Currículo para o Século XXI 2017

Conferência Internacional

Pensar a Matemática

Energizers and hindrances for the design and implementation of mathematics curricula

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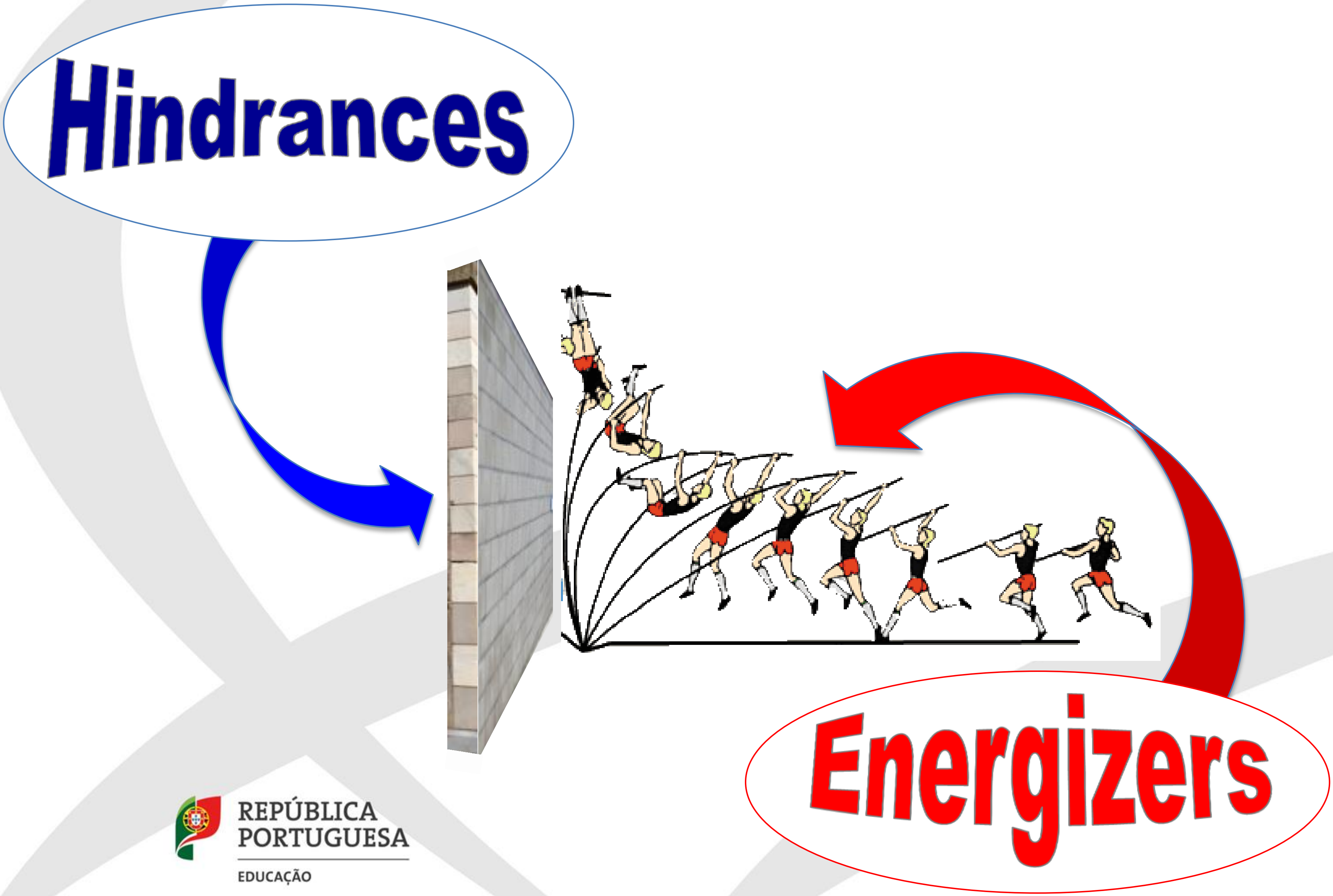
A metaphor for my talk



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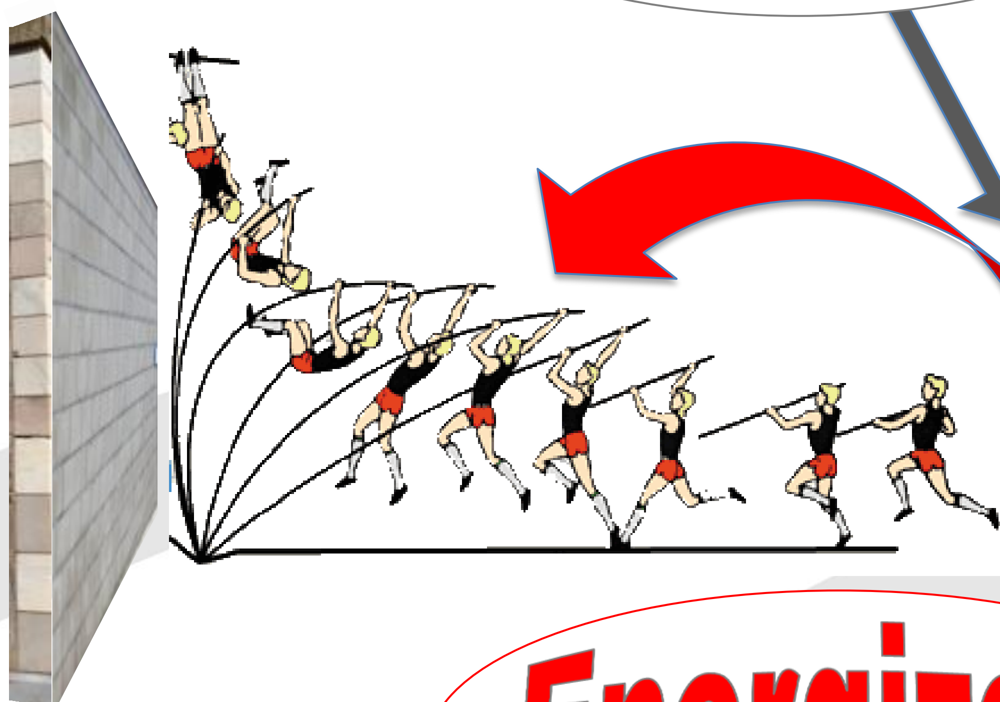
A metaphor for my talk

