa Trowerna from the Pyemairrenner mob in Tasmania which includes Trawlwoolway and Plairmairrenner and related clans.

Ian Anderson spoke to *Professional Educator* about the work of Murrup Barak and issues facing Indigenous Australians in higher education.

PE: What are the origins and objectives of Murrup Barak?

IA: The Murrup Barak Institute for Indigenous Development was established in 2009 to provide an organisational structure that would lead the development of an integrated whole of university strategy in Indigenous development. We have a focus around academic development in teaching and learning and research; a focus on organisational development such as leading the implementation of our Indigenous employment framework; a role supporting the recruitment and support of Indigenous students; and also an external interface of building partnerships with Indigenous communities and other strategic partners. What we want to do is to shift the focus from just dealing with students to actually look at what we do in teaching and learning and research so that it connects up the academic components of the university strategy with our Indigenous student strategy.

PE: What do you think are some of the biggest issues facing Indigenous education today? Have they changed or are they still the same issues we were grappling with 20 years ago?

IA: There's been incremental gain in a number of educational indicators. For example we've seen improving retention rates for Aboriginal and Torres Strait Islander students to Year 12. However, there are still quite stark inequalities in educational outcomes. Many of the problems are very similar (to those of the past). We've got growth in professional capacity to better tackle these issues. These issues have, at a policy level and also at an institutional level, moved from ones that are in the margins to ones that are much more central to policy and more central to education strategy. I think that the other big change is a much stronger focus on higher education. Twenty years ago it was very much a focus around early childhood and the schooling years. We need to continue to focus on those really critically important parts of education but it's increasingly recognised that we're not going to make significant gains in Indigenous social inequalities, we're not going to improve Indigenous health outcomes, we're not going to improve the Aboriginal economy if we don't tackle higher education. I think that's an important platform for change. The broader issue is that Indigenous development requires resources. We've done much better at putting financial resources into Aboriginal development but we've got a way to go in terms of the human capital that we need.

PE: Indigenous participation in higher education remains low compared to that of non-Indigenous Australian students. What do you think needs to be done to boost Indigenous participation in higher education?

IA: There are a number of critical issues that need to change. We need to work in partnership with the schooling sector to improve the numbers of Aboriginal people who finish school and who are tertiary ready. That's both an issue of retention but it's also significantly an issue of working with families and schools to help improve educational outcomes. We need to look at ways in which we can find work rounds – pathways for Aboriginal people already in the workforce as mature age students or articulations between the VET sector and higher education sector. We need to do that while at all times maintaining a focus on quality and outcomes. That needs innovation in curriculum. That needs strong Indigenous leadership and that needs a rethink of the institutional frameworks within higher education. One of the things that the higher education system is very good at doing is managing what I call excess demand. We, particularly in Go8 institutions, tend to be very good at saying 'no' to people and not very good at developing educational pipelines. That's not the case across the whole sector but it's a problem, particularly for Aboriginal education where what we need to do is to create the market and work with other educational providers and families to create demand.

PE: Gaining a place in university seems to be only part of the battle because we also have much lower completion rates of higher education courses by Indigenous students. Why do you think that is and what extra support do Indigenous students need to ensure that they can complete the courses?

“...I don't think that across the sector we see shining examples of success everywhere, we see pockets of success, and we've got to learn from those pockets of success.”

IA: We need at a sector-wide level to get the settings right in selection and recruitment of students and also get the setting right in terms of the educational platform that we provide people once they are in university in order to get the outcomes in terms of completion or retention. One of the things that we tend to get wrong is, that we can do better is make sure that once someone comes into the university that they have the educational pathway to ensure success, whether that's through bridging programs, other enabling programs or transition programs or however that is configured, we've got to make sure that we are not asking people to take a risk and enrol in a program that it's not reasonable to expect that they would complete. All in all I don't think that across the sector we see shining examples of success everywhere, we see pockets of success, and we've got to learn from those pockets of success. Some institutions get very high completion rates but are very conservative in their selection and educational support for example. That's a particular challenge for institutions such as mine. I think I should say the framework for this is not about disadvantage. I think the framework that we should be driving change around is the recognition that Aboriginal people have the same capabilities as other Australians but they haven't had the educational opportunities in order to realise those capabilities. We have to provide them with the educational opportunities to help them realise that capability.

