

Numeracy Proxies and Practices: Studies in Approximations of the "Real"

Luke Tunstall
Michigan State University
National Numeracy Network Conference
October 13, 2018



Outline

- I. Context of the work
- II. Guiding literature
 - A. Social practices
 - B. Assessment validity
- III. The study
- IV. Findings and implications
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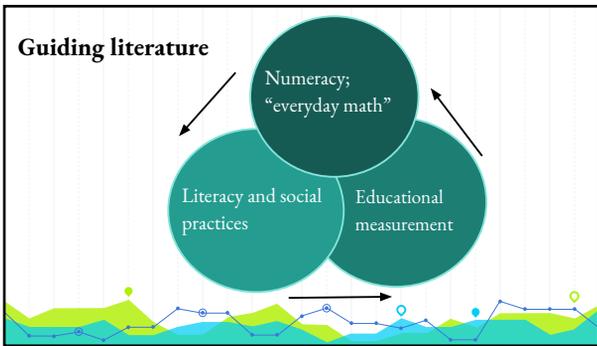
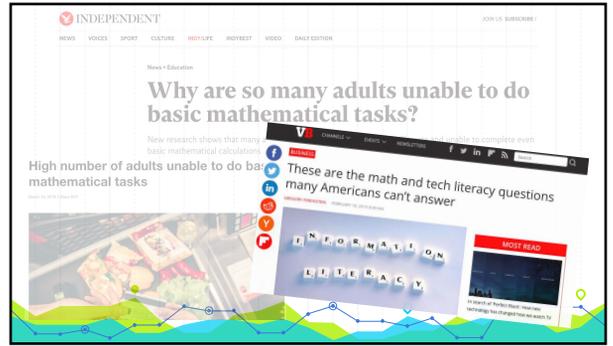
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DOESN'T ADD UP

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Practices also help us to complicate any assumption that ability *determines* action (e.g., Kahan, Peters, Dawson, & Slovic, 2017)

Practices—a few examples

16 Tweets That Exploded My Brain This Week — You've Been Warned

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AERA 2016
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2,462 Impact Factor

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Journal

All Issues

Current Issue

Online First

Validity in educational measurement

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From the American Educational Research Association, American Psychological Association, & National Council on Measurement in Education (2014):

Validity refers to the **degree** to which **evidence** and **theory** support the **interpretations** of test scores entailed by **proposed uses** of a test. (p. 11)

Validity falls along a spectrum, not into a binary



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Sources of validity evidence include:

- content/construct alignment
- relation to other variables (convergent and discriminant evidence)
- internal structure
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- Computer-based, closed-response questions
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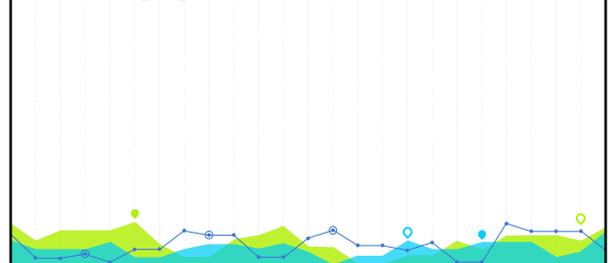
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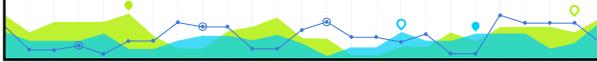
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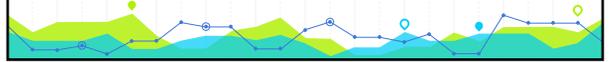
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Findings—Publicly available items

Education & Skills Online

Unit 1 - Question 1/1

Look at the information about workplace injuries at Beauchamp Manufacturing. Click on the graph to answer the question below.

The factory manager checked the graph that had been prepared using the data in the table for 2011. He noticed that the bars went backwards. Click on the two incorrect bars on the graph.

BEAUCHAMP MANUFACTURING

Month	2010	2011
Jan	20	17
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TOTAL	300	273

Number of workers injured per month in 2011

The Beauchamp Manufacturing company records its workplace accidents each year. The table above shows the number of workers injured during each month for 2010 and 2011.