Hindrances

Ambiguities



Energizers

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Overview

XXI century society: a challenge for curricula

A multidimensional framework for curricula

Energizers for acting on teachers' beliefs:

- Technology
- Assessment
- Teachers' education programs

Hindrances for learning:

- Technology
- Gender gap in Mathematics

Paideia 2.0: an example

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XXI century society: a complex challenge for curricula

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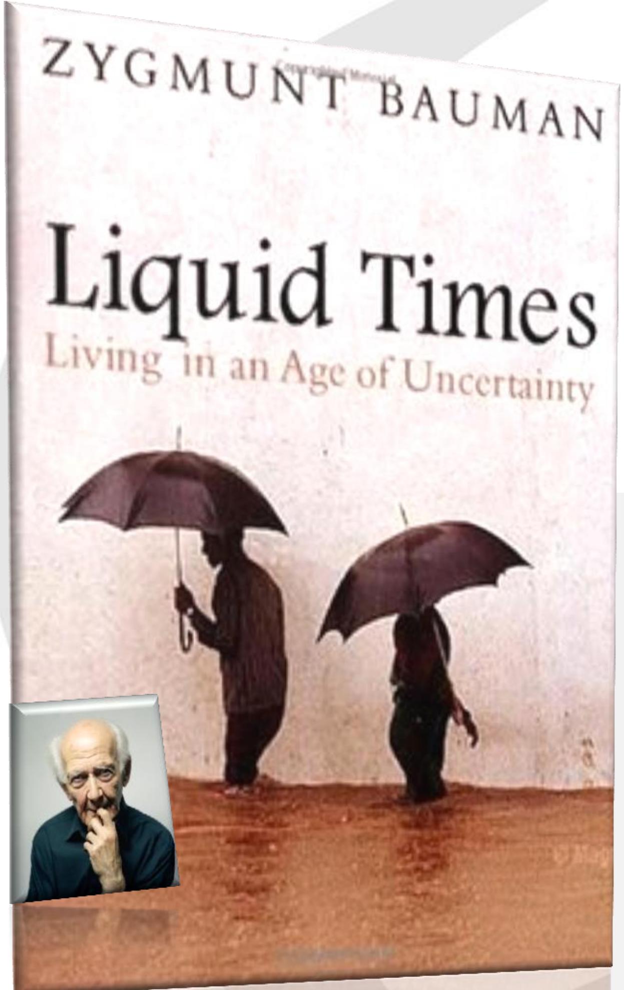

Liquid Times:

- Constantly changing conditions
- Uncertain future
- Collapse of long-term thinking
- Focus on short-term goals
- Focus on individual responsibility
- Risk is to stand still

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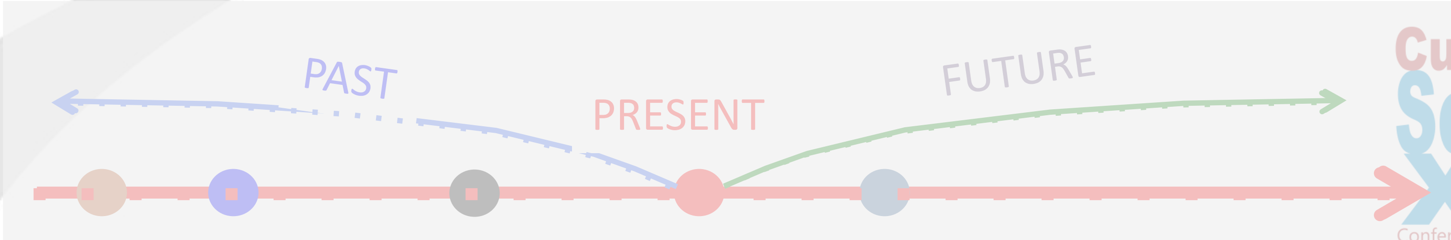

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- *Pointillist time*
- *Nowist culture:* dissolution of the plot that connects the present with the past and with the future
- *Lack of narratives:* the fragments threaten to become hegemonic.

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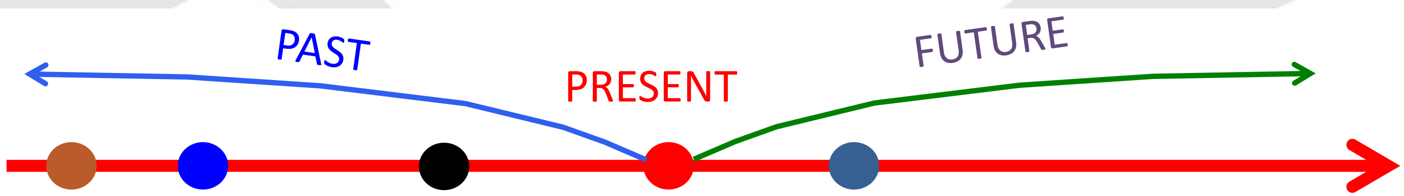
Too much information **= Zero** information

Towards a παιδεία 2.0
(= paideia + "liquid" practices)

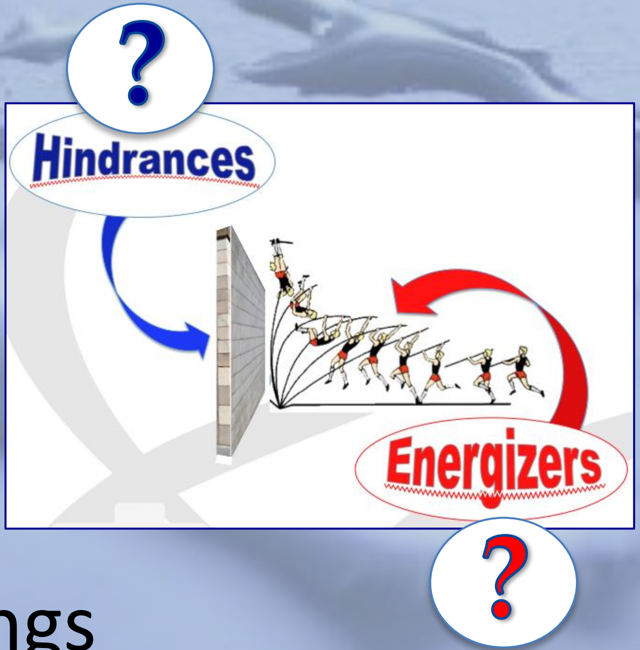
- Against pointillist time
- Reconstructing narratives
- Reconstructing intersubjective links
- Using the ICT affordances for surfing through the liquid society



