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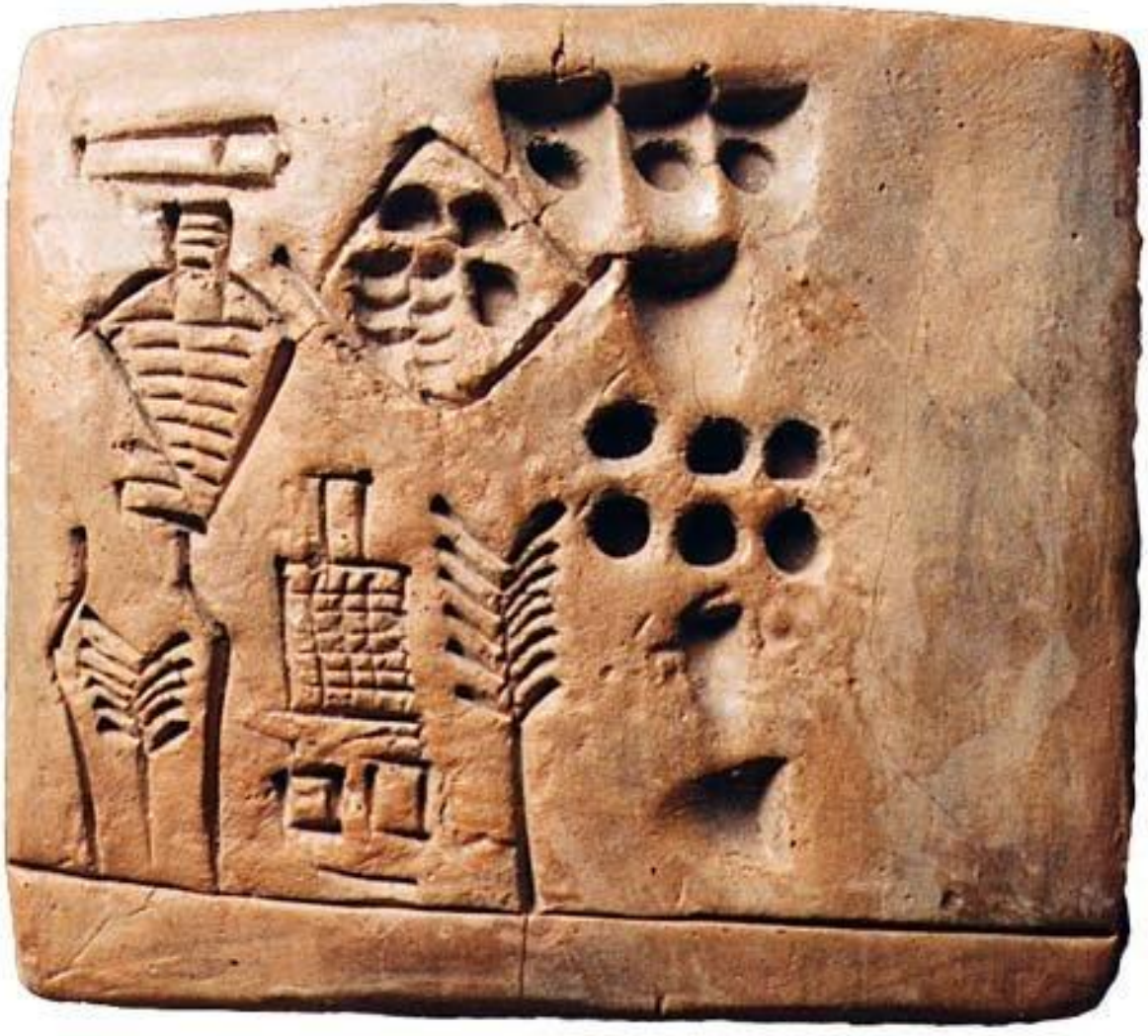
Adult numeracy practices: imperative implications for education

Kees Hoogland

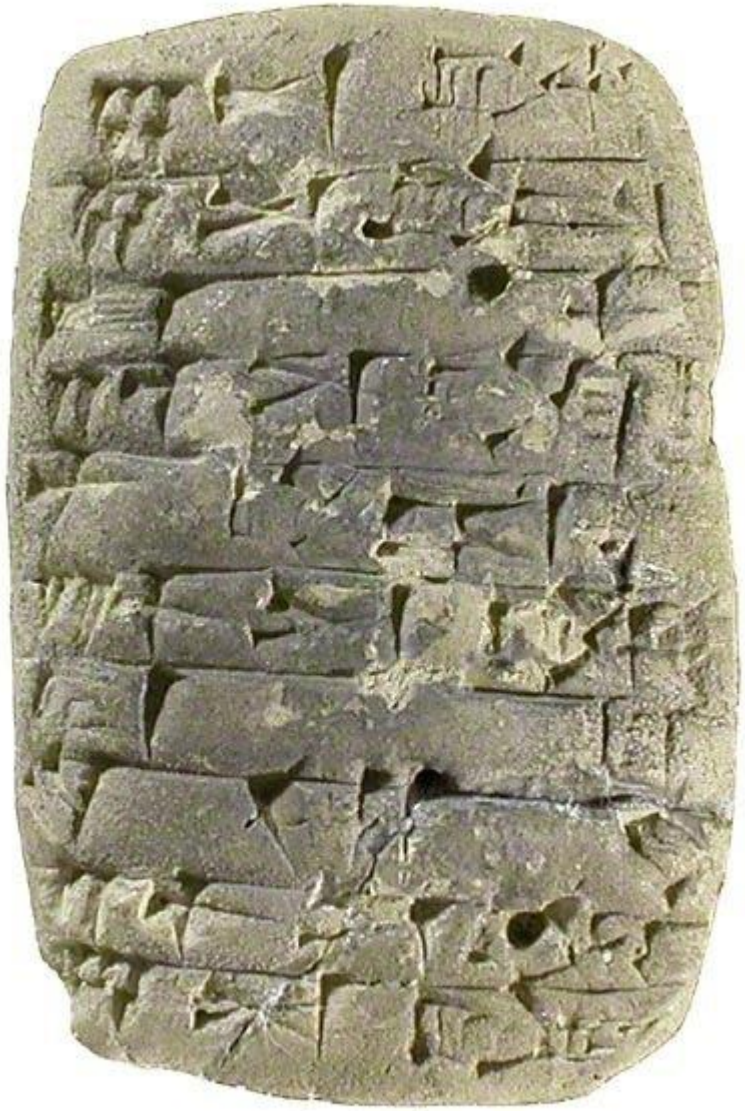
Wednesday 10th July 2019 – ALM26, Lund, Sweden

Numeracy practices



MS 1717
Beer Production. Pictographic script Uruk III , Sumer, 31st c. BC

Source: Schøyen Collection
https://www.schoyencollection.com/



MS 1952/39
Beer distributed from the official stores.
Sumer, 2080-2010 BC

RECORD OF BEER DISTRIBUTED FROM THE OFFICIAL STORES ON THE 12TH AND 13TH DAYS OF A MONTH, MENTIONING BEST BEER AND ORDINARY BEER, FOR THE TEMPLE, FOR THE STORE AND FOR THE HOUSE OF LU-DINGIRRA

What comes along?

