The buried N in LLN: the challenge of numeracy and maths, crucial foundation skills for a global future

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Outline

- Introductions
- Background: PIAAC – what is it?
- What does PIAAC tell us?
- PIAAC Review & highlights
- Q&A

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The OECD’s Programme for the International Assessment of Adult Competencies (PIAAC) is an international assessment of the proficiency of adults (aged 16-65 years) in reading, numeracy and problem solving in technology-rich environments.

The first cycle of the study involved three waves of data collection: the first in 2011-12 (24 countries), the second in 2014-15 (nine countries) with a third wave planned for 2017-18 (six countries).


Wide range of research reports and publications available – mainly international and overseas – few Australian research papers. Reference list and links at the end.
Background

- Household survey methodology - own homes or in some other agreed location under the supervision of trained interviewers. Conducted in Australia by the ABS.
- The assessment was undertaken either as a computer-based assessment (CBA) on a laptop computer or, in the case of adults with little or no familiarity with ICT (or who refused to undertake the test on computer), in a paper and pencil format.
- What percent of adult Australians (aged 15-74) undertook the assessment on the laptop?
It is important to note that the PIAAC numeracy assessment describes a range of numeracy capabilities (aspirationally full) in the adult population. This covers at one extreme, adults who have university level training and, at the other, adults who have very low levels of education (e.g. who left school at or before the age of 15). At the same time, it covers both young adults still in education and adults who completed their formal education 30-50 years prior to undertaking the assessment.
What do we know from PIAAC in Australia?

44% at level 2 or below in literacy
54% at level 2 or below in numeracy

Gender difference in numeracy:
49.4% of males are at level 2 or below in numeracy
59.0% of females are at level 2 or below in numeracy
A difference of almost 10%!
One of the easiest 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”.

About 3.7% (620,000) Australians aged 15-74 years of age are operating at this level.
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 Below Level 1 numeracy item.

1.1 million Australians (6.7%) aged 15-74 years of age are operating at this level.

Is the bar set lower for numeracy?

A closer examination of Australia’s performance reveals the following:
- **Numeracy** represents a particular challenge in Australia.
- Signs of poor **numeracy** performance can be traced back to initial schooling.
- **Women** have weaker **numeracy** skills than men.
- There is a relatively **large gap** between the most proficient and least proficient adults in literacy and in numeracy.
- Many **well-educated** adults have **low literacy and/or numeracy** skills.
- Young **women** in Australia are much more likely to be not in employment, education or training (NEET) than young men.
As an example of the analytic potential of PIAAC this graph shows that adults with high proficiencies in literacy and in numeracy are much more likely, compared to those with lower skills, to report good health, to be employed, to have higher earnings, and to have positive social dispositions and take part in community life. And that **numeracy** appears to be a more potent predictor of social and economic outcomes such as health, employment, and high salary, compared with literacy.
The aim was to prepare a review of the framework that guided the assessment of numeracy in the 1st cycle of PIAAC in readiness for Cycle 2 in 2021-22.

The review aimed to evaluate the extent to which the framework and existing assessment content:

- reflected current understandings of adult numeracy
- continues to be an appropriate basis for the assessment of the capacity of adults to successfully undertake the range of numeracy tasks that they will face in their everyday and working lives in the third decade of the 21st century.
PIAAC Review

Areas to address:
- Theoretical developments
- 21st century digital implications
- Assessment developments
- Relationship with PISA
- Numeracy or mathematical components
The Review Team recommended that there are two related issues to be explicitly addressed in updating and refining the existing PIAAC framework definition and description.

- Definition of numeracy and numerate behaviour including:
  - disposition to use mathematics
  - the ability to see mathematics in a numeracy situation
  - critical reflection and reasoning/judgement
  - degree of accuracy

- Authenticity of numeracy activities and integration with technology – now have improved capacity to use technology to facilitate assessment tasks.
PIAAC Review: Theoretical developments

Figure 5. Model for numeracy in the twenty-first century

Goos, Geiger & Dole, 2014
21st century digital technologies provide tools and processes that mediate thinking as well as action and are not just devices that can be used to complete manual, hands-on tasks more efficiently – thinking tools.

It is not just about the use of digital tools to replace traditional physical or cognitive skills – digital tools increasingly mediate young workers' ways of reasoning, acting and working. This activity is reshaping the structuring practices and deployment of skills in workplaces.

Techno-mathematical literacies

More than just part of workplace practices

Need to be aware of non-technology based environments still
The existing PIAAC numeracy items generally expect a static response, with little interactivity available either in the stimulus or in the response types.

In the context of the 21st century, especially within a workplace setting, the kinds of numeracy problems that are solved are complex, multidisciplinary and often open-ended. The answers and responses do not come in a multiple choice format with a single right answer—the next PIAAC assessment needs to better reflect 21st Century digital and technological actions and responses.

Needs to strike a balance though
A farmer has cows and chickens. He only sees 50 legs and 18 heads. How many are cows and how many are chickens?

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.
Challenges of 21st Century assessment developments:

- cost
- time available for testing
- feasibility of producing and using any animations, simulations, video or audio support and translating into potentially 30 different languages
- trialing and psychometric checking for performance, reliability and validity
# PIAAC Review: Assessment Developments

**The dimension of assessment possibilities**

The figure represents a spectrum of options and possibilities for the delivery of assessments of numeracy where the scoring can be done automatically.

