Reviewing the PIAAC numeracy assessment framework

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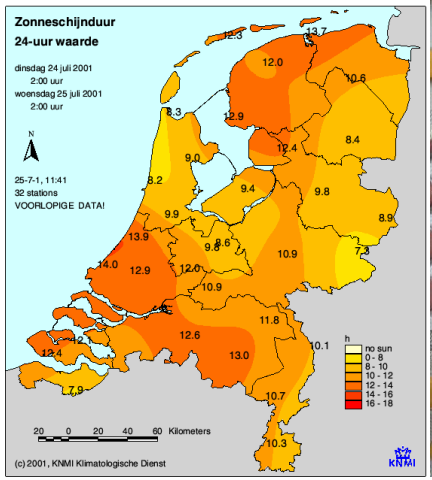
Numeracy *is the ability to access, use, interpret, and communicate mathematical information and ideas, in order to engage in and manage the mathematical demands of a range of situations in adult life*

Numerate Behavior *involves managing a situation or solving a problem in a real context, by responding to mathematical content/information/ideas represented in multiple ways.*



OECD review request

In particular, the review needed to address the following issues

- **Theoretical developments**: identify any theoretical developments in the understanding and conceptualisation of adult numeracy that are relevant for the assessment of numeracy in PIAAC;
- **21st century digital implications**: discuss how to ensure that the assessment reflects the importance of digital information, representations, devices and applications as realities that adults have to manage in dealing with the numerical demands of everyday life;
- **Assessment developments**: identify any developments in the assessment of numeracy (particularly of adults) that could be relevant for PIAAC (e.g., item types and formats, use of animation, and modelling);
- **Relationship with PISA**: discuss how the relationship between the PIAAC numeracy framework and the PISA mathematical literacy framework and assessment should be conceived, developed (if appropriate) and presented;
- **Numeracy or mathematical components**: evaluate the utility and feasibility of the implementation of an equivalent to the PIAAC reading components and numeracy assessments; and
- **Recommendations**: make recommendations regarding the definition of the construct of numeracy and the priorities for development of the assessment framework for numeracy in the second cycle of PIAAC.

Issues to be reviewed

- Theoretical developments around adult numeracy
- 21st century digital implications for (digital) assessment
- Assessment developments in general and specific for numeracy
- Opportunities for closer relationship with PISA
- Opportunities for numeracy or mathematical "components"

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Reviewing team

Review of the PIAAC **Numeracy Assessment Framework:**

- Diana Coben, University of Waikato, New Zealand
- Vincent Geiger, Australian Catholic University, Australia
- Lynda Ginsburg, Rutgers University, USA
- Kees Hoogland, SLO, Institute for Curriculum Development, The Netherlands
- Terry Maguire, *National Forum* for the Enhancement of Teaching and Learning in Higher Education, Ireland
- Sue Thomson, ACER, Australia
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Methodology

The methodology combined

- Review of the existing framework and item pool,
- A review of the literature,
- Research, review, and discussion by the team on 5 themes
- Synthesis and reporting.

The methods focused upon generating findings regarding the tasks listed in the rquest.

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Theoretical developments

four related issues to be explicitly addressed in updating and refining the existing PIAAC framework definition and description:

- disposition to use mathematics
- the ability to see mathematics in a numeracy situation
- critical reflection
- degree of accuracy

21st century digital implications

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. Many technologies are thinking tools, which in turn have a range of implications for life, citizenship and the workplace. These tools and processes can often change the numeracy task itself and so transform practices within adults' lives and within the workplace. The use and application of a range of techno-mathematical literacies underpins much of this. These 21st century aspects of numeracy practices need to be reflected in a revised framework and in the associated assessment tasks, but a balance needs to be kept between numeracy and mathematics actions in digital and technological environments versus those embedded in other, non-digital ways.