- The numerate world 21st c. AD: the digital age
- Developments in the concept of numeracy.
- Numeracy as social practice: what does it mean?
  - Multidimensionality
- The significance of psychological and sociological factors
- A small hands-on try-out
- Implications
- Call for action

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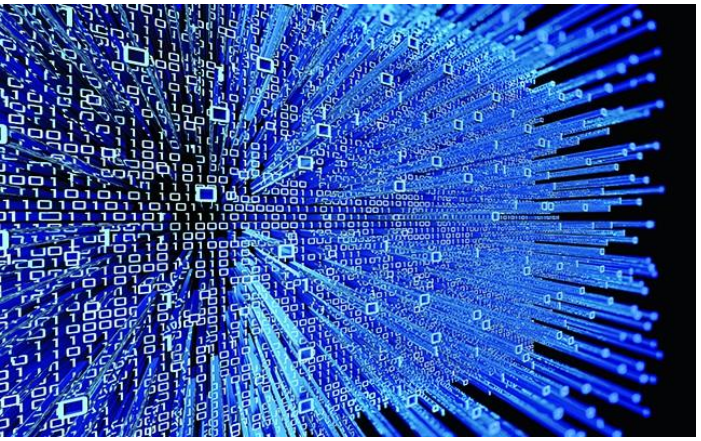
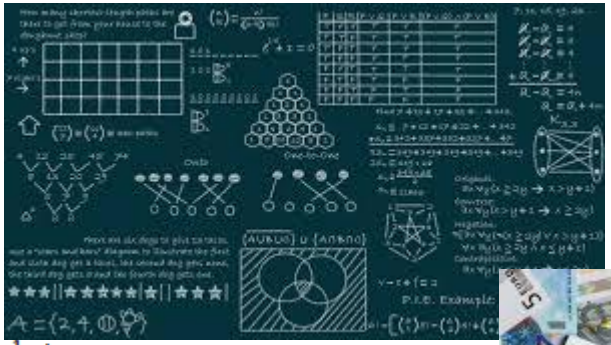
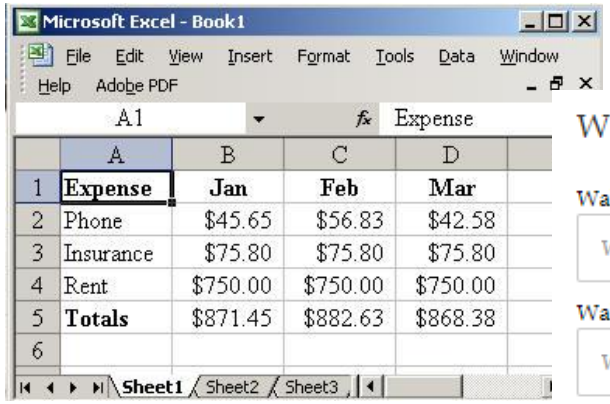
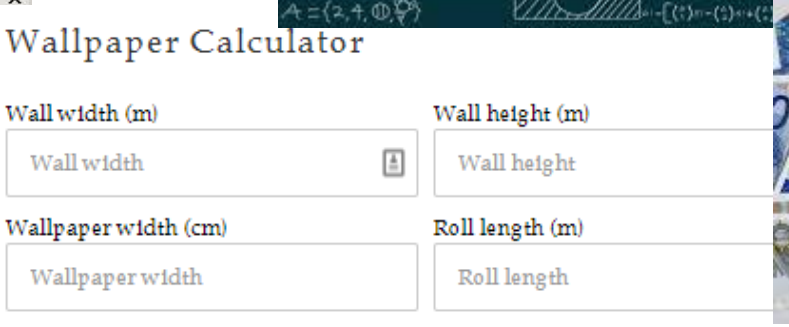
The Numerate world 21st c. AD Situations









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The Numerate world 21st c. AD

People in real life

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Adult numeracy to be part of our society

ScienceLit
SCIENCE LITERACY FOR ALL!

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ScienceLit project: Scientific literacy for all! is an ERASMUS+ project which works to make possible one of the current European challenges: to promote and disseminate scientific knowledge among all cultures and sectors of society. So its contribution is to get science closer to adult people, especially those who are in at-risk situation.

Horizon 2020

IMPACT-EV
Evaluating the impact and outcomes of EU SSH research

EVIDENCE FOR SOCIETY
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Most Read Projects

WIEGO Women in Informal Employment: Globalizing and Organizing

Posted on: 2015-02-01 15:21:08 | Website | Institution: **Harvard Kennedy School**

WIEGO is a global network with the aim of securing financial support to those with low income works, especially women, in the informal economy. WIEGO believes in the equality of economic opportunities and rights of all human beings. WIEGO makes a change in this field by creating capacity on informal worker organizations, expanding the workers' knowledge, and influencing local, national and international policies.

SOCIAL IMPACT OF SCIENCE
Open New Horizons for Science and Societies
facebook Group

In collaboration with:
FECYT

Tweets by @SIORepository

The Numerate world 21st c. AD
Examples in literature

- Zevenbergen (1996) Boat Building
- Evans (2000) Numeracy practices and emotions
- Coben (…) Nursing practices
- Bakker c.s (…): Airplane pilots, Bank personnel, Laboratory workers
- Keogh (2018) Looking at numeracy at work
- Yasukawa e.a (Eds.) (2018): Kiwifruit orchards, Building stone walls, Managing debts

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The Numerate world 21st c.AD

Cognitive processes	*Manifestations*
Interpretation	Product labels, advertisements, brochures, ….
Understanding of hidden algorithms	Apps, websites, …
Valuating	Money, prices, …
Measuring	Length, weight, …
Estimating	Ubiquitous, ….
Critical thinking	Politics, intimidation with numbers
Knowing reference numbers	Body, country, world
…	…
…	…
…	…

Redefining basic skills

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Numeracy

Numeracy is basic skills in operations with numbers;
Numeracy is functional mathematics, a subset of mathematics;
Numeracy is defined by numerate behaviour of individuals;
Numeracy is a social practice (regarding the quantitative aspects of life);

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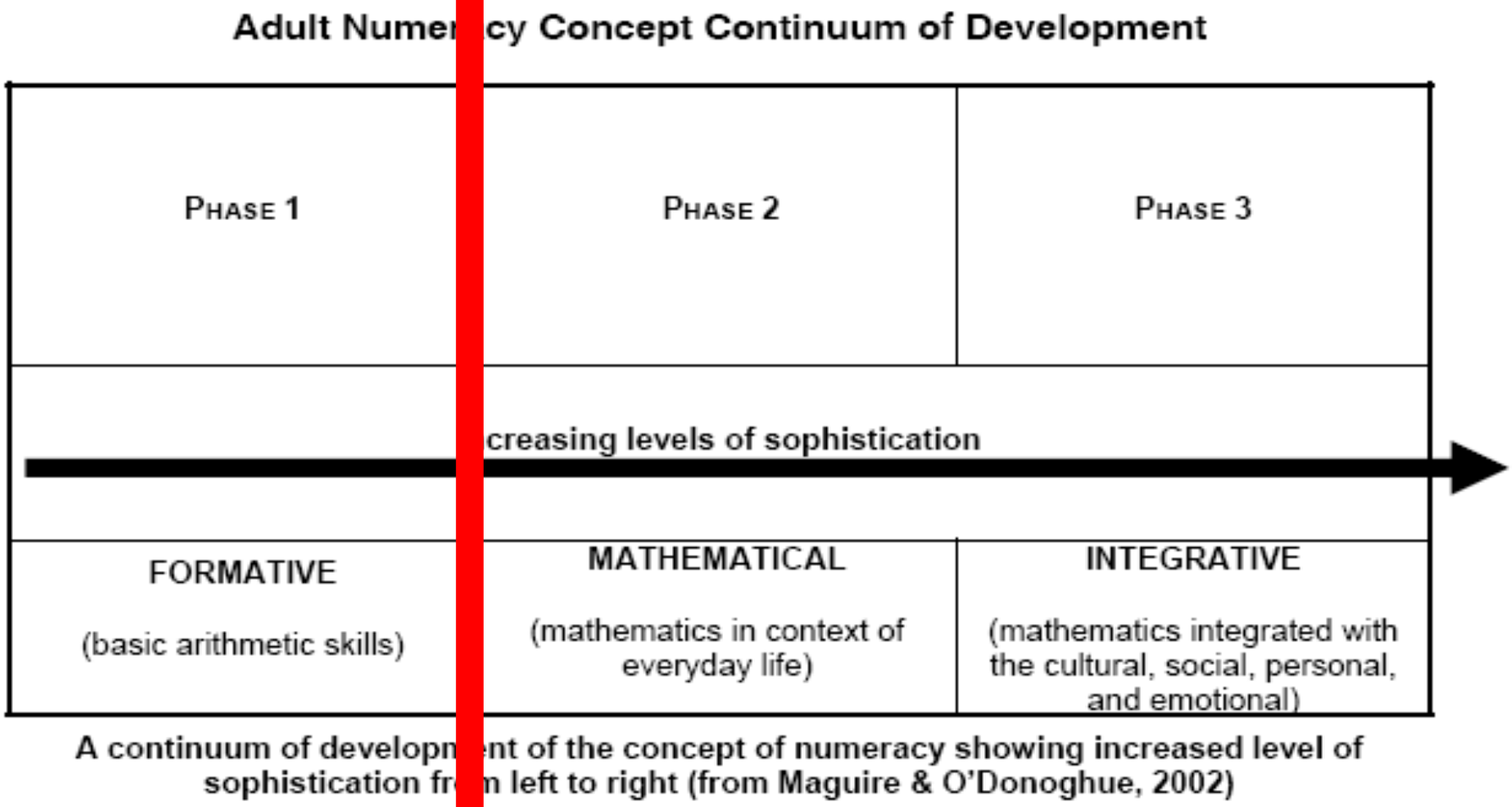
Paradigm barrier
Epistemological shift