<table>
<thead>
<tr>
<th>Category:</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of representation</strong></td>
<td>Decontextualised maths problem $2 \times 3 = ...$</td>
<td>Simple contextual word-based problems</td>
<td>Sophisticated contextual problems with images and descriptive representations (but no interactivity in response space)</td>
<td>Sophisticated contextual problems ... with depictive representations and interactivity in response space, but no interactivity in situation space</td>
<td>Sophisticated contextual problems ... with depictive representations and interactivity in response space, but no interactivity in situation space</td>
<td>More sophisticated multimodal contextual problems with interactivity in both the situation and response spaces</td>
<td>Content of all previous categories, with augmented or virtual reality, with simulation of real situations or in real situations. Full interactivity.</td>
</tr>
<tr>
<td><strong>Possible delivery</strong></td>
<td>Pen-and-paper CBA</td>
<td>Pen-and-paper CBA</td>
<td>Pen-and-paper CBA</td>
<td>CBA</td>
<td>CBA</td>
<td>CBA</td>
<td>CBA</td>
</tr>
<tr>
<td><strong>PISA interactivity classification</strong></td>
<td>Nil</td>
<td>Web (static only) Nil</td>
<td>Web (static only) Nil</td>
<td>AnM Web (static only) Nil</td>
<td>AnM DSV ICT iGr Web</td>
<td>AC AnM DSV ICT iGr Web ...</td>
<td></td>
</tr>
<tr>
<td><strong>Possible response types (automatically scored)</strong></td>
<td>Multiple Choice Numerical field</td>
<td>Multiple Choice Numerical field</td>
<td>Multiple Choice Numerical field, Click on, drag and drop, pull down menu, matching, ordering, etc.</td>
<td>Multiple Choice Numerical field Click on, drag and drop, pull down menu, matching, ordering, etc.</td>
<td>Click on, drag and drop, pull down menu, matching, ordering, manipulating fields to create a correct solution, digital working space with digital tools</td>
<td>Click on, drag and drop, pull down menu, matching, ordering, manipulating fields to create a correct solution, digital working space with digital tools</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 3. Framework on increasing sophistication of representation of reality in contextual mathematical problems.*
Both PISA and PIAAC describe mathematical literacy or numeracy as not synonymous with a minimal or low level of mathematical knowledge and skills. That is, both assessments view the constructs as describing competencies lying on a continuum.

Because many adults may not remember more formal school-based representations or technical language, the design of PIAAC items has taken into account from the outset the need to establish authenticity while reducing the use of formal notations and ‘school-like’ appearance and questions.

But quite consistent and most questions could move from one to the other.
The percentages of adults performing at the lowest level in numeracy in PIAAC are significantly higher than in literacy, therefore there is a very strong argument for developing an equivalent to the reading components assessment in the PIAAC numeracy assessment:

The overall performance in numeracy in PIAAC is that 5% of adults surveyed in the first wave of 24 countries were at Pre-Level 1. When including the second wave of countries, the results showed 6.7% were at Pre-Level 1 across 33 countries. This compares with a performance in reading literacy of 3.3% across the original 24 countries, and 4.5% for the second wave of 33 countries.
PIAAC Review: some research highlights about how vital maths/numeracy is in the 21st century

"This is one of the most interesting aspects/concepts of this project. The relationship between workplace mathematical skills and school mathematics could be described as ‘distant’ at best – Teacher observation"

The application of mathematics in the workplace is not straightforward and goes well beyond a command of ‘core’ mathematical content. Workers perform sophisticated functions which require them to be confident to use mathematical skills in problem-solving situations and to see the consequences of the mathematics related procedures.
• Mathematics was considered extremely important in all of the companies involved.

• Changing work practices are generating new demands for mathematical skills, particularly in areas such as efficiency, innovation and Quality & Continuous Improvement.
The young STEM workers who took part in the survey were often students who enjoyed school but, looking back, recognised that it had not effectively prepared them for their career in STEM. The majority of young STEM workers surveyed found school too remote from the realities of working life.

Consistent with increasing awareness and research about need for 21st C skills incl. more STEM

New Work Smarts: Skills that matter most

- **learn** (be a lifelong learner)
- **solve problems**
- **think critically**
- **use science and mathematics skills**
- **use verbal communication and interpersonal skills**
- **have an entrepreneurial mindset**

Foundation for Young Australians, *The New Work Smarts: Thriving in the New Work Order*, 2017
PIAAC: Current status

- PIAAC Cycle 2 underway
- Expert groups established and reviewing and refining frameworks
- Test development now occurring
- Field trials in 2020
- Main study in 2021-22
- Results out in 2023
- Australia is now participating, I understand
Some references

A wide range of international and country reports about the results of the PIAAC survey and the resulting research are readily available from the OECD: http://www.oecd.org/skills/piaac/publications.htm.


The 2017 OECD report about Australia is available from this blog: https://oecdeducationtoday.blogspot.com/2017/09/why-it-matters-if-you-cant-read-this.html

Some reports from the review include:


Chesters, Jenny, Ryan, Chris, Sinning, Mathias (2013) The returns to literacy skills in Australia, National Centre for Vocational Education Research (NCVER), Adelaide


Some references


Some references


For a full list of the Review paper’s references please contact Dave at: David.Tout@acer.edu.au

Paper title:

*Will be published as an OECD Working paper.*