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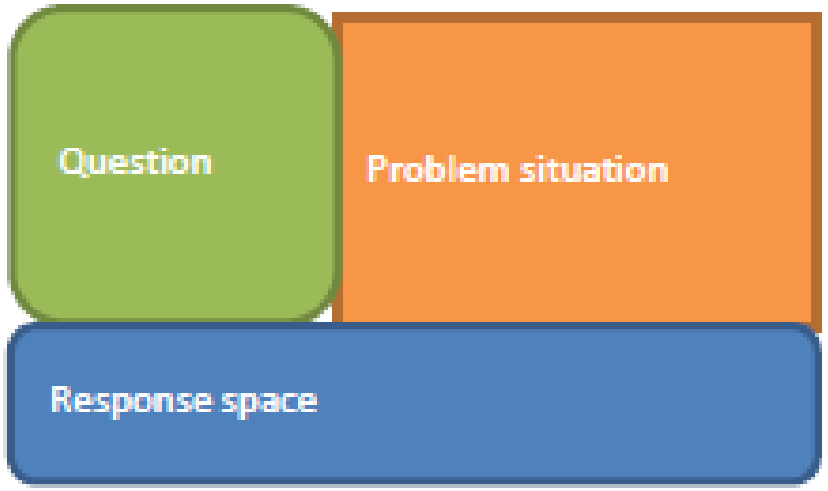
Assessment developments



Considering this in its broadest sense, the problem stimulus and situation can be described in words only, depicted through images and illustrations, animated, or shown through virtual or augmented reality, or it might be a simulation of a real situation, or be a real situation. (p.28)

M047: Lichen

A result of global warming is that the ice of some glaciers is melting. Twelve years after the ice disappears, tiny plants, called lichen, start to grow on the rocks.

Each lichen grows approximately in the shape of a circle.

The relationship between the diameter of this circle and the age of the lichen can be approximated with the formula:

$$d = 7.0 \times \sqrt{(t - 12)} \quad \text{for } t \geq 12$$

where d represents the diameter of the lichen in millimetres, and t represents the number of years after the ice has disappeared.

Question 1: LICHEN

M047Q01- 0 1 8 9

Using the formula, calculate the diameter of the lichen, 16 years after the ice disappeared.

Show your calculation.

Source: PISA Samples 2004

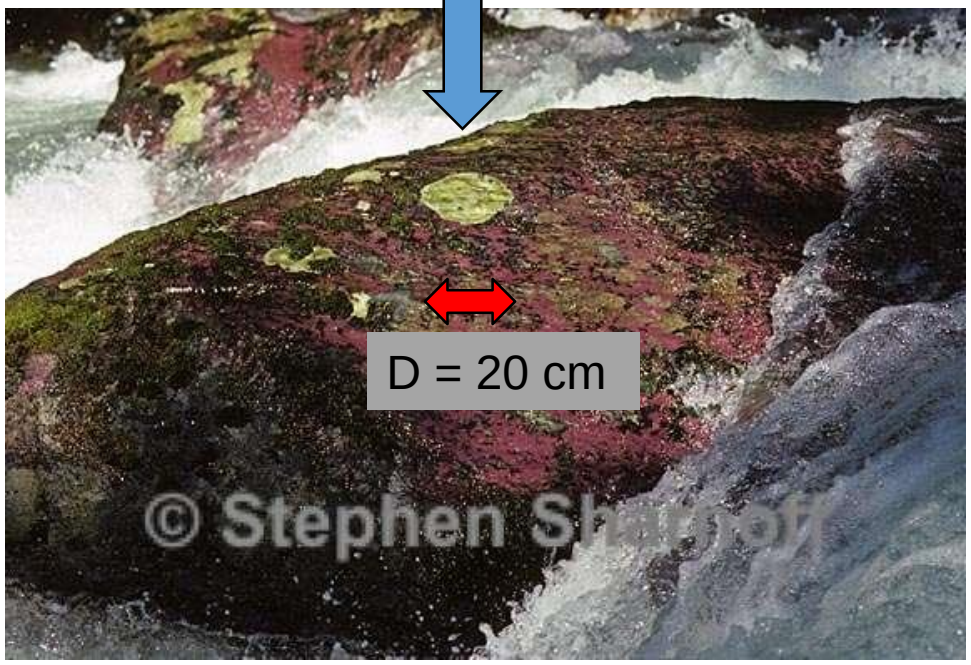
$$f(x) = 7\sqrt{x - 12}$$

Calculate $f(16)$

Global warming

The ice melts

12 years later lichen starts to grow.