Liquid practices

ICT (e.g. Mobiles) affordances
to enable learning in liquid society:

Accessing
Sharing
Building
Co-creating
Supporting
Managing
Across settings
Across time



(Franziska Trede, 2016)

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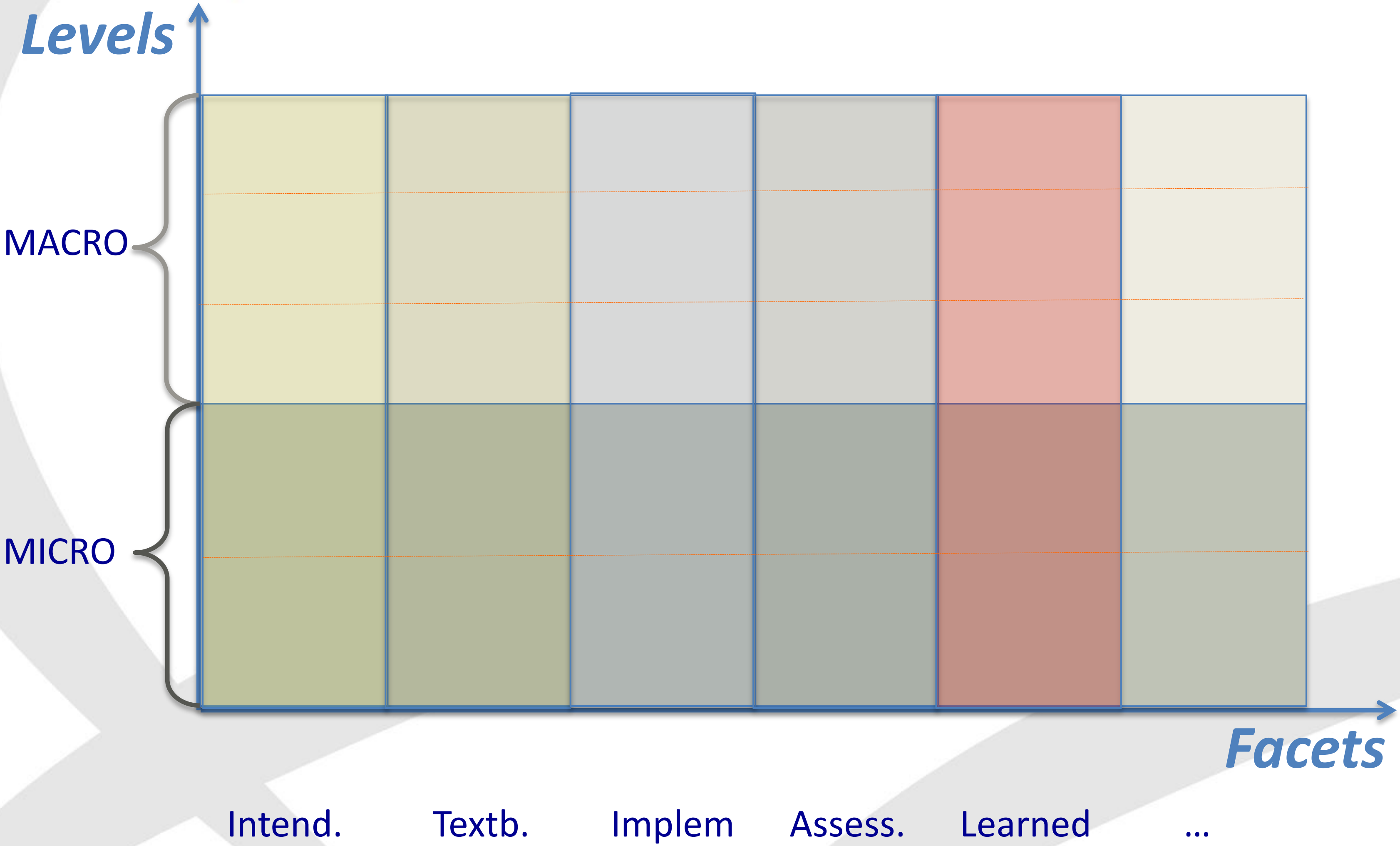
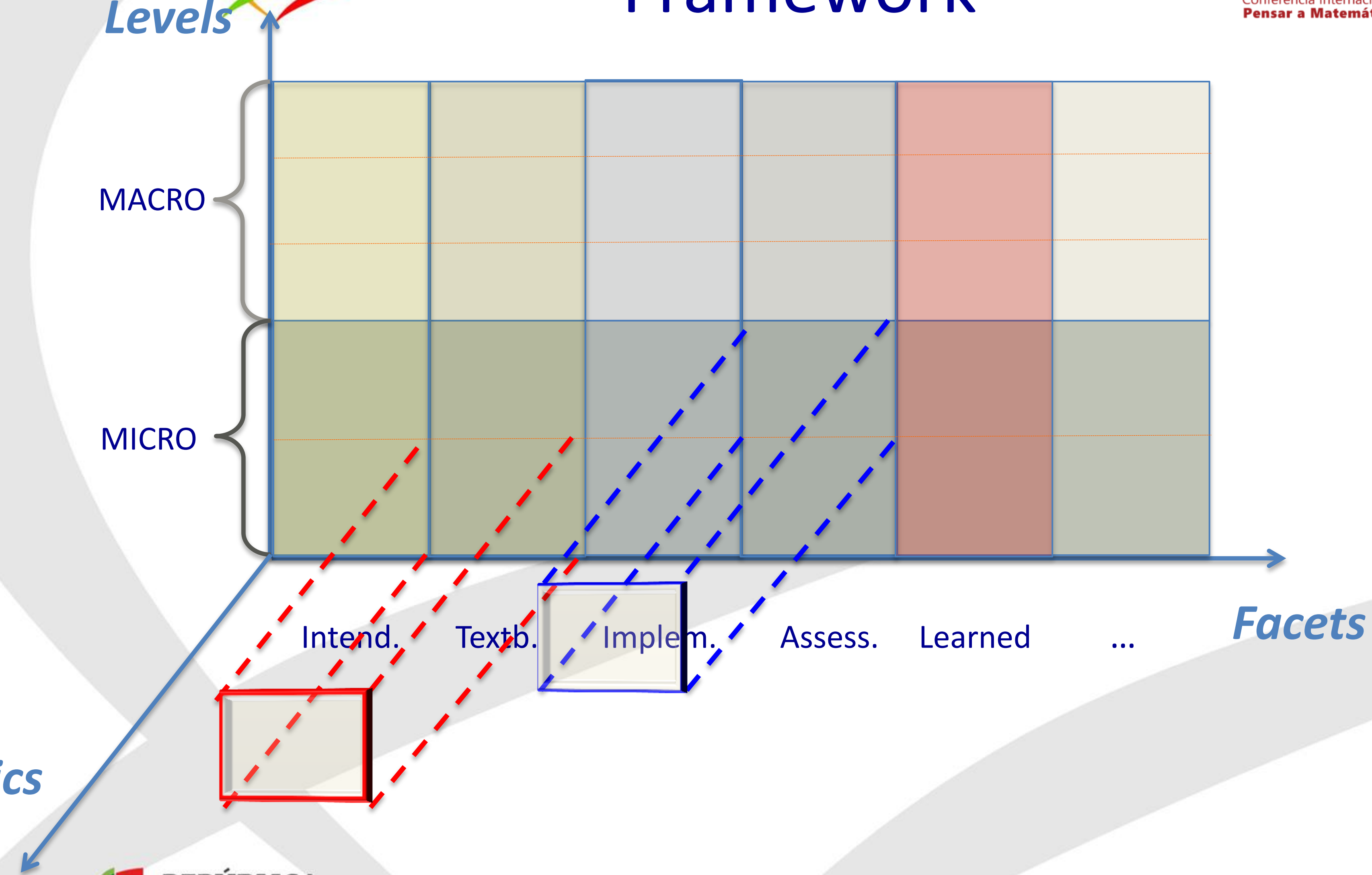
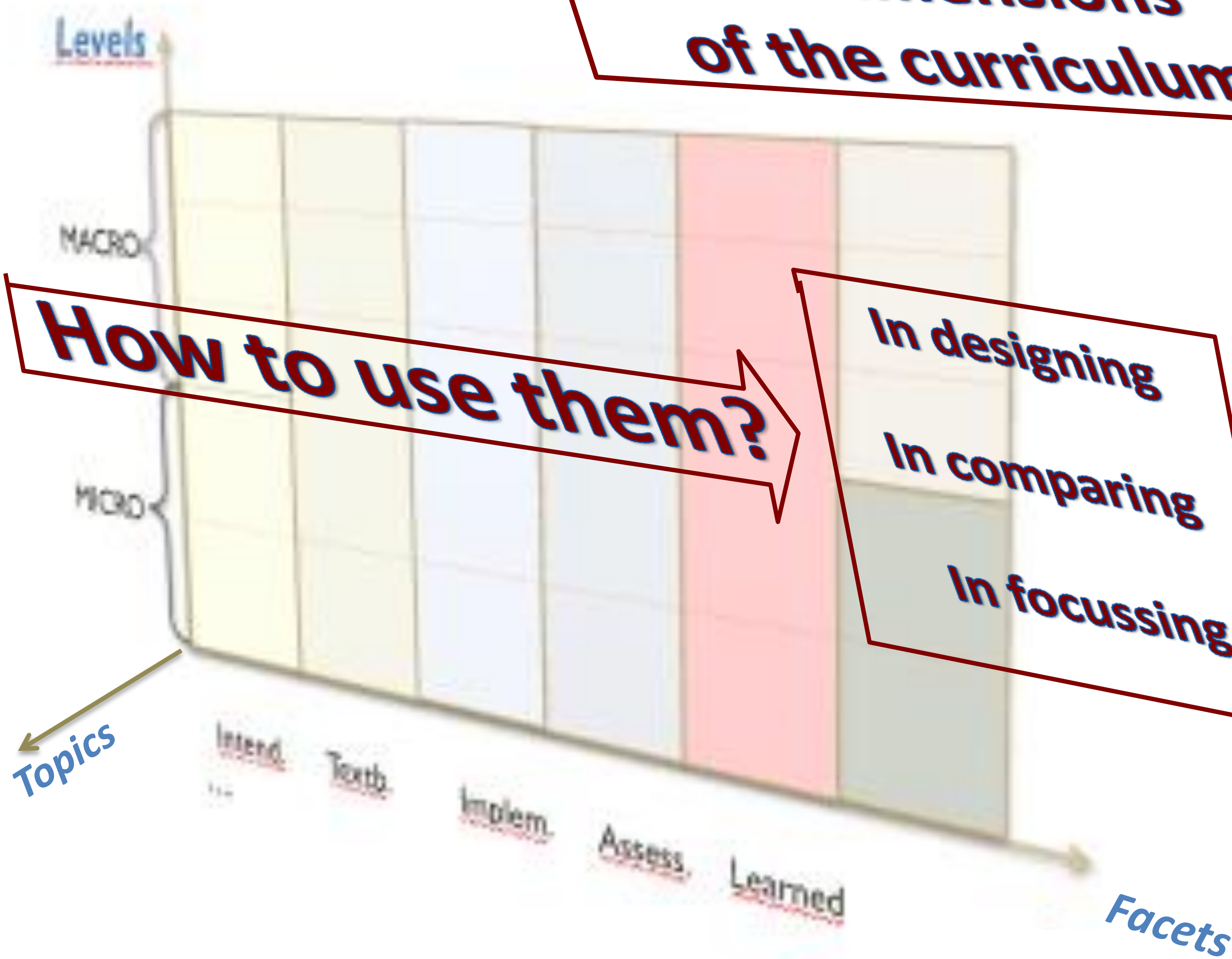
A multidimensional Framework