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Look at the shoe sale advertisement. Using the number keys, type your answer to the question below.

How much would you pay during the sale if you purchase the two pairs of shoes shown?

Running Shoes

SALE! Buy one pair - get the second (of equal or lesser value) for half price!

\$

\$29.50 \$34.20

Findings—Publicly available items

PIAAC

Look at the thermometer. Using the number keys, type your answer to the question below.

If the temperature shown decreases by 30 degrees Celsius, what would the temperature be in degrees Celsius (°C)?

°C

Findings—Publicly available items

PIAAC

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?

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 = 1,000 Wh = 1,000 Wh
 1 MWh = 1,000 kWh = 1,000,000 Wh
 1 GWh = 1,000 MWh = 1,000,000,000 Wh

Findings—Publicly available items



Look at the graph about the number of births. Click to answer the question below.

During which period(s) was there a decline in the number of births? Click all that apply.

- 1957 - 1967
- 1967 - 1977
- 1977 - 1987
- 1987 - 1997
- 1997 - 2007

The following graph shows the number of births in the United States from 1957 to 2007. Data are presented every 10 years.



Findings—To what extent is the assessment a valid measure of that construct?

Construct/content alignment

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Not well supported by existing theory (e.g., Saxe, 1988)

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Example, Level 4 description: “Tasks at this level require the respondent to understand a broad range of mathematical information that may be complex, abstract or embedded in unfamiliar contexts. These tasks involve undertaking multiple steps and choosing relevant problem-solving strategies and processes. Tasks tend to require analysis and more complex reasoning...Tasks at this level may also require understanding arguments or communicating well-reasoned explanations for answers or choices” (OECD, 2016, p. 72).

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The Survey of Adult Skills can help policy makers to:

- examine the impact of reading, numeracy and problem- solving skills on a range of economic and social outcomes;
- assess the performance of education and training systems, workplace practices and social policies in developing the skills required by the labour market and by society, in general; and
- identify the policy levers that can reduce deficiencies in key competencies.

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Policy recommendations

Recommendation 1: Take concerted action to improve basic skills and tackle inequities affecting sub-populations with weak skills.

Action is needed, for in its absence the skills of US adults will fall further behind those of other countries. As young cohorts replace older ones, the basic skills of their

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What is assessed

The Survey of Adult Skills (PIAAC) assesses the proficiency of adults from age 16 onwards in literacy, numeracy and problem solving in technology-rich environments. These skills are "key information-processing competencies" that are relevant to adults in many social contexts and work situations, and necessary for fully integrating and participating in the labour market, education and training, and social and civic life.

In addition, the survey collects a range of information on the reading- and numeracy-related activities of respondents, the use of information and communication technologies at work and in everyday life, and on a range of generic skills, such as collaborating with others and organising one's time, required of individuals in their work. Respondents are also asked whether their skills and qualifications match their work requirements and whether they have autonomy over key aspects of their work.

Summary of findings, with implications

- The PIAAC numeracy assessment measures a narrow version of numeracy that the test-makers do not adequately qualify in any existing reports
- The interpretation and uses of numeracy assessment scores go beyond what the test actually measures
- The validity argument for the PIAAC numeracy assessment is internally absent; from external review, its validity is questionable

New questions, future work

- What distinguishes the PIAAC numeracy assessment from other assessments of traditional mathematical literacy?
- What purpose *could* the PIAAC numeracy assessment, as operationalized today, serve?
- What *changes* could we suggest to the PIAAC, as well as to other existing numeracy assessments, to better account for the practices approach?