A continuum of development of the concept of numeracy showing increased level of sophistication from left to right (from Maguire & O'Donoghue, 2002)

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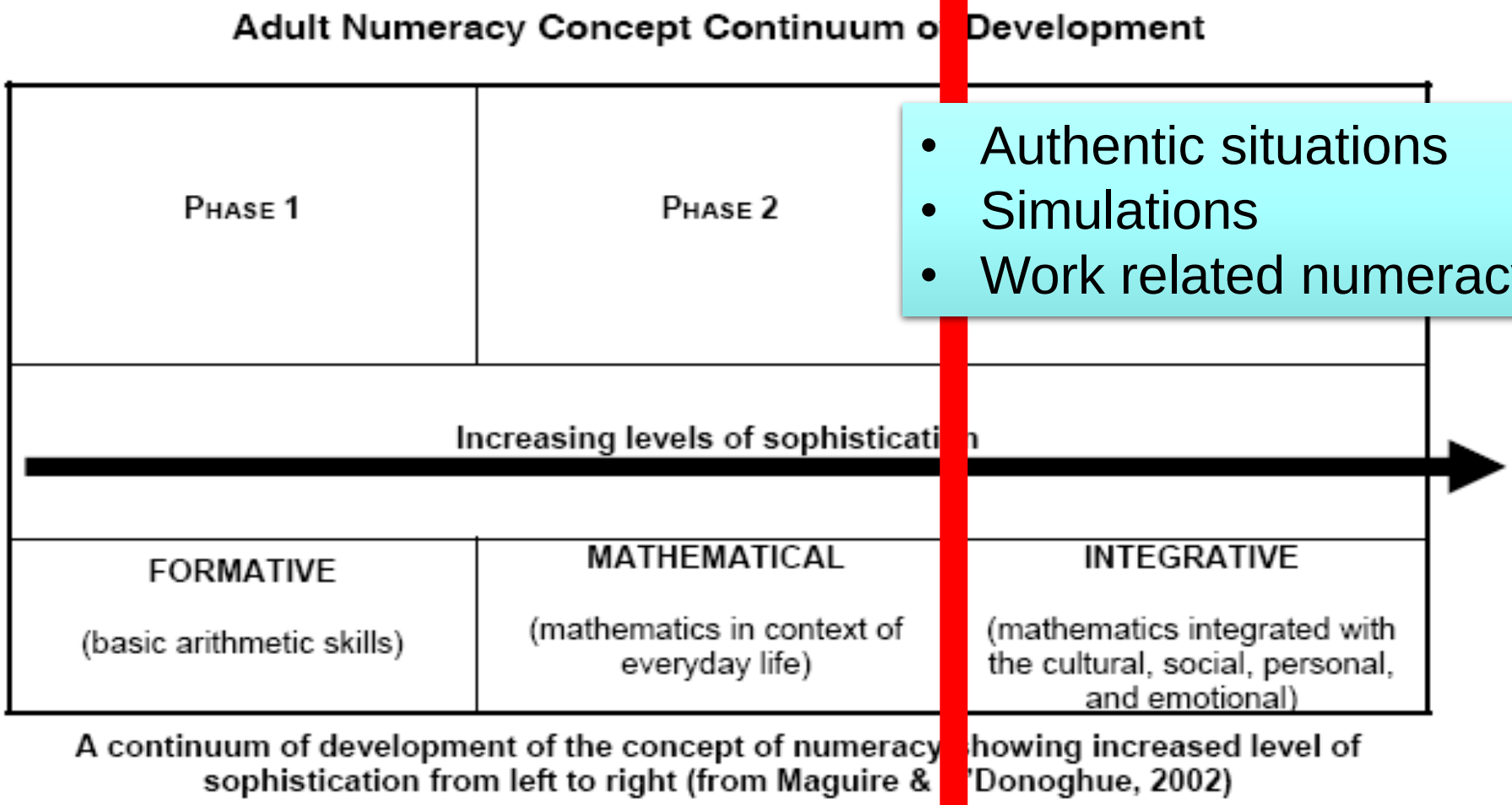
Maguire, T., & O'Donoghue, J. (2002). In L.O.Johansen, Wedege T.(Eds.), *A grounded approach to practioners training in Ireland: Some findings from a National survey of practitioners in Adult Basic Education*. Roskilde, Danmark: Hent, UK: Avanti books.

Paradigm barrier
Epistemological shift
Lack of a common approach??



- Authentic situations
- Simulations
- Work related numeracy

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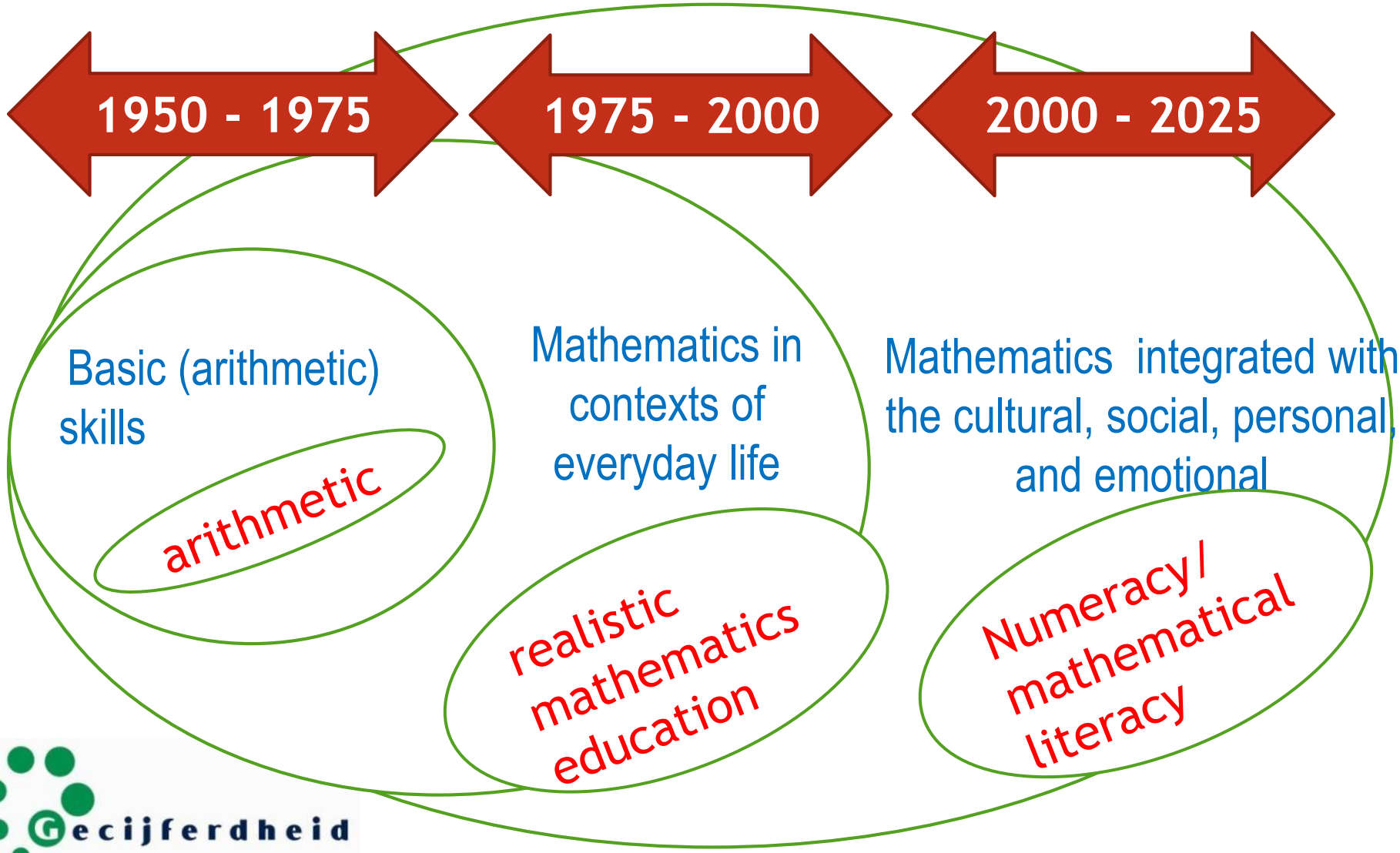
Maguire, T., & O'Donoghue, J. (2002). In L.O.Johansen, Wedege T.(Eds.), *A grounded approach to practioners training in Ireland: Some findings from a National survey of practitioners in Adult Basic Education*. Roskilde, Danmark: Hent, UK: Avanti books.

