Why is numeracy critical? Some lessons and reflections.

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Outline

Journey of a fortunate ANT:

- Adult Numeracy Teacher
- Adult Numeracy Trainer
- Adult Numeracy Theorist (thanks to BJ & ALLS?)
- Adult Numeracy Writer
- Adult Numeracy Test developer
- Adult Numeracy Traveller
- Now an adult Math and Numeracy educator!

Share with you some reflections on teaching and learning from my assessment work but based on years of working as an ANT
Why is maths/numeracy critical?
Why?

The square root of 9 is 3.

A) True.
B) False.
C) Who cares?
International Assessments & Frameworks - reflections

Some (personal) reflections from my journey with ALLS-PIAAC-PISA + more: Commonalities

- about maths in a context, not just maths/sums
- definitions, descriptions and aims are similar
- require a theoretical framework which needs to be supported by empirical evidence - frameworks worth reading
- items are similar in most ways
- items go through a thorough and exhaustive process before they get to be used – there are intensive peer reviews, pilot studies with respondent feedback, field trials, psychometric analysis and only then the final survey
- same methodology
- it is the items that are being assessed, not the learners/adults (IRT)
- generous marking/coding
Frameworks and assessments - reflections

Some (personal) reflections: Differences

- PISA suffered from the “Maths Wars” – has to satisfy all sides – political – but maybe that improved the 2012 version?
- PISA has a stronger interest in student ability to show evidence of the use of formal curriculum-school-based maths
- Complexity schemes:
  - PISA – more formal and school focussed
  - ALLS/PIAAC – blend of literacy and maths factors (starts low)
- Background questionnaire data richer for ALLS/PIAAC – e.g. education/work/wages/etc
Some (personal) reflections - results

- the ability to be empowered to have the capacity to make considered decisions, whether they be on the spot decisions at a workplace or when out shopping, or following instructions about a medical or health matter, or making decisions about financial matters, or understanding the implications of gambling, and more ..., all require good literacy AND NUMERACY skills

- the results of these surveys show that too many teenagers and adults in Australia (and in most countries?) do not have the above numeracy skills and they are, potentially, disempowered

- life in the 21st century requires higher level literacy and numeracy skills than ever before and this makes it more worrying.
Frameworks and assessments - reflections

Some (personal) reflections - limitations

- designed to provide an empirical, comparative ‘snapshot’ of the performance and abilities of the generic but representative adult population in relation to a test of literacy (reading in this instance), numeracy and the other skills being assessed using items that work psychometrically
- assessment items can only imitate real life literacy and numeracy tasks and cannot be genuinely socially or contextually situated.
- do not allow for oral transactions and responses, or for accessing support as in real life
- the data and results are NOT about rates of illiteracy or innumeracy, and don’t claim to be
- the reality with the numeracy (and similarly with the literacy) tasks is that the stimuli are shorter and simplified versions of real texts – so often real life is more demanding
Frameworks and assessments - reflections

Why? Is the bar set lower for numeracy??

One of the easiest ALLS/PIAAC literacy tasks (categorised as Below Level 1) directs the reader to look at a medicine label to determine the “maximum number of days you should take this medicine”.

E.g. about 3.7% of Australians aged 15-74 years of age are operating at this level.
Frameworks and assessments - reflections

And is the bar set lower for numeracy??

Adults were asked to look at a photograph containing two cartons of coca cola bottles (changed to water bottles for PIAAC) and give the total number of bottles in the two full cases.

This was a Pre-Level 1 item:

About 6.7% Australians aged 15-74 years of age are operating at this level.
What do assessments tell us? PISA

- PISA issues - what “expert” mathematicians and math educators think 15 year olds should know
- Shelving Library Books: “Three reviewers agreed that the mathematics in this item was trivial”
- Charts: “simply reading a graph, and was not significant mathematics”
- Z’s fan merchandise: “this item does not involve significant mathematics”
- “the present selection of items and the formulation of the questions are much better than in previous years, where the questions often were loaded with unnecessary—and [hard to read]—information.”
- Good to see what some student CAN do!
What do assessments tell us? PISA

Differences between PISA and ALLS:

- PISA narrower – PISA doesn’t go very low, but should!
- This is what 7 test development centres around the world wrote as the “expected” range of items for 15 year olds.
Why is numeracy critical?