PE: What would be some of the long-term implications for the lower participation and completion rates of Indigenous students in higher education?

IA: I can pick out a couple of examples. Aboriginal employment in the information and communications technology industry is extremely low and this is a growing part of the economy. We're not going to realise opportunities for employment unless people have some form of post compulsory secondary education, whether that be in the VET sector or in the higher education sector. There is a higher rate of participation of Aboriginal people in the mineral and resources economy albeit at entry level. If the economic potential of the mineral resources boom is going to be realised for Indigenous Australians we need to be absolutely certain that we're providing opportunities for mid-level employment and professional employment through programs such as engineering. We cannot expect the Aboriginal economy to develop and Indigenous employment to develop if we're just going to rely on employment through the Indigenous community sector or in the public sector.

PE: We have a federal election coming up in September. Do you have a policy 'wish list' for the incoming government, whoever that may be?

IA: Firstly Indigenous higher education has to be a priority. It's not a boutique end of Indigenous policy. It needs to be central to the Indigenous policy agenda. The second thing is that we can no longer tolerate the poor outcomes in Indigenous education across the whole educational pipeline. We have seen that good policy, resource development and institution building have started to get traction in other areas such as in Indigenous health. If we're going to speed up the traction in the Indigenous education space we need to go through some fundamental paradigm shifts about how we build a platform for change.

Professor Ian Anderson will speak at ACE's national conference, Forward Thinking: Emerging Answer's to Education's Big Questions in Melbourne on 21 June.

Trust in our schools: the missing part of school improvement?

Have you ever perseverated upon a problem or issue for a period of time and found yourself baffled, and then suddenly in a flash of insight the solution seemed to leap into your consciousness. I doubt any of us would have run through the streets naked shouting 'eureka!' as Archimedes did, but we have all had 'eureka' moments of true enlightenment, when suddenly a world of confusion becomes one of total clarity. Now, after over twenty years of thinking about, writing about, and also working in various school improvement projects internationally I think I have experienced a 'eureka' moment. What has troubled me all these years is that with all the knowledge we have about school improvement to enhance student achievement, the wide variety of school improvement projects available from which to learn, and the genuine passion that many policy makers and policy implementers continue to bring to these efforts, most school improvement efforts tend to experience short term success, and in time regress to the mean, leaving schools no better off, and in some cases worse off than before any interventions. There has always seemed to me to be something missing in these efforts, but what it was eluded me. This is where my 'eureka' moment comes in.

Periodically, international organisations and foundations publish comparative data on nations, such as the best place to live, the best environmental record, the happiest country and so on. As a Canadian I naturally check to see how my country stacks up. Two comparative studies on trust captured my attention, one by the Pew Research Centre (Wilk & Holzgart, 2007) that examined the degree of trust within a society, and a second that assesses nations' reputations and trust levels internationally (Transparency International, 2010). My 'eureka' moment came when I matched these trust measures to the results on the OECD Programme for International Student Assessment (PISA). Students from nations that rated highly on trust indicators also performed very well on PISA's measures of student achievement (OECD, 2009a). The students of these higher performing nations demonstrated greater resilience in the face of obstacles and were less affected by their family's socioeconomic status (OECD, 2009b). My insight from this data was perhaps not original, but it was original to me - high trust (not blind trust, as I will explain) leads to high achievement and low trust contributes to low achievement and fewer opportunities to succeed for students from less affluent homes. This idea, of course, raises many questions into the nature of trust and its relationship to student achievement and success in

school. In the remainder of this article I will address these and other related questions by briefly outlining some of the considerable work that has already taken place around the topic of trust and school success, develop in more detail two aspects of trust that affect schools and their leaders, and finally describe an investigation and its purposes that I have initiated with colleagues internationally that will provide an avenue for you the reader to further our collective understanding of how trust functions within schools and school districts.