References

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The Atlantic

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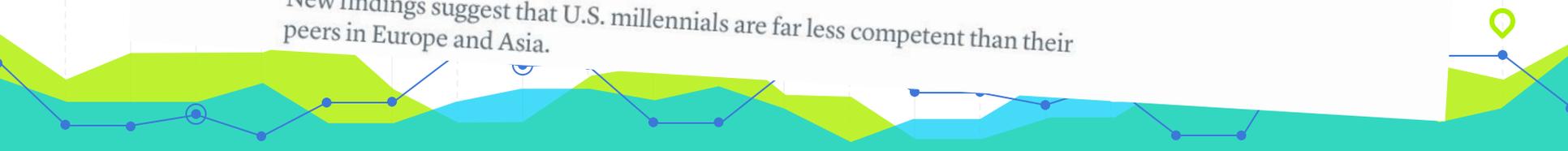
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EDUCATION

The Skills Gap: America's Young Workers Are Lagging Behind

New findings suggest that U.S. millennials are far less competent than their peers in Europe and Asia.



News > Education

Why are so many adults unable to do basic mathematical tasks?

New research shows that many adults are unable to do basic mathematical calculations and unable to complete even

High number of adults unable to do basic mathematical tasks

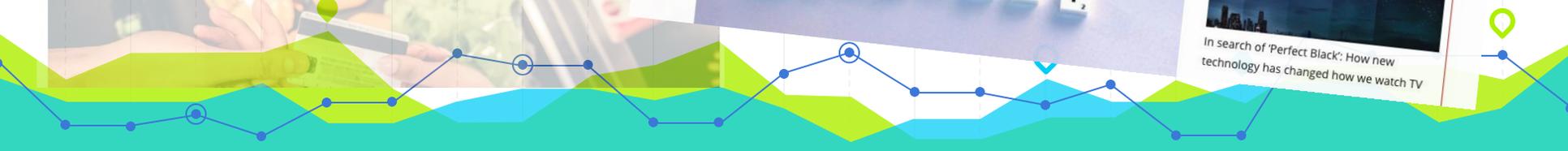
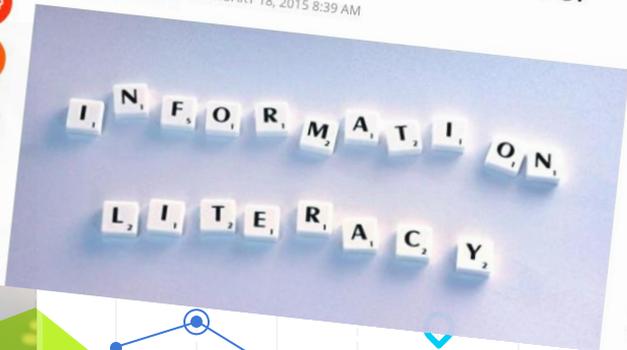
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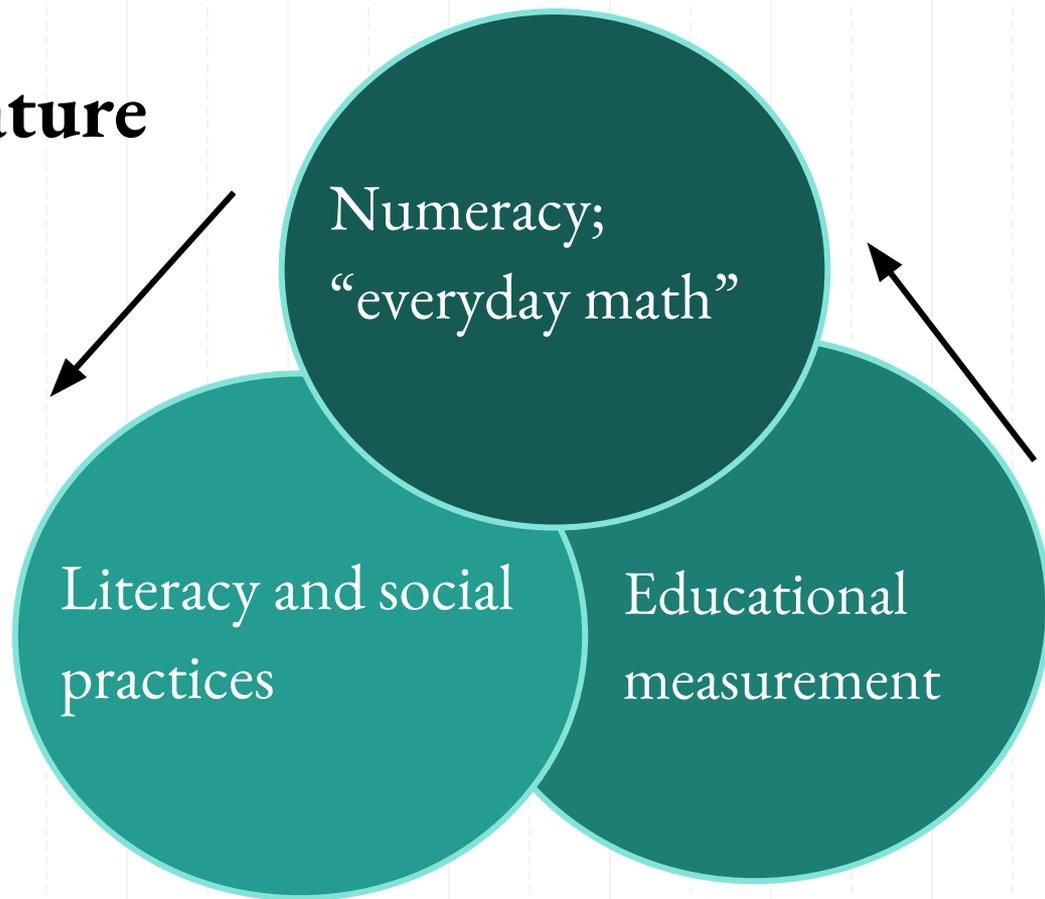
BUSINESS