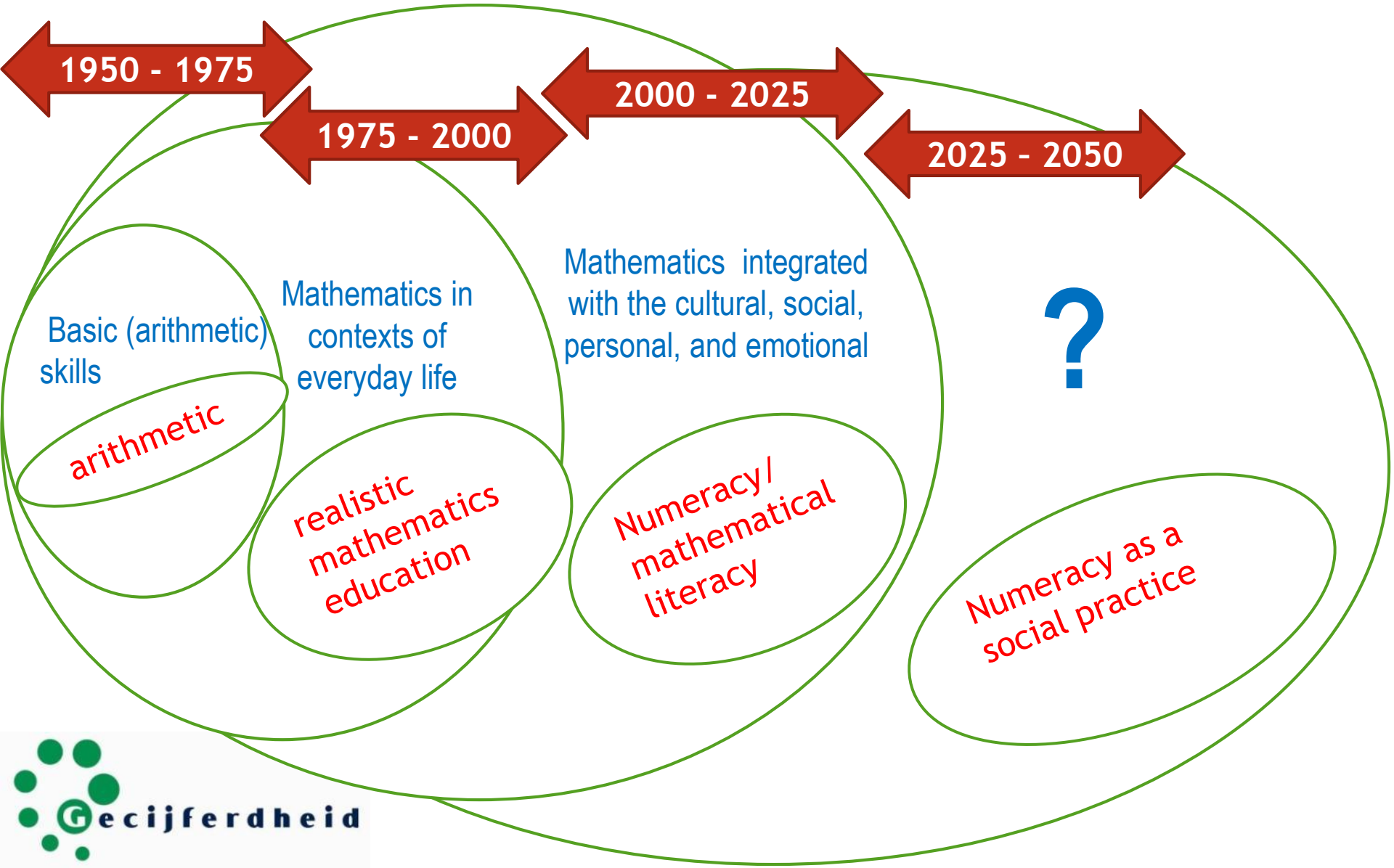
Numeracy Conceptual development



Gecijferdheid


BASED ON THE UNTOLD TRUE STORY
HIDDEN
FIGURES

Numeracy conceptual development



Gecijferdheid

Numeracy as social practice (NSP)

A social practice view of numeracy not only takes into account the different contexts in which numeracy is practised, such as school, college, work and home, but also how people's life and histories, goals, values and attitudes will influence the way they carry out numeracy.

- (See Oughton, 2013)

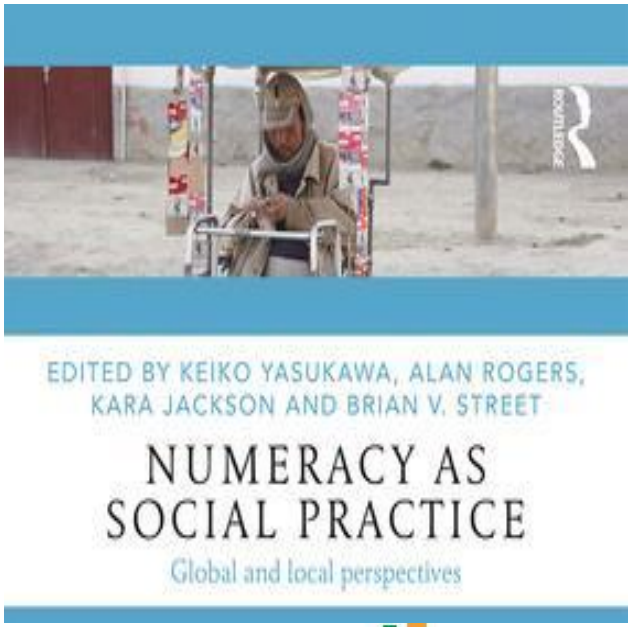
HOW ??