A multidimensional Framework



The dimensions of the curriculum



How to use them?

In designing

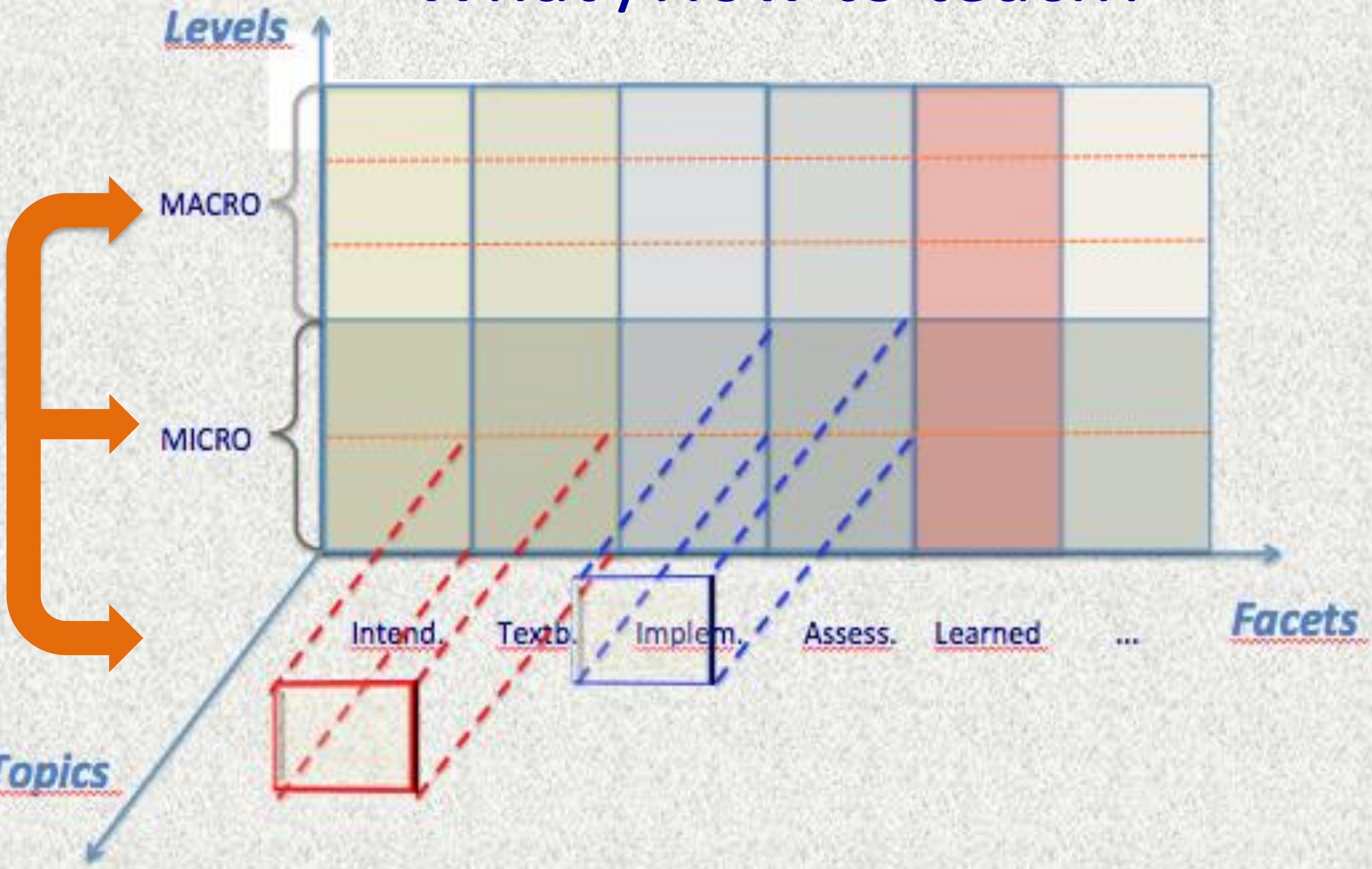
In comparing

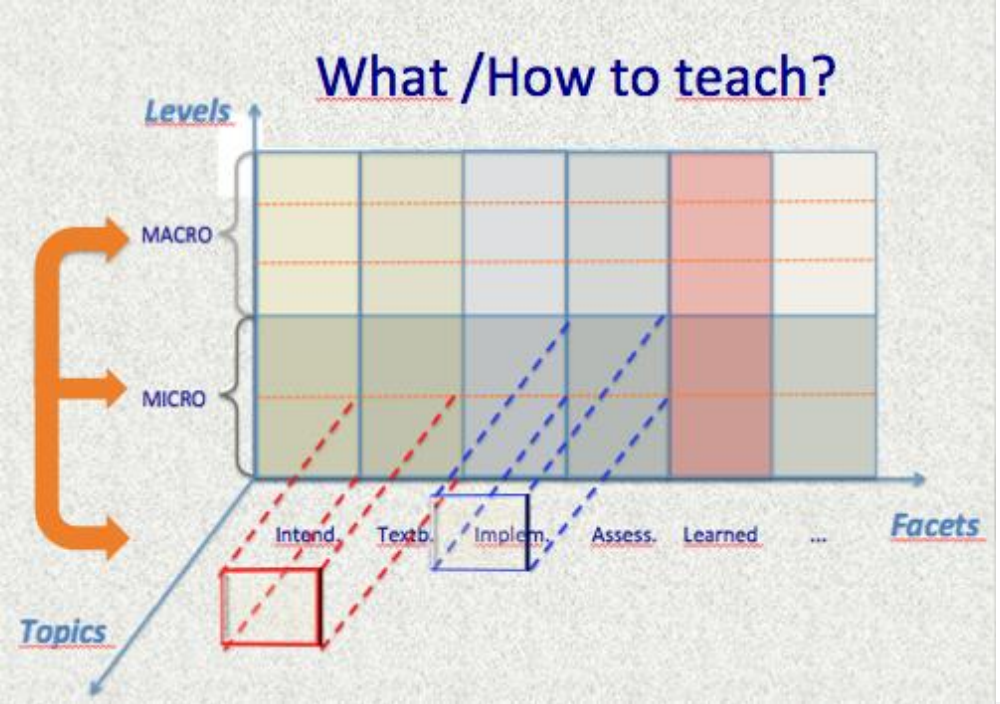
In focussing

Curricola

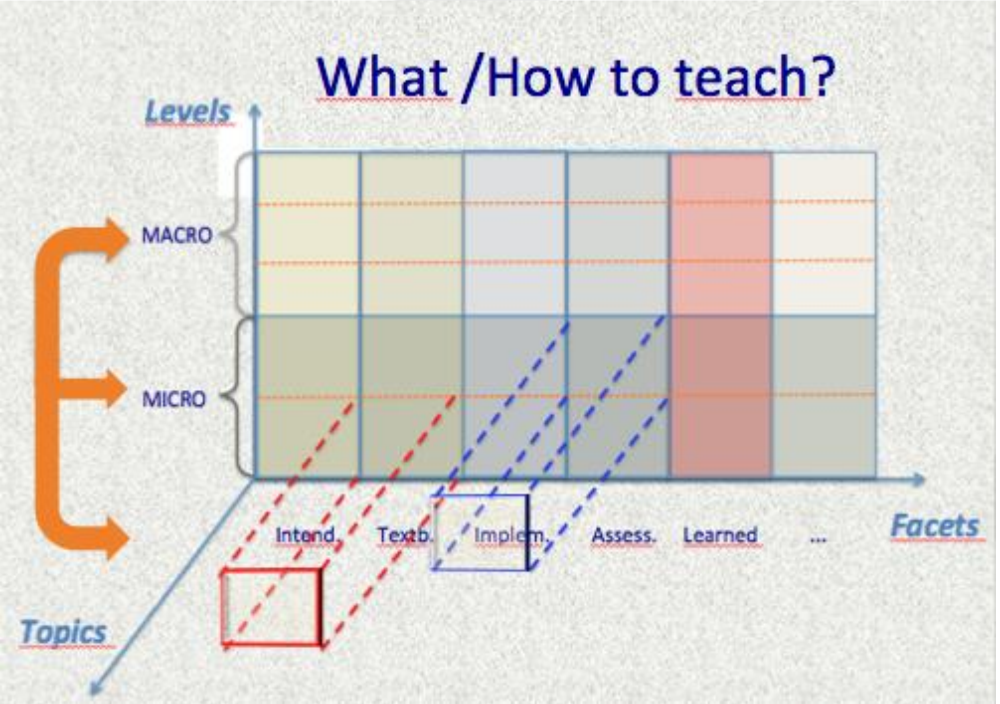
1a. Designing Curricula: a complex task

What /How to teach?





*The development of a school curriculum must take into account both the **instrumenta**l and the **cultural** function of mathematics: it is an essential instrument for a quantitative understanding of reality and logically coherent and systematic knowledge characterised by a strong cultural unity.*



The teacher is supposed to tackle these themes in an integrated manner, trying to connect them to other topics and to other subject disciplines.

Many examples are necessary to give the sense of the integration of the three structural components.

1b. Comparing Curricola: the risk of ambiguity

The structural description of curricula can be an antidote against possible mistakes done when analysing curricula for different purposes: comparisons, assessments, content, …

The complexity of the structure shows how complex any analysis should be and how easy can be drawing superficial or wrong conclusions because some level or facet is forgotten.

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As E. Silver (2009) points out, the intentions and actions of the consumers of international comparisons often rest on too simplistic assumptions about the relationship among the various interactive constituent parts of the education system in a country: official curriculum goals, textbooks used in schools, teaching practices, teacher preparation and ongoing support, and student learning outcomes.

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This superficial approach can have negative consequences: for example policy makers could be induced to undertake programs and give recommendations, which rest on partial or misinterpreted data.