These are the math and tech literacy questions many Americans can't answer

GREGORY FERENSTEIN FEBRUARY 18, 2015 8:39 AM



Guiding literature



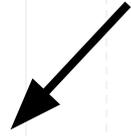
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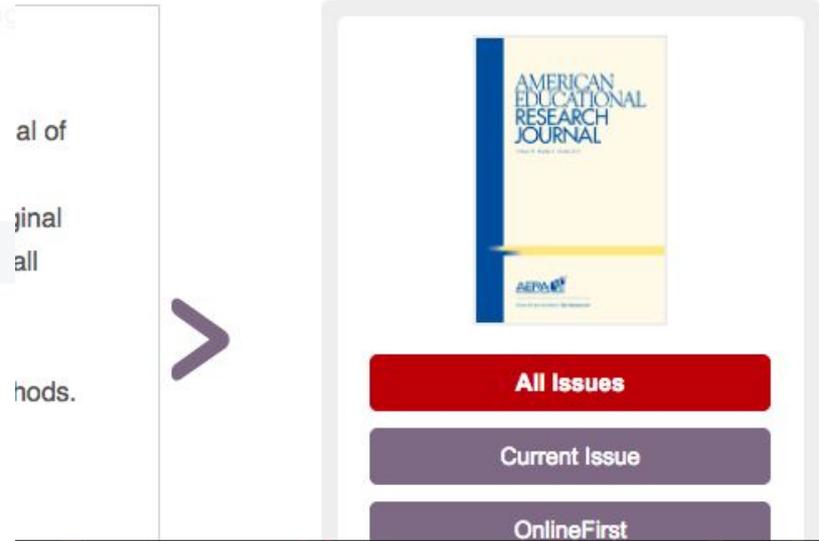
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The navigation menu is displayed on a light gray background. It features a large blue chevron pointing to the right. Below the chevron is a vertical stack of three buttons: a red button labeled "All Issues", a dark purple button labeled "Current Issue", and a dark purple button labeled "OnlineFirst". To the left of the buttons is a vertical list of text: "al of", "jinal", "all", and "hods.".