- Research-informed by
  - Situated cognition (Lave, 1988)
  - Cultural-historical activity theory (CHAT, …)
  - Literacy as social practice (LSP, …)
  - Ethnomathematics (D'Ambrosio)

(See Yasukawa et al.(Eds), 2018)

  - Pedagogy of the oppressed (Freire)

(see Freire, 1970, 1996)



Discussed in numerous articles e.g., by Coben, Yasukawa

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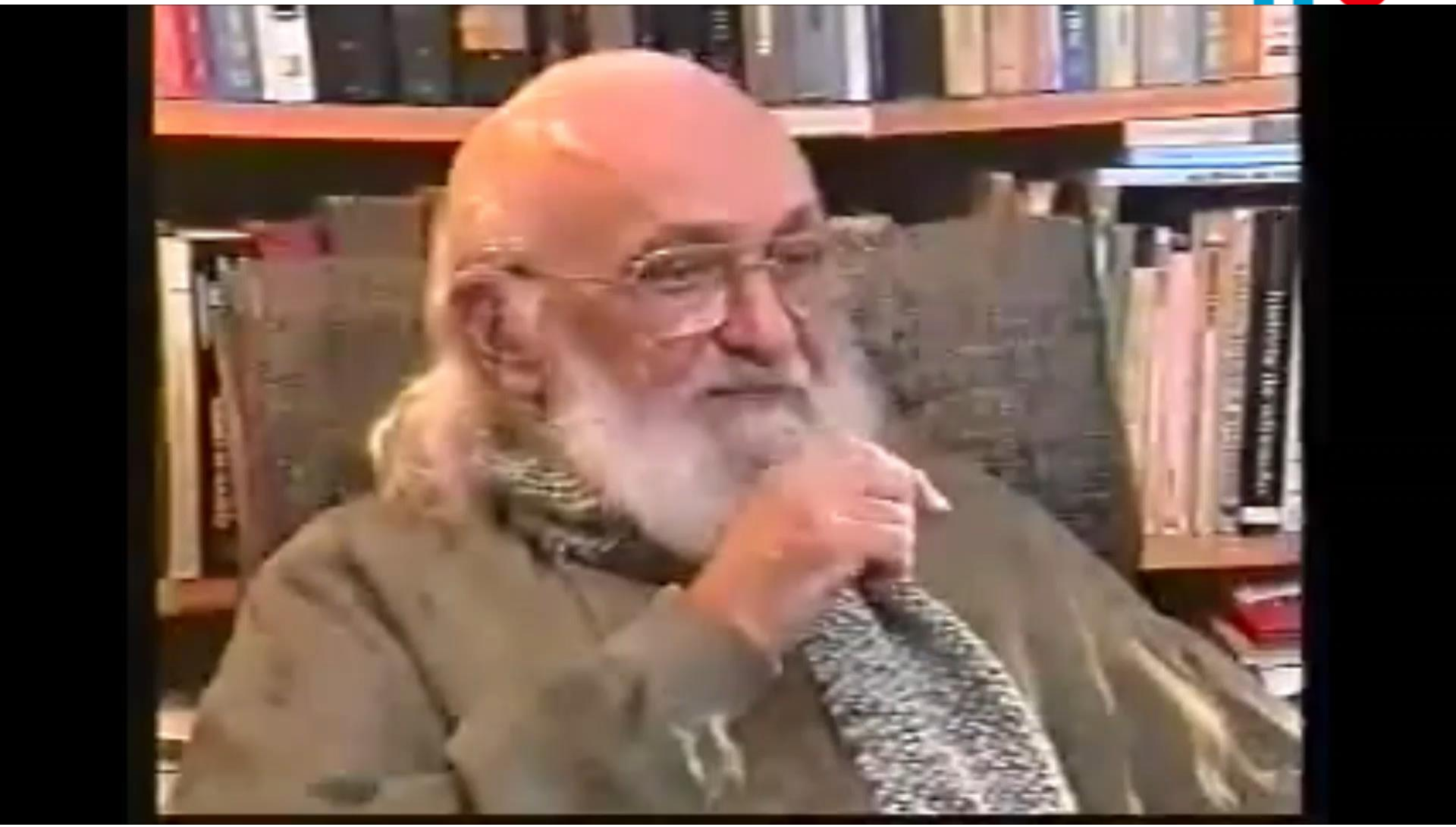

Freire & D'Ambrosio (1992 ICME, sevilla)

https://www.youtube.com/watch?v=o8OUA7jE2UQ

Freire & D'Ambrosio (1996 ICME, Sevilla, English spoken

https://www.youtube.com/watch?v=f3gew78IKI4

English version: 6m10 - 8m 35 e.v.

7m30
8h30 how much is lost
9h25 so our your students to …..
9h42 read verbalise, equivalence,
10h34 natural part

Vulnerability
Empowerment
Autonomy
Free of Anxiety

"Democratize the naturalness of mathematics. This is citizenship."

Integral (integrative, holistic,) perspective

Acknowledging “Numeracy as a social practice”

Implies: Multidimensional aspects

- cognitive and psychological aspects
- multidimensional individual profiles

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Integral (Integrative, holistic,) perspective

Acknowledging that power relations play a role: exploitation, gate keeping and selection, inclusion and exclusion, gender stereotypes about handling numbers, formatting power (or terror) of school mathematics, …

Implies:

- Explicitly take into account in developing education
- Explicitly take into account in assessing and measuring
- Explicitly discuss such topics with learners: they are after all adult citizen

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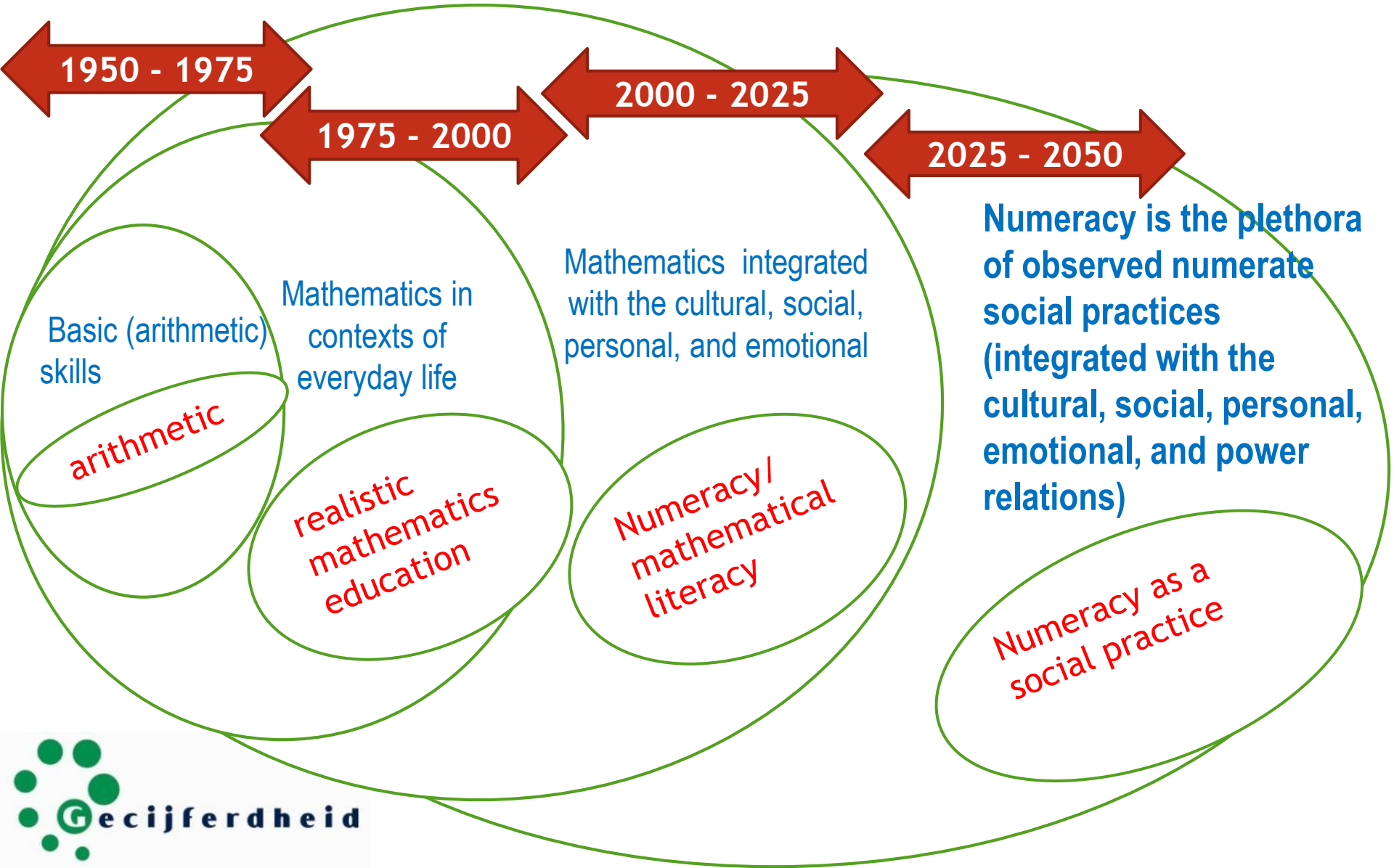
Numeracy conceptual development