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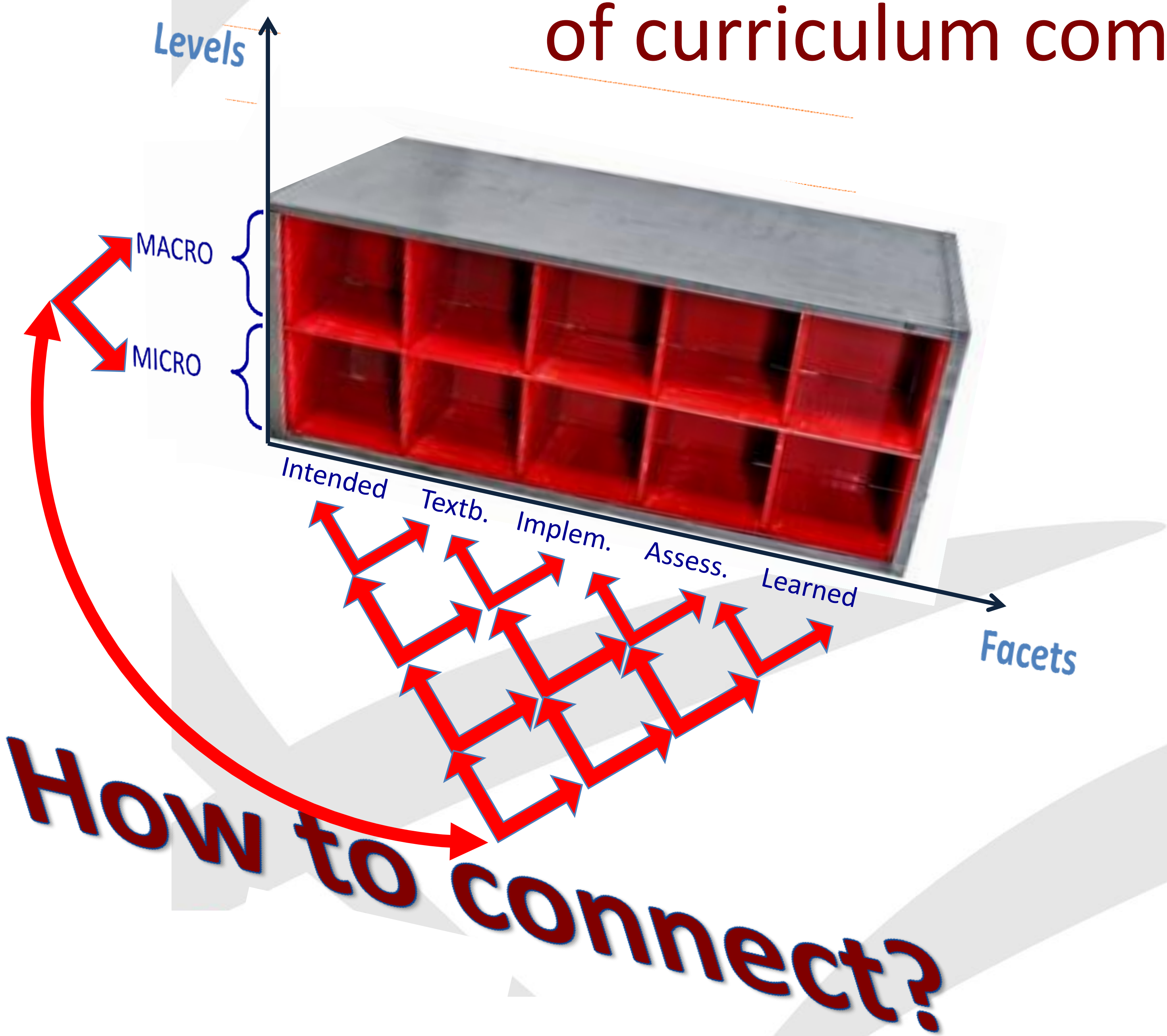
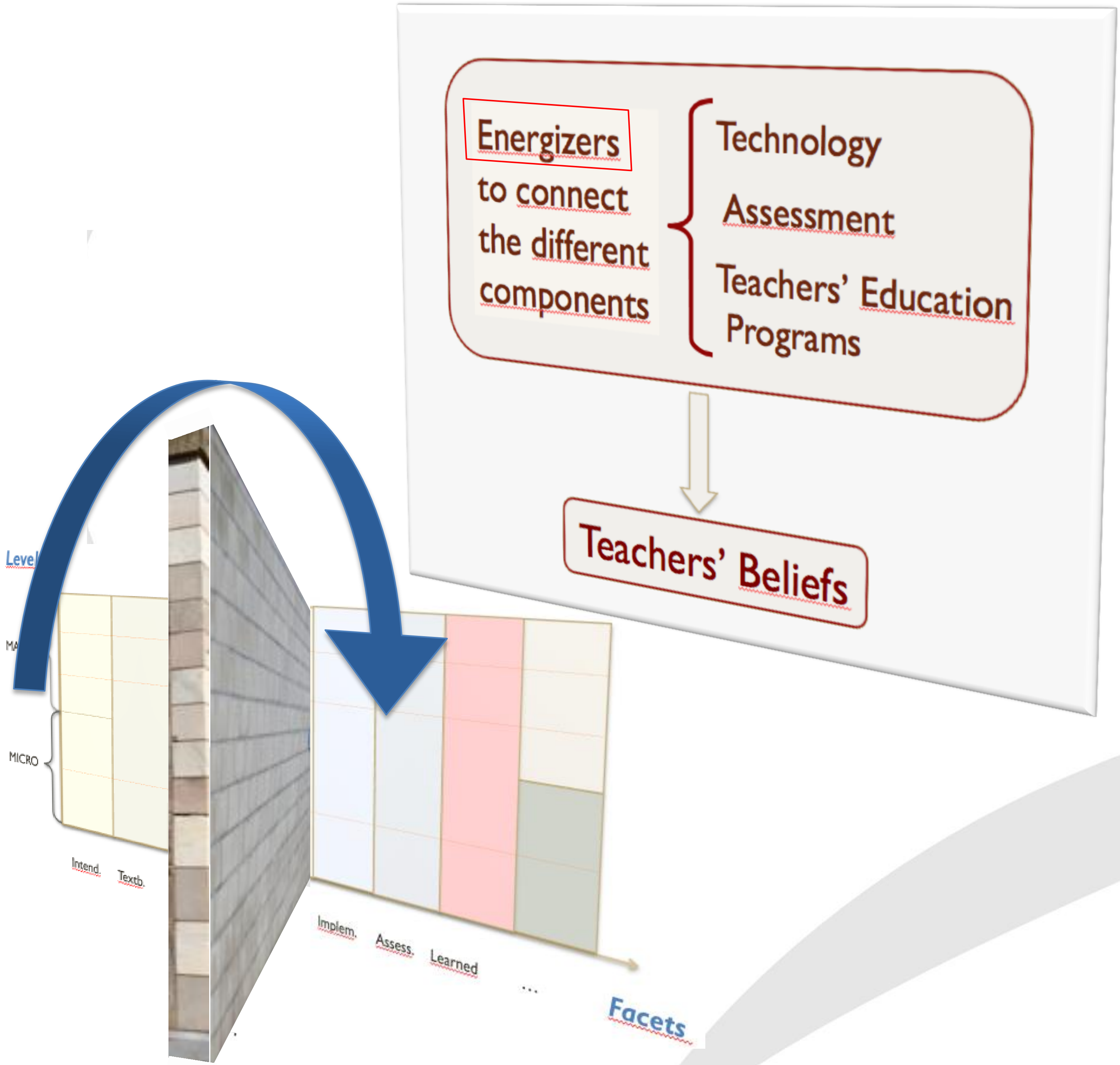
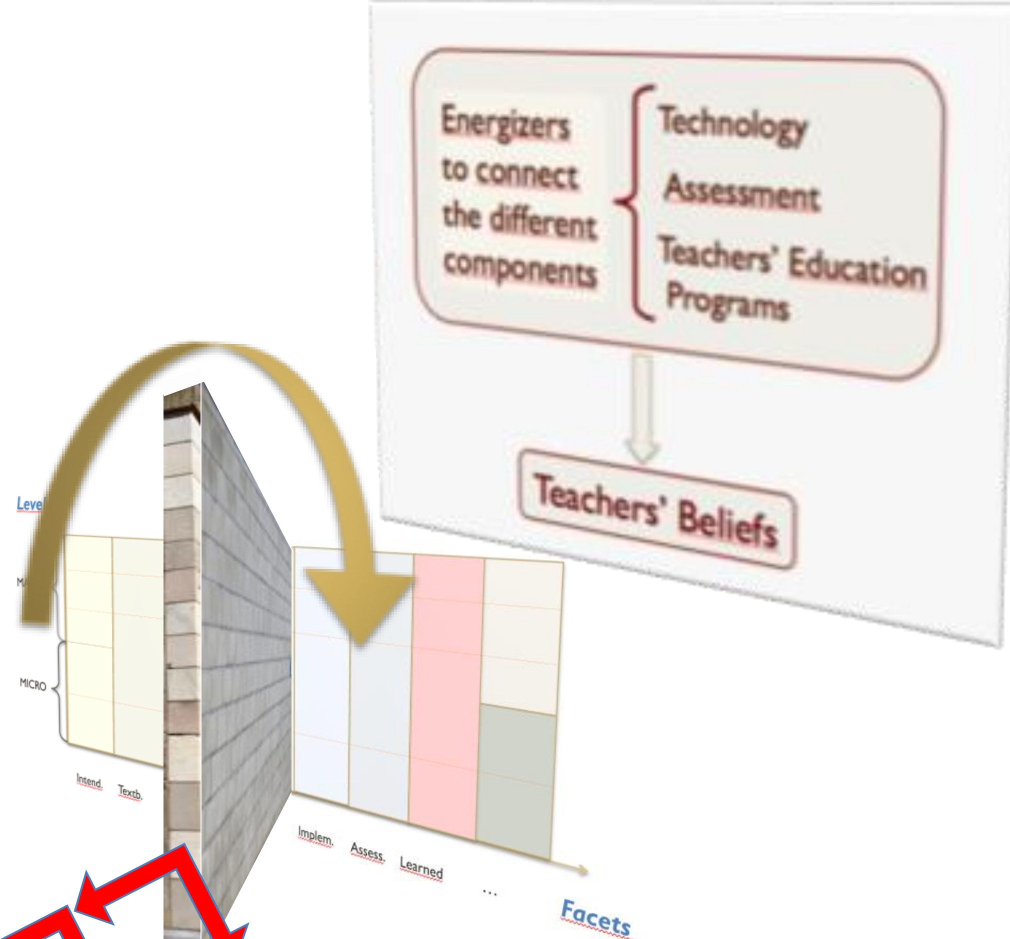
The compartmentalization of curriculum components




Energizers
to connect
the different
components
Technology
Assessment
Teachers' Education
Programs
Teachers' Beliefs
Level
MICRO
Intend.
Textb.
Implem.
Assess.
Learned
…
Facets



Without the contribution of teachers to the elaboration of curricula there is no change in the implemented curriculum.