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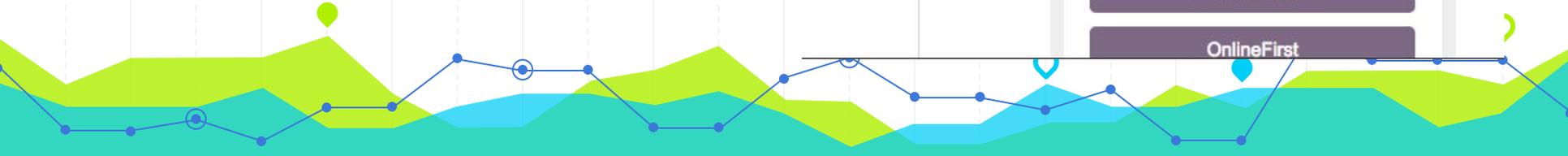
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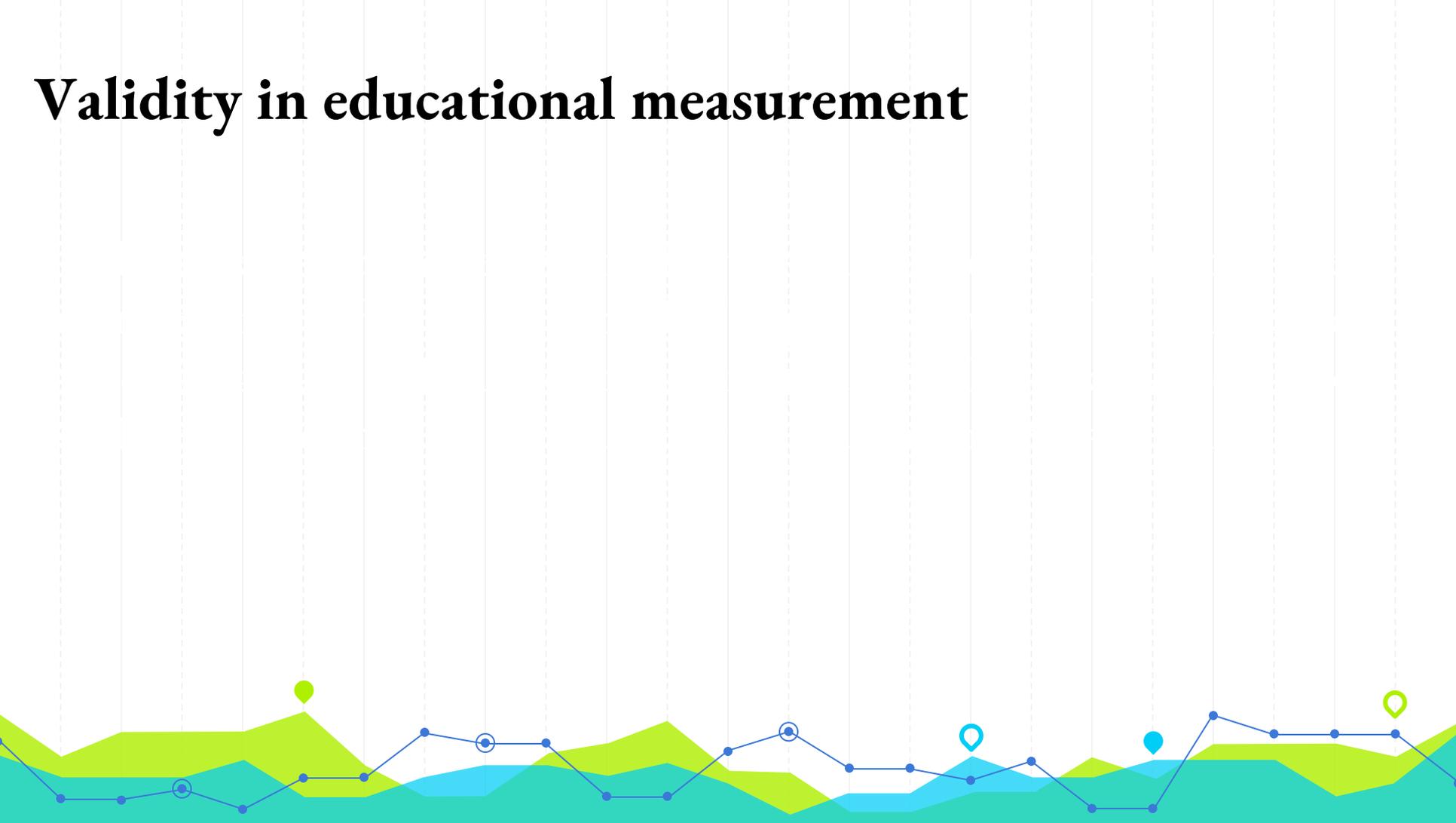
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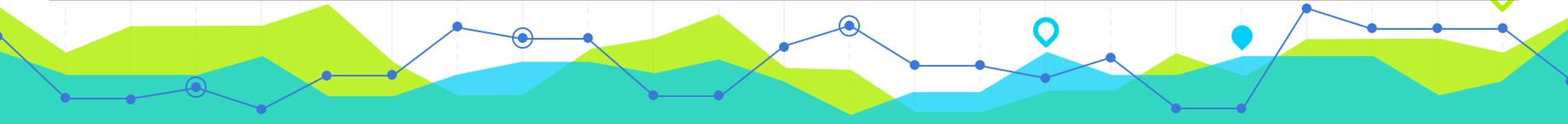
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\$