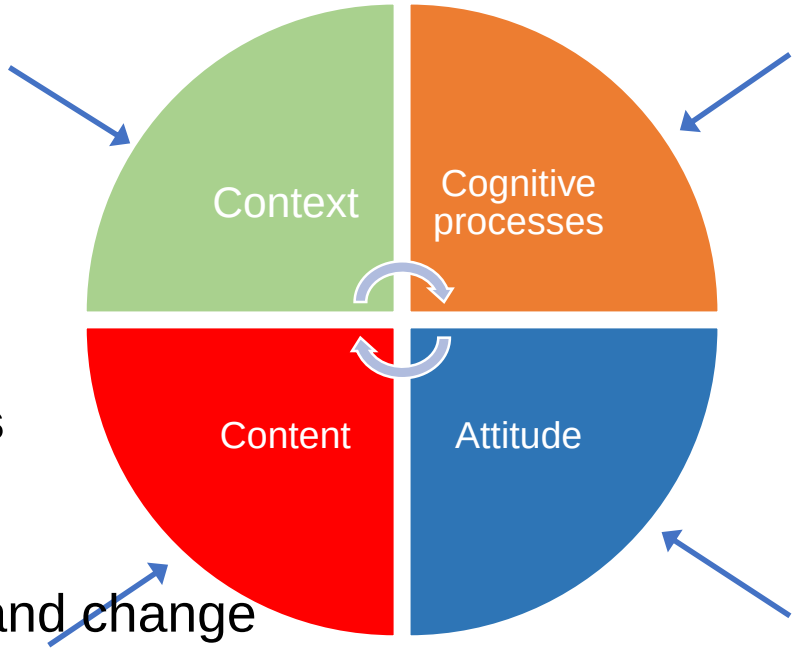


Gecijferdheid

Aspects of numeracy

Context
Everyday life
Work-related
Citizenship
Further learning
Financies
Health and care
Recreation

Higher order skills
Managing situations
Analyzing situations
Processing information
Reasoning
Mathematizing
Problem solving
Critical thinking



Knowledge and skills
Quantity and number
Dimension and Shape
Pattern, relationships and change
Data and chance
Using a calculator
Using spreadsheets
Using digital skills

Attitude
Self-confidence
Affection
Beliefs
Cooperation
Flexibility
Math anxiety
Learning difficulties

Situational demands

Individual competences

Integral (integrative, holistic,) perspective
A numeracy framework

Considering “Numeracy education”

Implies levels / (measurable) goals / progress, implies

- describing behaviour in a “valued system”
- defining progress as a result of educational interventions
- categorizing demands (of e.g., jobs, daily life)
- categorizing test items (of measuring tools)
- categorizing relevant psychological scales

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Common European Framework of Reference for Language (CEFR)

- CEFR symposium 1992 Report of the Symposium (1992)
- CEFR Companion Volume with New Descriptors 2018

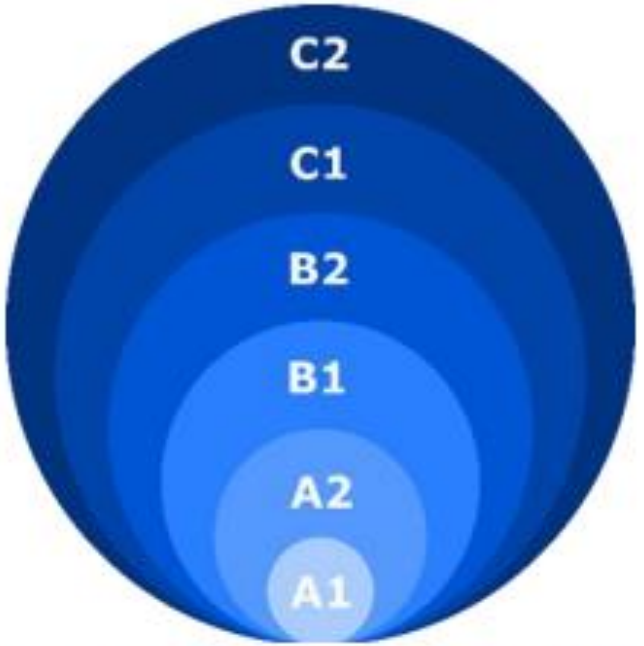

Figure 3 – CEFR Common Reference Levels

CEFR for languages

PROFICIENT USER	C2	Can understand with ease virtually everything heard or read. Can summarise information from different spoken and written sources, reconstructing arguments and accounts in a coherent presentation. Can express him/herself spontaneously, very fluently and precisely, differentiating finer shades of meaning even in more complex situations.
	C1	Can understand a wide range of demanding, longer texts, and recognise implicit meaning. Can express him/herself fluently and spontaneously without much obvious searching for expressions. Can use language flexibly and effectively for social, academic and professional purposes. Can produce clear, well-structured, detailed text on complex subjects, showing controlled use of organisational patterns, connectors and cohesive devices.
INDEPENDENT USER	B2	Can understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in his/her field of specialisation. Can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party. Can produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.
	B1	Can understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure, etc. Can deal with most situations likely to arise whilst travelling in an area where the language is spoken. Can produce simple connected text on topics which are familiar or of personal interest. Can describe experiences and events, dreams, hopes & ambitions and briefly give reasons and explanations for opinions and plans.
BASIC USER	A2	Can understand sentences and frequently used expressions related to areas of most immediate relevance (e.g. very basic personal and family information, shopping, local geography, employment). Can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. Can describe in simple terms aspects of his/her background, immediate environment and matters in areas of immediate need.
	A1	Can understand and use familiar everyday expressions and very basic phrases aimed at the satisfaction of needs of a concrete type. Can introduce him/herself and others and can ask and answer questions about personal details such as where he/she lives, people he/she knows and things he/she has. Can interact in a simple way provided the other person talks slowly and clearly and is prepared to help.

