Towards a Second Cycle of PIAAC

Programme for the International Assessment of Adult Competencies

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Today's program

- Planning PIAAC cycle 2
- Conceptual Developments
  - Framework
  - Item development
- Questions and Discussions

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Year	Survey	Sponsor	Sample
2003	Adult Literacy and Lifeskills (ALL) Survey	Statistics Canada	16- to 65-year-olds in 11 countries, including 3,420 U.S. participants
2003	National Assessment of Adult Literacy (NAAL)	NCES	19,000 adults aged 16 and older residing in households and federal and state prisons
2011	Program for the International Assessment of Adult Competencies (PIAAC)	NCES	5,000 adults (minimum sample size) aged 16 to 65 in U.S. and 24 other countries

PIAAC Cycle 1

Program for the International Assessment of Adult Competencies (PIAAC)	
Developed by	Organization for Economic Cooperation and Development (OECD)
Managed by	International Consortium
Administration	2011 – 2012; administered in households
# Countries	24
Sample size	5,000+ individuals per country
Participants	Approx. 166,000, ages 16 - 65
# Languages	32 for direct assessment, 36 for background questionnaire
Reports	International and national reports, released October 2013

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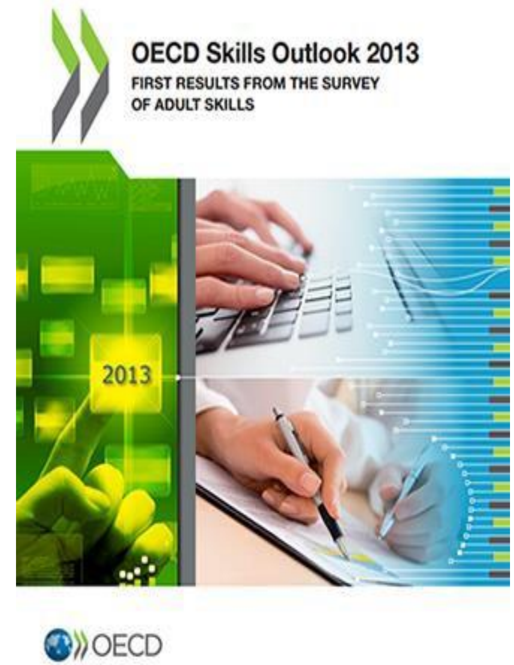
Round 1 countries (2008-13)			
Australia	Denmark	Italy	Russian Federation
Austria	Estonia	Japan	Slovak Republic
Belgium	Finland	Korea	Spain
Canada	France	Netherlands	Sweden
Cyprus	Germany	Norway	United Kingdom
Czech Republic	Ireland	Poland	United States



Round 2 countries (2012-16)		
Chile	Israel	Singapore
Greece	Lithuania	Slovenia
Indonesia	New Zealand	Turkey

Background Questionnaire	Module on Skills Use	Direct Assessment Domains
• Demographic characteristics • Education and training • Work experience (present and past) • Social and linguistic background • Literacy and numeracy practices • Use of information and communications technology	Skills participants regularly use in their job and home life	• Literacy • Numeracy • Problem solving in technology-rich environments • Reading Components

Numeracy Framework Development

- Before 2009: IALLS, ALL, PISA
- 2009 Numeracy Framework PIAAC
- 2017 Review of Framework PIAAC
- 2019 Revised Framework PIAAC

- A new element: numeracy components

Numeracy components – 2nd cycle of PIAAC

- Initial search for research on assessments on numeracy capability for adults who struggle with numeracy/mathematical proficiency
- Outcomes of this search were very limited with most search results focused on dyscalculia or other cognitive or physical disabilities
- The search was then broadened to themes drawn out of the Review of the PIAAC Numeracy Framework
  - Big Ideas in Mathematics
  - Number sense
  - Embeddedness
  - Authenticity

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Big Ideas in Mathematics

- Big ideas in Mathematics (BIM) is connected to “noticing connections among different mathematics’ contents and being competent in using them.”