Running Shoes

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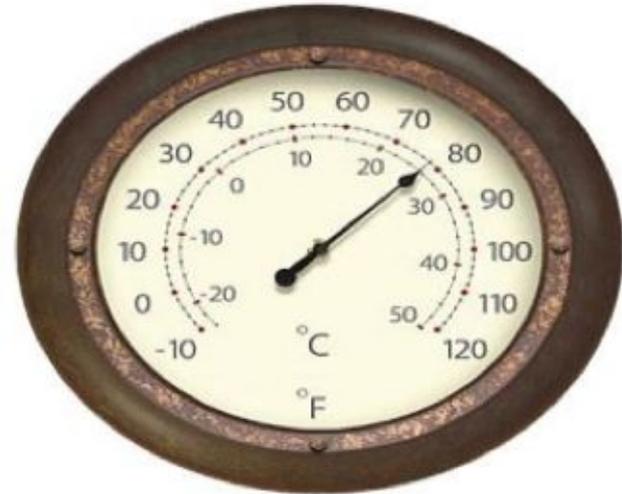
\$34.20

Findings—Publically available items



Look at the thermometer. Using the number keys, type your answer to the question below.

If the temperature shown decreases by 30 degrees Celsius, what would the temperature be in degrees Celsius ($^{\circ}\text{C}$)?

 $^{\circ}\text{C}$ 

Findings—Publically available items

OECD PIAAC Section

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

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

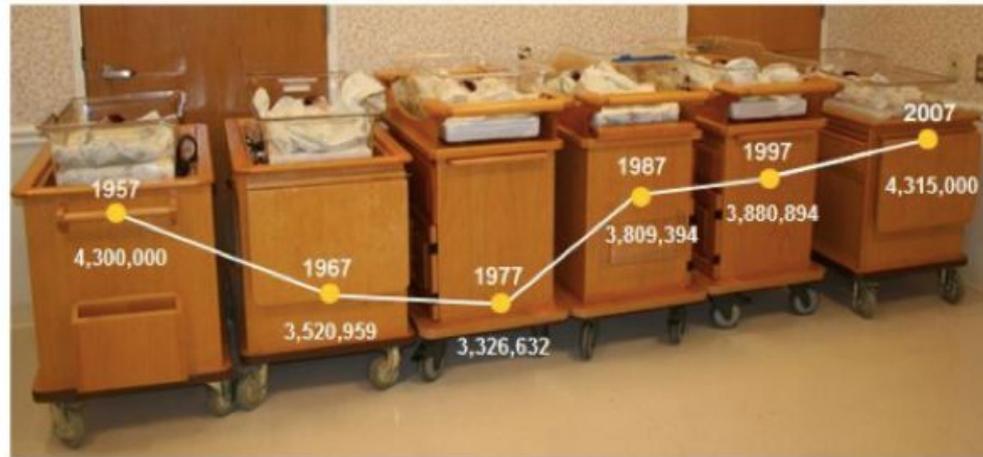
Findings—Publically available items

Look at the graph about the number of births. Click to answer the question below.

During which period(s) was there a decline in the number of births? Click all that apply.