Overall (functional) levels

(Note. categories ≠ tresholds)

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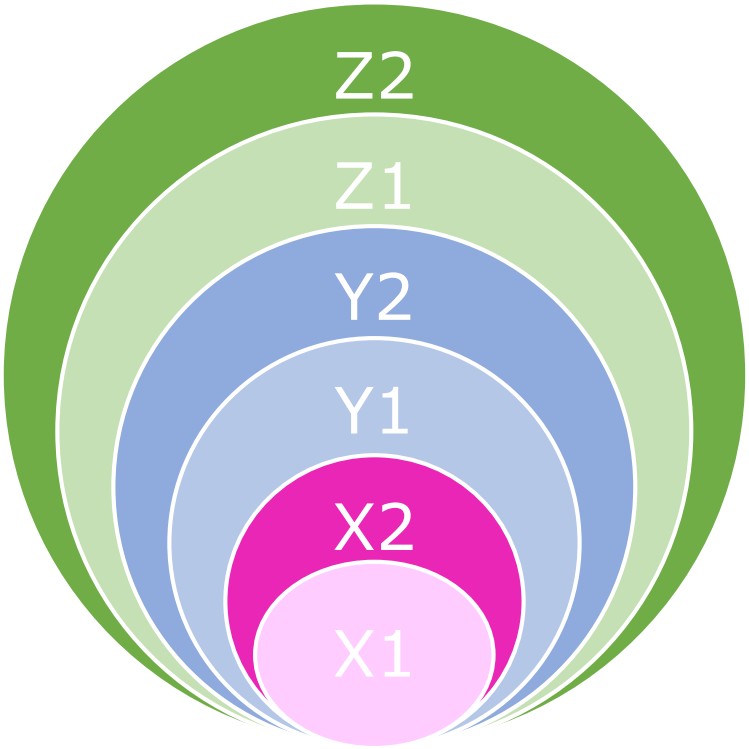
Z Professional use	Z Specialized societal and work situations	Z Proficient user
Y Citizen use	Y Societal and regular work situations	Y Advanced User
X Personal use	X Daily-life situations	X Starting user



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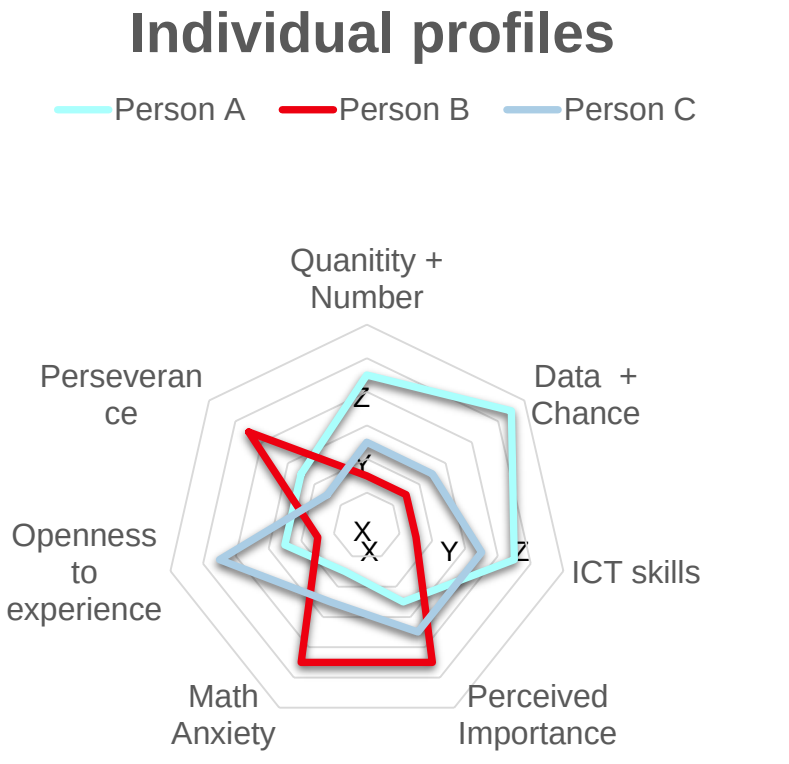
Individual multidimensional profiles



Content

- Quantity + Number
- Space + Shape
- Relationship + Change
- Data + Chance

Other Skills

- ICT skills

Attitude

- Enjoyment
- Perceived importance
- Intrinsic value
- Usefulness
- Confidence in learning
- Math Anxiety

Personality

- Openness to experience
- Conscientiousness
- Perseverance
- Independence
- Self-efficacy

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For each dimension there are measuring tools: tests, observations, portfolio proofs, self-evaluations, ….

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Individual multidimensional profiles

Content

- Quantity + Number
- Space + Shape
- Relationship + Change
- Data + Chance
- …
- …

Other Skills

- ICT skills
- …
- …

Attitude

- Enjoyment
- Perceived importance
- Intrinsic value
- Usefulness
- Confidence in learning
- Math Anxiety
- …

Personality

- Openness to experience
- Conscientiousness
- Perseverance
- Self-efficacy
- …
- …

For each dimension we need measuring tools: tests, observations, portfolio entries, proofs, self-evaluations, ….

1. Which content, skills, attitude and personality dimensions are missing from the perspective of “Numeracy as a social practice”?

2. On which (sub)dimensions are there easy-to-use measuring tools, specific regarding numeracy?

3. Is it possible to make list of the sociological factors, specific regarding numeracy?

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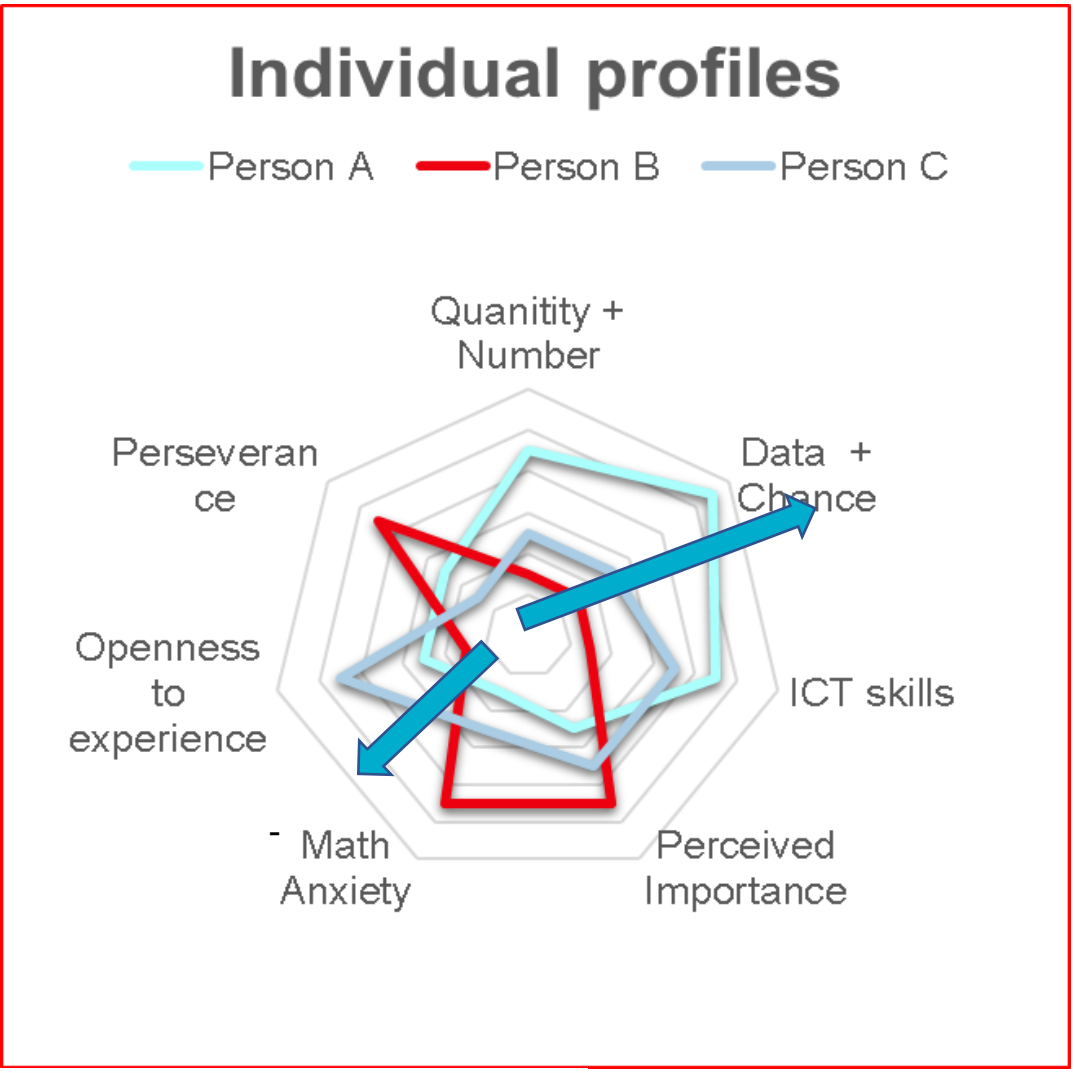
(Hypothetical) Learning Trajectories