Table 1. The big ideas in mathematics, in the literature

Charles & Carmel (2005)		**Kuntze, Lerman, Murphy, Siller, Kurz-Milcke, Winbourne, … & Schneider (2009)**	**Siemon et al (2012, 2006)**	
Numbers		Analyzing functional dependency	Number	Trusting the count
	Counting numbers	Anticipating, distinguishing cases, systematizing		Place value
	Whole numbers	Changing the perspective		Multiplicative thinking
	Integers	Classifying		(Multiplicative) Partioning
	Fractions / Rational numbers	Dealing with infinity		Proportional reasoning
The base ten numeration system		Dealing with variation and uncertainty		Generalising algebraic reasoning
	Whole numbers	Doing-undoing/inverting		
	Decimals	Exploring and developing students' understandings through questioning		
Equivalence		Extending the domain	**Perry & Dockett (2002) Powerful mathematics ideas**	
	Numbers and numeration	Finding and using analogies		
	Number theory and fractions	Finding arguments and proofs	Mathematization	
	Algebraic expressions and equations	Formalizing	Connections	
	Measurement	Generating and using algorithms	Argumentation	
Comparison		Going beyond	Number sense and mental computation	
	Numbers and expressions	Making connections with mathematics exploring multiple strategies	Algebraic reasoning	
	Fractions, ratios and percent	Modelling	Spatial and geometric thinking	
	Geometry and measurement	Ordering	Data and probability sense	
Operation meanings and relationships		Specializing/ generalizing		
	Whole numbers	Using misconceptions and errors for learning		
	Rational numbers (fractions and decimals)	Using multiple representations		

Table 1. (…/…) The big ideas in mathematics, in the literature

	Integers	**Jones, Langrall, Thornton, & Nisbet (2002)**	
Properties			
	Properties and operations	Whole number and operations	
	Properties of equality	Rational numbers	
Basic facts and algorithms		Geometry	
	Mental calculations	Probability	
	Whole number basic facts and algorithms	Data exploration	
	Rational number algorithms	Algebraic thinking and other underrepresented domains	
	Measurement		
Estimation		**NCTM (1989, 2000)**	
	Numerical	Number & Operations	Problem Solving
	Measurement	Algebraic reasoning	Reasoning & Proof
Patterns		Geometry	Communication
	Numbers	Measurement	Connections
	Geometry	Data and probability	Representation
Variable			
Proportionality			
Relations and functions			
Equations and inequalities			
Shapes and solids			
Orientation and location			
	Lines and line segments		
	Objects		
Transformations			
Measurement			
Data collection			
Data representation			
Data distribution			
Chance			

Tension between mathematics and numeracy

- FitzSimons and Coben (2009) draw on Bernstein's notion of horizontal and vertical discourses to explain the difference between the structure of mathematics and that of numeracy.
  - Mathematics => Vertical discourse
  - Numeracy => Horizontal discourse

Big Ideas in Mathematics

- It is highly problematic to attempt to identify "essential" mathematics ideas or "big ideas" in the numeracy space as this challenge must be accompanied by the qualifiers such as – For what purpose? In which context? Within what milieu of social-expectation? These questions are important regardless of the perspective you take on numeracy – as social or human capital.
- None-the-less, there have been attempts to identify the: 1) types/forms of mathematics that are used across cultures; 2) capabilities associated with industrial situations; 3) forms of mathematical demands required in the 21st century – digital and graphic formats

Types/forms of mathematics that are used across cultures

- Bishop (1988) drew on the tradition of ethno-mathematics to identify a range of activities and practices that were cultural as well as technical in which mathematics was embedded. These six 'pan-cultural' mathematical activities take place in all societies and include:
  - counting
  - locating
  - measuring
  - designing
  - explaining
  - playing
- Barton (2009) developed a model for what he argued all cultures had systems for dealing with:
  - quantity or measurement,
  - relationships between things or ideas
  - space, shapes or patterns"

…the QRS-system

Capabilities associated with both narrowly defined industrial situations

- Wake and Williams (2001), for example provide advice that the development of numeracy capability should emphasise
  - using relatively 'low level' mathematics in quite complex situations and contexts;
  - encouraging experiences of a diversity of conventions and methods;
  - having students experience activities where the mathematics is embodied in context and to use artefacts with which they have become familiar;
  - preparing students to transform their existing mathematical knowledge to make sense of activities in unfamiliar workplace situations;
  - having students design spreadsheet programmes for modelling and for the recording, processing and analysis of data; and
  - making students aware that there are many and varied ways to solve any problem
- An alternative view is provided by Hoyles et al. (2002) who argue that essential workplace capabilities should include:
  - an ability to perform paper-and-pencil calculations and mental calculations, as well as calculating correctly with a calculator;
  - calculating and estimating (quickly and mentally), including understanding percentages;
  - multi- step problem-solving;
  - use of extrapolation;
  - recognizing anomalous effects and erroneous answers when monitoring systems;
  - communicating mathematics to other users and interpreting the mathematics of other users; and
  - developing an ability to cope with the unexpected

Difficulties with mathematics in online environments

- Thomas and Ward (2010) identified 3 skills that were most commonly found to be insufficient:
  - conversion between units of measure (e.g., telling the time – digital/analogue; litres to millilitres)
  - calculating fractional amounts and percentages (a quarter of a kilogram)
  - knowledge of tenths and hundredths in decimal numbers (reading scales accurately)

Reading and interpreting of graphical information

- Diezmann, Lowrie, Sugars and Logan (2009) identify the reading and interpreting of information graphics as a vital capability in to function and productively contribute in modern society. They argue that individuals need the following capabilities:
  - be able to identify whether the intent of the graphic is to provide a context or present mathematical information;
  - develop adequate knowledge about the various types of graphic; and
  - have opportunities to experience visually diverse examples of the same type of information graphic.