Trust issues pervade virtually every social relationship throughout our lives. It would be impossible to drive a car unless we trusted that other drivers followed the rules of the road. We trust the mail arrives on time, pharmacists (chemists) fill our drug prescriptions accurately, pilots land our plane safely, and our opponents at golf or cards play by the rules. Trust is the glue that binds our societies together, or sadly in many cases distrust is the toxin that divides individuals, families, organisations and, in the extreme, nations. As the financial tycoon Warren Buffet has observed 'Trust is like the air we breathe. When it is present no one really notices. But when it is absent, everybody notices' (Buffet cited in Covey, 2012, p.12).

Definitions of trust abound in the literature on the topic but almost all seem to have threads of three fundamental concepts, honesty, reliability and caring (see Tshannen-Moran, 2004; Kutsyuruba, Walker & Noonan, 2012). Do individuals and their institutions have integrity; do they walk their talk; do they say what they mean and mean what they say? Are they open and transparent or secretive and calculating? Are they consistent, competent and have the interests of others in mind? Are they benevolent and recognise the inherent vulnerability of others? Covey (2012) summarises all of these definitions under the one word - confidence. Trust makes or breaks governments, businesses and social organisations like churches and schools. It is the element that creates the confidence among individuals within a society or organisations that accelerates change, or the suspicion that slows it down, or in the extreme buries it (Covey, 2012). Trust is a central tenet of civil democratic societies. In the words of Tom Friedman (2012) of the New York Times, 'You can't have a democracy without trust and you can't have citizens without trust - without trust that everyone will be treated with equality, no matter who is in power, and without trust and shared vision in what kind of society people are trying to build.'

My 30 years as an educational leader in many different capacities have taught me that trust or lack of it is also a key ingredient in educational leadership - trust in my colleagues, trust in myself to make wise decisions, trust in others' judgments, trust that decisions will be carried out, trust that the data used to inform decisions are factual, timely and honest, trust in the policies and procedures that our organisations have developed over time, and trust that our efforts contribute to school improvement and enhanced student achievement. As Carrie Leana (2011)

reports in her study on social capital, 'The relationships among teachers in a school characterised by high trust and frequent interaction - that is when social capital is strong-student achievement scores improve.' Research by Alan Daly and Janet Crispeels (2008) confirms this 'trust-achievement' connection. They state that 'Empirical evidence has ... shown that several aspects of trust - benevolence, reliability, competence, integrity, openness, and respect - are strongly connected with school performance and student outcomes.' Similarly, Bryck and Schneider's (2002) research in Chicago led them to state 'That a broad base of trust across a school community lubricates much of a school's day to day functioning and is a critical resource as local leaders embark on ambitious school improvement plans' and Vivienne Robinson's (2011) analysis of the change literature led her to conclude that 'There is compelling evidence that the level of trust among the members of a school community makes an important difference to the way they work together and to the social and academic progress of students.' Additionally, there is a burgeoning business literature that ties levels of trust to corporate success (see Covey, 2012; Hurley, 2011; Seidman, 2007). From a broad array of evidence, we can conclude that highly successful schools and school districts, state, and national school systems build strong bonds of trust between and among policy makers and policy implementers. Conversely, policy makers in less successful schools and school systems tend to foment distrust, anxiety, and in some situations, downright hostility and fear among the very people who must implement policies. This results in policy implementers such as teachers and principals in low trust environments responding to messages of distrust by overtly or covertly sabotaging change efforts, gaming verification systems, or engaging in militant union activities (Hargreaves & Fink, 2006).

Levels of Trust

This suggests that trust (and distrust) levels in schools and districts and even nations exist on somewhat of a sliding scale. At one extreme is paranoia, in which those who must implement policies totally distrust the methods and motives of policy makers who in turn demonstrate their distrust of the capacity and intentions of implementers by the indiscriminate use of continuous, intrusive, and overbearing verification systems to force compliance to top-down policies. At the other extreme is blind trust in which policy makers trust policy implementers in virtually all circumstances and no one bothers to verify whether this trust is appropriately placed. This suggests a dynamic relationship between trust and verification. Too much trust leaves policy makers vulnerable politically and professionally, and too much or injudicious verification strips policy implementers of their autonomy and stifles creativity and innovation.