Model:

D = 7 * SQRT (t)

D is diameter in mm
t is age of lichen in years

How old is the lichen?

How long ago the ice melted?

Category:	A	B	C	D	E	F	G
Type of representation	Decontextualised maths problem 2 x 3 = ...	Simple contextual word-based problems You have 25 sheep. Three are stolen. How many do you have left?	Sophisticated contextual problems with images and descriptive representations (but no interactivity in response space)	Sophisticated contextual problems ... with depictive representations and interactivity in response space, but no interactivity in **situation** space	Sophisticated contextual problems Short video clips or animations as representation with interactivity in response space, but no interactivity in **situation** space)	More sophisticated **multimodal** contextual problems with interactivity in **both** the **situation** and **response** spaces	Content of all previous categories, with augmented or virtual reality, with simulation of real situations or in real situations. Full interactivity.
Possible delivery	Pen-and-paper CBA	Pen-and-paper CBA	Pen-and-paper CBA	CBA	CBA	CBA	CBA
PISA interactivity classification	Nil	Web (static only) Nil	Web (static only) Nil	Web (static only) Nil	AnM Web (static only) Nil	AC AnM DSV ICT IGr Web	AC AnM DSV ICT IGr Web ...
Possible response types (automatically scored)	Multiple Choice Numerical field	Multiple Choice Numerical field	Multiple Choice Numerical field	Multiple Choice Numerical field, Click on, drag and drop, pull down menu, matching, ordering, etc.	Multiple Choice Numerical field Click on, drag and drop, pull down menu, matching, ordering, etc.	Click on, drag and drop, pull down menu, matching, ordering, manipulating fields to create a correct solution (e.g., spreadsheet,), digital working space with digital tools	Click on, drag and drop, pull down menu, matching, ordering, manipulating fields to create a correct solution, digital working space with digital tools, physical actions in simulations (e.g., choosing an object by grabbing it)

Figure 3. Framework on increasing sophistication of representation of reality in contextual mathematical problems.

Relationship with PISA

Challenge in real world context

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

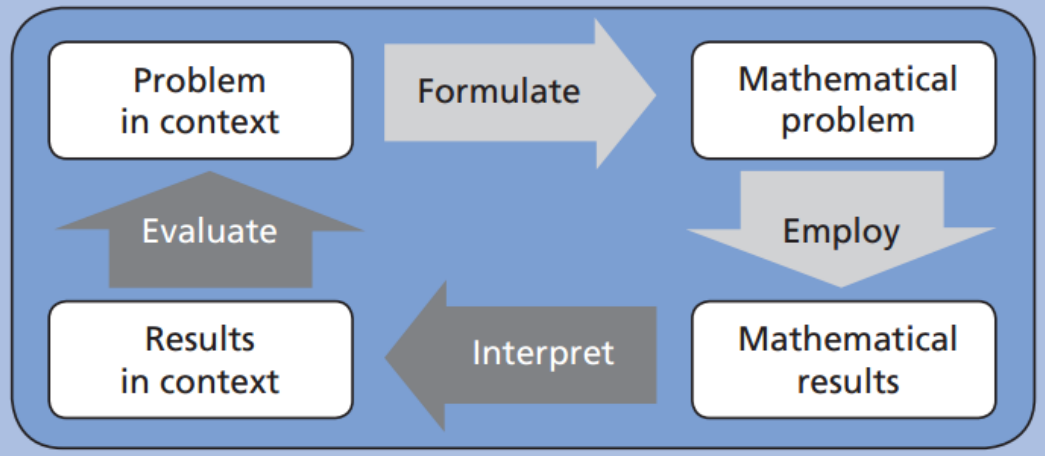
Real world context categories: Personal; Societal; Occupational; Scientific

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



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Numeracy or mathematical components

Item formats

- Examples of the most appropriate item formats and delivery that could be expected of respondents being assessed on numeracy components items have been discussed above. This will be dependent on the method of delivery, but some of the recommended options, which would support a numeracy components assessment, would include:
- use of photos and realistic representations of real-life objects
- use of real items or objects for tasks such as comparing, sorting or classifying
- drag and drop items or click on items on laptop or a tablet using touch screen capabilities
- video or audio supported items
- having the administrator record oral answers for the respondent.