Likelihood of positive social and economic outcomes among highly literate or numerate adults

- Good to excellent health
- Being employed
- High levels of trust
- Participation in volunteer activities
- High levels of political efficacy
- High wages

(But also see Bynner & Parsons UK research)
Mathematical thought and action

Mathematical concepts, knowledge and skills

Fundamental mathematical capabilities: Communication; Representation; Devising strategies; Mathematisation; Reasoning and argument; Using symbolic, formal and technical language and operations; Using mathematical tools

Processes: Formulate, Employ, Interpret/Evaluate

Problem in context

Formulate

Mathematical problem

Employ

Mathematical results

Evaluate

Interpret

Results in context

Challenge in real world context

Mathematical content categories: Quantity; Uncertainty & data; Change & relationships; Space & shape

Real world context categories: Personal; Societal; Occupational; Scientific
Frameworks - reflections

Complexity Factor 1: Type of Match/Problem Transparency
- How difficult is it to identify and decide what action to take? How many literacy skills are required?
  - 1 Obvious
  - 3 Embedded
  - 2 Explicit
  - 4 Hidden

Complexity Factor 2: Plausibility of Distractors
- How many other pieces of mathematical information are present? Is all the necessary information there?
  - 1 No distractors
  - 3 Several distractors
  - 2 Info. all there
  - 4 Info. not all there

Complexity Factor 3: Complexity of Mathematical Information/data
- How complex is the mathematical information that needs to be manipulated?
  - 1 Concrete
  - 5 Abstract
  - Simple
  - Complex

Complexity Factor 4: Type of Operation/Skill
- How complex is the mathematical action that is required?
  - 1 Simple
  - 5 Complex

Complexity Factor 5: Expected Number of Operations
- How many steps and types of steps are required?
  - 1 One
  - 3 Many
  - The same process
  - Different processes

Factor Score:
Reflections and Lessons for T&L?

- Schools generally do NOT prepare students for maths in the real world – they need numeracy/mathematical literacy
- Learning maths as an adult is NOT a hierarchal set of skills as per school based curriculum frameworks
- Numeracy/mathematical literacy needs to be taught – look at the complexity schemes for indicators of what the issues are for T&L
- Context is important, as is both the ability to excavate the maths from the context and to understand the maths and apply it to a context
- Gender can still be a crucial issue that is not being targeted
- Assessment frameworks and complexity schemes worth reading and learning from – they have been very influential in reading theory
Lynn A. Steen, one of the most articulate spokespeople for “Quantitative Literacy”, stated that:

"...numeracy is not the same as mathematics, nor is it an alternative to mathematics. Today's students need both mathematics and numeracy. Whereas mathematics asks students to rise above context, quantitative literacy is anchored in real data that reflect engagement with life's diverse contexts and situations."
Reflections and Lessons for T&L?

- Numeracy demands are complex and increasing (e.g. Hoyles et al 2002)
- Recent AAMT/AiG/OCS project in Australia: http://www.aamt.edu.au/Activities-and-projects/Workplace-maths-skills
- Need to research more about the important role of maths in work and in life – how important is it – how does it relate to school maths? How do adults engage and use maths? More of the above research. Are demands and expectations changing/increasing?
- Don’t lower our standards or expectations – counter the community/cultural attitude that it’s OK to not be good at maths. It counts socially and economically.
And to finish, why do this ...

A drum of petrol containing 480 litres was shared between 5 drivers. The first driver took \( \frac{2}{3} \) of the contents of the drum, the second took \( \frac{1}{4} \) of what was left, and the remainder was shared equally between the last three drivers. How many litres did each of the remaining drivers receive?

Four horses cost as much as 3 cows, 4 sheep as much as 2 horses, and 3 lambs as much as 1 sheep. How many cows could I exchange for 40 lambs?

Two trains are 150 kilometres apart and are heading toward each other along a single track. The first train is going 90 kilometres an hour; the second train is going 60 kilometres an hour. Flying at a constant speed of 110 kilometres an hour, a bird takes off from the head of the first train, flies to the head of the second, immediately turns and flies back to the head of the second, and keeps going like this until the two trains crash. How far does the bird fly?

How I see math word problems...
If I have 4 pencils and you have 7 apples how many pancakes will fit on the roof? Purple, because aliens don't wear hats.
when we could do this ...

... use PISA/PIAAC type items like this

The Gotemba walking trail up Mount Fuji is about 9 kilometres (km) long.

Walkers need to return from the 18 km walk by 8 pm.

Toshi estimates that he can walk up the mountain at 1.5 kilometres per hour on average, and down at twice that speed. These speeds take into account meal breaks and rest times.

Using Toshi’s estimated speeds, what is the latest time he can begin his walk so that he can return by 8 pm?
Discussion and questions
Further information

PISA and PIAAC

The OECD website for PISA is: http://www.oecd.org/pisa/
The OECD website for PIAAC is: www.oecd.org/site/piaac/
PIAAC reports are available from: www.oecd.org/site/piaac/publications.htm
PIAAC conference videos: vimeo.com/album/2571591. The two key overview videos are these two:
vimeo.com/album/2571591/video/79372616 &
vimeo.com/album/2571591/video/78496266
Some references

- Bynner, John & Parsons, Samantha (2005) *Does numeracy matter more?*, National Research and Development Centre for Adult Literacy and Numeracy (NRDC), London
- Tout, D & Motteram, G 2006 *Foundation Numeracy in Context*, ACER Press, Melbourne