It was former US President Ronald Reagan who made the phrase 'trust but verify' famous in dealing with the Soviet Union. This advice makes sense when we engage in any potentially trusting relationship. In education, policy makers use such verification strategies as standardised testing, inspection systems and various reporting mechanisms to determine the success or failure of policy initiatives. Bureaucracies which are inherently distrustful employ superior-subordinate evaluation schemes to ensure the person on the lower wrung is trustworthy, and by implication compliant. Teachers and school leaders who are often remote from the bureaucratic initiators of policy have to depend on intermediaries such as their unions, the press, or word of mouth to determine whether to trust policy makers and their policies. The diagram (see below) suggests levels of trust between these two extremes.



Low Trust schools and systems on this schemata exist when policy makers sacrifice the trust of policy implementers in an organisation in the name of quick, easily measured, politically motivated results that are often accompanied by a plethora of invasive and often punitive verification measures. We can see this pattern emerging in New Zealand at the moment. Similarly, a number of my Australian colleagues have suggested to me that their federal government's recent school improvement efforts are heavy on low trust strategies.

Conditional Trust occurs when policy makers promote trusting relationships with some parts of its implementer community by minimising verification strategies such as inspections with some schools and districts while increasing the pressure on the less successful. This appears to be the approach of the Cameron government in England that has decreased inspections of supposedly successful schools and amped them up for lower achieving schools that are usually in lower SES neighbourhoods.

High Trust organisations can act with speed and efficiency because they do not have to navigate turbulent seas of resistance, anger, incompetence, and disengagement. High quality schools and systems trust their educators and particularly teachers to deliver superior educational programs to all children. Most provinces of Canada would fit this category as well as Finland (Sahlberg, 2011; Tucker, 2011).

Types of Trust

It is the ability to balance trust- and verification at all levels of an educational system that creates the context for positive growth and change for sustainable school improvement. Trust is multifaceted. Keith Walker and his colleagues explain that 'Trust can be built brokered and bolstered as well as breached, broken and betrayed' (Kutsyruba, Walker & Noonan, 2012, p. 3). To develop these ideas, let us turn to just two types of trust- interpersonal or relational trust between leaders and colleagues, and institutional trust between schools, districts and their communities.

“ It was former US President Ronald Reagan who made the phrase ‘trust but verify’ famous in dealing with the Soviet Union. ”

Relational Trust

Themes of honesty (or dishonesty), transparency, competence, and respect for others define relational trust. The same sequence follows in virtually all our interpersonal engagements. Relational trust answers such implicit questions that staff members have of their leaders as how well do you know me and care about me as a person? Do you truly respect me? What do you know about my interests, my family, my aspirations, my fears, and the support I may need to do my job well? Do you really listen to me at a deep level? Are you open to influence or do you just pretend to be interested? Do you treat me with civility and friendliness? Are you with me for the long haul or are you using me to advance your own career?

The degree to which relational trust exists in a school, a district, or even a school jurisdiction will determine staff members' willingness to commit time and energy beyond their contractual obligations to provide extra help to students, coach teams, organise students' events, festivals, concerts and attend to the myriad of activities outside the classroom that make schools vibrant and engaging places for students. Similarly, teachers' commitment to engaging in collegial efforts that contribute to enhanced student performance is directly correlated to their feelings of efficacy and wellbeing derived from relational trust. We base decisions to follow the leadership of others on relational trust in that person's competence, dedication to shared purposes, and integrity. We also base our willingness to interact with schools, churches and businesses on our trust in these institutions.

Institutional Trust

Institutional trust refers to the degree to which an organisation's various constituencies continue to have confidence in its competence, integrity, and sustainability. The most egregious examples lately of a loss of institutional trust at renowned, indeed revered institutions, relate to the scandals over child sex abuse among Catholic priests and more recently by a well known American football coach at Pennsylvania State University. In each case, it was not the crimes with all their seriousness that has shaken communities' trust in the institutions, because one can rationalise that every large institution will have a few bad characters, but it was the cover up by these institutions that considered the good reputation of the institution more important than the welfare of victims and potential victims of child abuse.