Embeddedness

- The embeddedness of mathematics refers to a deep connection to the context in which it is utilised. This can mean that the way mathematics is used to operate on a task is fundamentally shaped by the context in which it is employed.
- As Harris notes:

  In work [. . .] mathematical activity arises from within practical tasks, often from the spoken instruction of a supervisor and always for an obvious purpose which has nothing to do with the numbers working out well. Thus, students taught to react to isolated, abstract and written commands in the specialist language and carefully controlled figures of a school mathematics class, find themselves confronted with the urgent spoken, if not shouted, instructions in a completely different context and code.

Embeddedness

- Yasukawa, Brown and Black (2013) make a clear connection between embeddedness and social practice arguing that numeracy practices cannot be understood independently of the social, cultural, historical and political contexts.
- To illustrate this point that make the comparison of students completing calculations individually, using paper and pen and perhaps a calculator against the use of mathematics in the supermarket, in which the same calculations completed at a checkout counter by the shop assistant using a cash register.
- In this situation the shopper might perform an estimation to avoid being overcharged. However, the shop assistant is equally concerned with charging the customer the correct price and recording accurate record of the items sold via the cash register. The calculations are the same but the purpose – which is related to context - is different.

Embeddedness

- Embeddedness has led some researchers to talk about the invisibility of mathematics within work or social contexts.
- This means that mathematics can be fundamental to activities that are not obviously mathematical (FitzSimons & Coben, 2009).
- For example, in the use of technology in the workplace where digital tools used to complete tasks often obscure underpinning mathematical activity. As Kent (2004) argues, within techno-mathematical situations in workplaces there is a shift from "fluency in *doing* explicit "pen and paper" mathematical procedures to a fluency with *using* and interpreting output from IT systems and software, and the mathematical models deployed within them'.
- Building on this point, Wedege (2010) defines two forms of *invisible mathematics* as (a) subjectively invisible mathematics where people do not recognise the mathematics that they do as mathematics and (b) objectively invisible mathematics in which mathematics is hidden in technology.

Authenticity

- Likeness of a tasks conducted away from a real work situation to the real world situation. How well does the tsk mirror the real world situation?
- Very challenging because of the question – To who is this authentic? (Voss, 202013)
- Genuine authenticity may be impossible to achieve because of its connection to embeddedness.

Numerate behavior involves ***managing a situation or solving a problem in a real context*** (everyday life, work, societal, further learning) ***by responding*** (identifying, interpreting, acting upon, communicating about) ***to mathematical information*** (quantity & number, dimension & shape, pattern & relationships, data & chance, change) ***that is represented in a range of ways*** (objects & pictures, numbers & symbols, diagrams & maps, graphs, tables, texts, formulae) ***and requires the activation of a range of enabling processes and behaviors*** (mathematical knowledge and understanding, mathematical problem solving skills, literacy skills, beliefs and attitudes). (Gal et al, 1999)

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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.*

Item development

- How to assess such a sophistacted numeracy concept?
- How to represent “reality” in an assessment setting
  - Item types
  - Item delivery
  - Interactivity with respondents

Several facets of items to consider

- Domain
- Processes
- Scope
- Representation of reality
  - Text and symbols
  - Images of (physical) objects
  - Structured Information (Tables, diagrams, ..)
  - Dynamic animations
- Interactivity with respondents

PIAAC

Section _4

Unit 11 - Question 1/1

Read the article about wind power stations. Using the number keys, type your answer to the question below.

How many wind power stations would be needed to replace the power generated by the nuclear reactor?

Wind Power Stations

- Old item

In 2005, the Swedish government closed the last nuclear reactor at the Barsebäck power plant. The reactor had been generating an average energy output of 3,572 GWh of electrical energy per year.

Work continues in Sweden on installing large offshore wind farms using wind power stations. Each wind power station produces about 6,000 MWh of electrical energy per year.

For your information:

Electrical energy is measured in Watt hours (Wh)

1 kWh	= 1 kilo Wh	=	1,000 Wh
1 MWh	= 1 Mega Wh	=	1,000,000 Wh
1 GWh	= 1 Giga Wh	=	1,000,000,000 Wh

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Does the speed sign above mean you must travel at:

a) 80 km per hour
b) slower than 80 kilometres per hour
c) faster than 80 kilometres per hour
d) 80 kilometres per hour or slower
e) The road ends in 80 kilometres

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- Brainstorm and study of some examples provided at the workshop

Thank you for your attention and input !

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