- 1957 - 1967
- 1967 - 1977
- 1977 - 1987
- 1987 - 1997
- 1997 - 2007

The following graph shows the number of births in the United States from 1957 to 2007. Data are presented every 10 years.



Findings—To what extent is the assessment a valid measure of that construct?

Construct/content alignment

“Numeracy is defined as 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. To this end, numeracy involves managing a situation or solving a problem in a real context, by responding to mathematical content/information/ideas represented in multiple ways” (OECD, 2016, p. 24).



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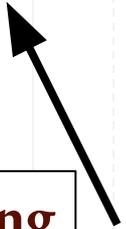


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Not well supported by existing theory (e.g., Saxe, 1988)



Findings—To what extent is the assessment a valid measure of that construct?

Interpretation and uses of scores



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Interpretation and uses of scores

- Scores are reported along a proficiency continuum with five “levels”



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Example, Level 4 description: “Tasks at this level require the respondent to understand a broad range of mathematical information that may be complex, abstract or embedded in unfamiliar contexts. These tasks involve undertaking multiple steps and choosing relevant problem-solving strategies and processes. Tasks tend to require analysis and more complex reasoning...Tasks at this level may also require understanding arguments or communicating well-reasoned explanations for answers or choices” (OECD, 2016, p. 72).

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Interpretation and uses of scores

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Example, Level 4 description: “Tasks at this level require the respondent to understand a broad range of mathematical information that may be complex, abstract or embedded in unfamiliar contexts. These tasks involve undertaking multiple steps and choosing relevant problem-solving strategies and processes. Tasks tend to require analysis and more complex reasoning...Tasks at this level may also require understanding arguments or communicating well-reasoned explanations for answers or choices” (OECD, 2016, p. 72).

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Interpretation and uses of scores

The Survey of Adult Skills can help policy makers to:

- examine the impact of reading, numeracy and problem- solving skills on a range of economic and social outcomes;
- assess the performance of education and training systems, workplace practices and social policies in developing the skills required by the labour market and by society, in general; and
- identify the policy levers that can reduce deficiencies in key competencies.



Findings—To what extent is the assessment a valid measure of that construct?

Interpretation and uses of scores

Policy recommendations

Recommendation 1: Take concerted action to improve basic skills and tackle inequities affecting sub-populations with weak skills.

Action is needed, for in its absence the skills of US adults will fall further behind those of other countries. As young cohorts replace older ones, the basic skills of their



Outline

- I. Context of the work
- II. Guiding literature
 - A. Social practices
 - B. Assessment validity
- III. The study
- IV. **Findings and implications**
- V. Questions and discussion



Summary of findings, with implications

- The PIAAC numeracy assessment measures a narrow version of numeracy that the test-makers do not adequately qualify in any existing reports



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What is assessed

The Survey of Adult Skills (PIAAC) assesses the proficiency of adults from age 16 onwards in literacy, numeracy and problem solving in technology-rich environments. These skills are “key information-processing competencies” that are relevant to adults in many social contexts and work situations, and necessary for fully integrating and participating in the labour market, education and training, and social and civic life.

In addition, the survey collects a range of information on the reading- and numeracy-related activities of respondents, the use of information and communication technologies at work and in everyday life, and on a range of generic skills, such as collaborating with others and organising one’s time, required of individuals in their work. Respondents are also asked whether their skills and qualifications match their work requirements and whether they have autonomy over key aspects of their work.

Summary of findings, with implications

- The PIAAC numeracy assessment measures a narrow version of numeracy that the test-makers do not adequately qualify in any existing reports
- The interpretation and uses of numeracy assessment scores go beyond what the test actually measures
- The validity argument for the PIAAC numeracy assessment is internally absent; from external review, its validity is questionable



New questions, future work

- What distinguishes the PIAAC numeracy assessment from other assessments of traditional mathematical literacy?
- What purpose *could* the PIAAC numeracy assessment, as operationalized today, serve?
- What *changes* could we suggest to the PIAAC, as well as to other existing numeracy assessments, to better account for the practices approach?



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