In *Sustainable Leadership*, Andy Hargreaves and I outlined five action principles to ensure sustainability in practice. With a little adaptation these action principles provide some useful rules for building institutional trust (Hargreaves & Fink, 2006, pp. 256-252). The first rule of institutional trust is *transparency* - open, honest communication of the good news and the bad. Cover ups come undone in time and the repercussions are far worse than an up front disclosure of problems. The second rule of institutional trust is *vigilance*. Organisations maintain institutional trust by verifying with its important constituencies that they continue to maintain their trust in the organisation's mission, competence and integrity. Effective leaders who spend their time on problem seeking expend considerably less time later on in problem solving. I found it useful as a principal to spend a great deal of time in the community and to encourage my faculty colleagues to participate in community activities. I needed eyes and ears in the community.

Activism is the third rule of institutional trust building. Leaders not only read and respond to their environments, they actively go about influencing them in ways that benefit the school and its students. If this involves addressing

environmental issues in a community, or taking on political challenges that impinge on the school then activist leaders make sure that their school's perspective is front and centre. Similarly, schools and districts need to get out in front with their stories, tell the world how they are pursuing excellence in all aspects of their operation and explain how they are addressing contemporary approaches to student learning, and if necessary, acknowledge missteps and actively address their solutions publicly. Building trust not only requires active engagement it also requires immense *patience*. Policies and practices designed to build relationships between the school and its communities require sustained, perseverant, and consistent implementation over time, from one year to the next, from one leader to the next. A school's reputation takes a long time to build and a short time to destroy.

Finally, trust is built and maintained and enhanced 'By systems that are personalised for people's use and that are compatible with human capacity' (Hargreaves & Fink, 2006, p. 262). For example, attention to the *design* of a school's communication mechanisms must address what Vincente (2003) calls the 'human factor'. Web sites that require a PhD from MIT to decipher, unappealing, wordy, and lengthy newsletters, phone recording systems that may save money but lose the caller in a myriad of choices, not only fail to communicate, they often antagonise and undermine institutional trust. Institutional trust is the result of multiple decisions within schools and school districts that have at their heart a 'theory of action' that places the needs of its students and their parents at the centre of every decision its leaders make.

An Investigation

To this point, I have suggested that high trust nations correlate strongly to high student achievement, and that high trust school jurisdictions and schools relate positively to improved student achievement. We know that 'trust' works, but the question remains how and under what circumstances does it work? To address this and the many other trust related questions, I have, with a team of scholarly international colleagues, initiated an investigation that will attempt

to understand the trust dimension to school change at a much deeper level. We need your help and only 15 minutes of your time. We would appreciate you completing a short, 30 item online survey related to your views on trust, and how trust plays out in your state and nation. This will give us important information that will inform education in Australia and also provide useful cross national information on how trust or lack of it impacts upon school improvement efforts.

Dean Fink is an international educational development consultant with experience in 31 different countries and every state in Australia. He is a former superintendent and principal with the Halton Board of Education in Ontario, Canada and has taught at all levels of education from primary grades to graduate school.

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The Australian advisors for this project are Dr. Warren Marks an associate of Macquarie University and University of Melbourne, and Dr. Norman McCulla, Director of Educational Leadership Macquarie University.

We will use this and other publications to feedback results. If you want more information or a list of the international advisory team contact deanfink@cogeco.ca

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As a member of ACE you will be part of a community of educators who have made a commitment to raising the status of their profession, and to their own professional growth and development, by joining Australia's leading education professional association. ACE members engage with enduring educational issues, and the hot topics of the day, through networking, professional reading and a range of events and activities organised through our regional groups across Australia. Member benefits include:

- the opportunity to contribute to an informed advocacy body for the education profession
- the entitlement to use the letters MACE as a recognised, professional post-nominal
- opportunities to network with your colleagues and cutting-edge presenters at ACE conferences and events
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