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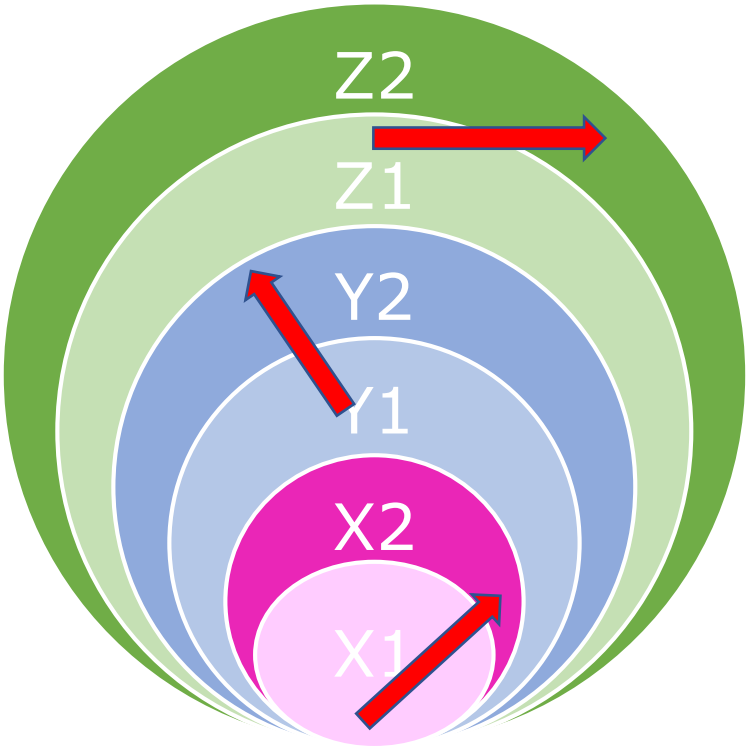

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Case A
Circle the typical level:
X1, X2, Y1, Y2, Z1, Z2

Circle the dimensions that are playing a role

c1, c2, c3, c4,
s1, s2, s3, s4
a1, a2, a3, a4, a5, a6,
p1, p2, p3, p4, p5

Others:
…
…

Case B
Circle the typical level:
X1, X2, Y1, Y2, Z1, Z2

Circle the dimensions that are playing a role

c1, c2, c3, c4,
s1, s2, s3, s4
a1, a2, a3, a4, a5, a6,
p1, p2, p3, p4, p5

Others:
…
…

Case C
Circle the typical level:
X1, X2, Y1, Y2, Z1, Z2

Circle the dimensions that are playing a role

c1, c2, c3, c4,
s1, s2, s3, s4
a1, a2, a3, a4, a5, a6,
p1, p2, p3, p4, p5

Others:
…
…

Case D
Circle the typical level:
X1, X2, Y1, Y2, Z1, Z2

Circle the dimensions that are playing a role

c1, c2, c3, c4,
s1, s2, s3, s4
a1, a2, a3, a4, a5, a6,
p1, p2, p3, p4, p5

Others:
…
…

Name (optional):
E-mail (optional):

Content

c1 Quantity + Number
c2 Space + Shape
c3 Relationship + Change
c4 Data + Chance

Other Skills

s1 ICT skills
s2
s3
s4

Attitude

a1 Enjoyment
a2 Perceived importance
a3 Intrinsic value
a4 Usefulness
a5 Confidence in learning
a6 Math Anxiety

Personality

p1 Openness to experience
p2 Conscientiousness
p3 Perseverance
p4 Independence
p5 Self-efficacy

Case A - Characteristics

- Shania (27) has 3 children in the age of 1,3 and 8. She lives with her husband in a 3 room apartment. She works part-time in retail shop as shop assistant. She has a school history with a lot of gaps because her parents travelled through the country.
- She wants to understand the stuff her oldest kids get at school.
- She has problems with managing the household budget.

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Case B - Characteristics

- Jeffrey (29) lives from social welfare or little jobs on construction sites. He was bullied at school and did not make much learning progress.
- He is very materialistic but can not always assess the consequences of his action. He has debts.
- His hobbies are fitness, tattoos and dogs. He wants to understand better websites on his hobbies.

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Case C - Characteristics

- Archie (51) is a truck driver. He spends weeks in a row on the road. He can work quite well with the digital equipment in his truck. He wants a more regular job maybe in IT or in delivery for on-line shops.
- He has no formal qualifications because of some family problems in his youth.

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Case D - Characteristics

- Andrea (23) wants to have her own company. She is very good in selling things by phone from a call centre. She says: “I am not a number person. Every number scares the hell out of me.”
- She already started with courses a few times but dropped out when numeracy was involved.”

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Implication for education

Changing focus:

- More critical dialogues with the participants than “teaching” or “working through digital series of exercises”.
- Most on the time spent much more (most of?) time on interpretation and understanding
- Camouflage courses for groups with vulnerabilities (Health, debts, unemployment,…)
- Problem solving and mathematizing

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Common European Numeracy Framework

- Content
  - Domains (as in PIAAC, PISA; as in mathema curricula)
  - Big ideas in Mathematics
- Cognitive processes (higher order skills / 21st century skills)
  - Problem solving, reasoning, modelling, ….
- Affective aspects
  - Attitudes / qualities: self-efficacy, self-confidence, no math anxiety, critical interpretation, …
- Contexts / Themes /Life
  - Work, daily-life, in house, in society, public domain (politics, media), private domain (shopping, economic domain (money, rent & mortgage, …)

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Some statistical sidesteps

Include dimensions in models !!

- $\tilde{\theta} = \alpha\theta + \varepsilon$ estimate individual cognitive capacity by some test
- Individual educational outcome

  $$\text{IEO} = \alpha\theta + \sum_{j=1}^{k} \beta_j X_j + \varepsilon$$

- Macrolevel Educational Outcome =

  $$\text{MEO} = \sum_{i=1}^{n} (\alpha_i\, \theta_i + \sum_{j=1}^{p} \beta_{i,j} X_{i,j} + \varepsilon_i)$$

- Macrolevel + Sociological dimensions

  $$\text{MSEO} = \sum_{i=1}^{n} (\alpha_i\, \theta_i + \sum_{j=1}^{p} \beta_{i,j} X_{i,j} + \sum_{k=1}^{m} \gamma_{i,k} Y_{i,k} + \varepsilon_i)$$

Developing the CENF in Erasmus+

- Policy input
  - The **2019 European Numeracy Survey** across Europe (UL, Ireland)
  - Personal en professional networks around adult numeracy education
- Theoretical input
  - Systematic Literature Review on Numeracy (UB, Spain)
  - Existing supranational frameworks
    - PIAAC (1st and 2nd cycle) / PISA 2015, 2021 (OECD)
    - Principles and Standards (NCTM, USA)
    - ACARA, Australia
- Empirical Input
  - Professional development modules and trials (BFI, Austria)

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Challenges for the adult numeracy community (and beyond)

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- Redefine basic skills in (more) relevant cognitive processes and their manifestations (See e.g., PIAAC second cycle)
- Connect research and development with some common framework and ideas.
- Systematically acknowledge multidimensionality when dealing with numeracy (research, teaching, professional development, ….)

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End of presentation

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For information, collaboration, and comments, please contact Kees Hoogland

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Editor of Adults Learning Mathematics – International Journal ALM-IJ

Fellow of the International Society for Design and Development in Education

Chair of the Thematic Working Group - Adult Mathematics Education - at CERME 11 (Utrecht, 6-10 February 2019)