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A specific frame: Teachers' Beliefs and Curricula

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It is well known that there can be a great difference between the adopted curriculum and the intentions of people or institutions, who designed it, and the ways according to which the curriculum materials (e.g. textbooks) are concretely enacted in the classrooms.
The influence of teachers’ beliefs on this gap between the various facets of curricula is remarkable (e.g. see Kulm & Li, 2009).

Many studies, basing on PISA and TIMSS data, show that, notwithstanding the emphasis given in many curricula to high-level cognitive processes (e. g. reasoning and problem solving), the believes of teachers about the effective ways they can teach mathematics to “mean achievers” students are at the origin of the limited opportunities they give to their students in such processes in their lessons (Silver, 2009).

These beliefs persist in the schools notwithstanding many researches show that a better learning occurs exactly in those classrooms where teaching is based on high-level cognitive demands and not only on stressing procedural instruction.

Research conducted in the past decade or more in a variety of different classroom contexts has found that greater student learning occurs in classrooms where the high-level cognitive demands of mathematical tasks are consistently maintained throughout the instructional episode.

Silver, E. Cross-national comparisons of mathematics curriculum materials: what might we learn? *ZDM Mathematics Education* (2009) 41:827–832.

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of Railside School. *Teachers College Record*, 110(3), 608–645.

Stein, M. K., & Lane, S. (1996). Instructional tasks and the development of student capacity to think and reason: An analysis of the relationship between teaching and learning in a reform.

Tarr, J. E., Reys, R. E., Reys, B. J., Chavez, O., Shih, J., & Osterlind, S. J. (2008). The impact of middle-grades mathematics curricula and the classroom learning environment on student achievement. *Journal for Research in Mathematics Education*, 39, 247–280.

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Energizers to connect the different components

2a. Technology

2b. Assessment

2c. Teachers' Education Programs

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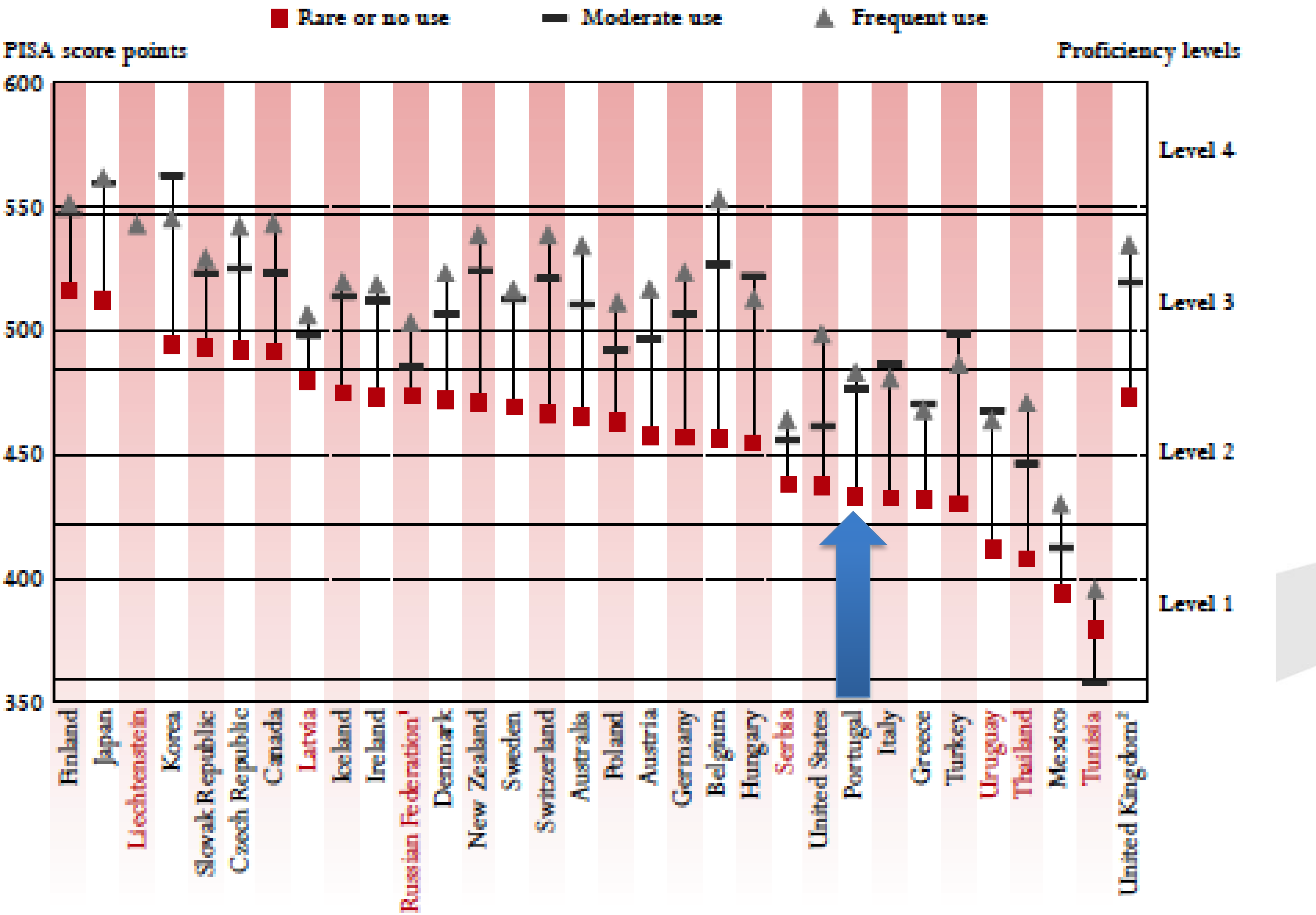
The Technology Principle of NCTM Principles & Standards

Technology:

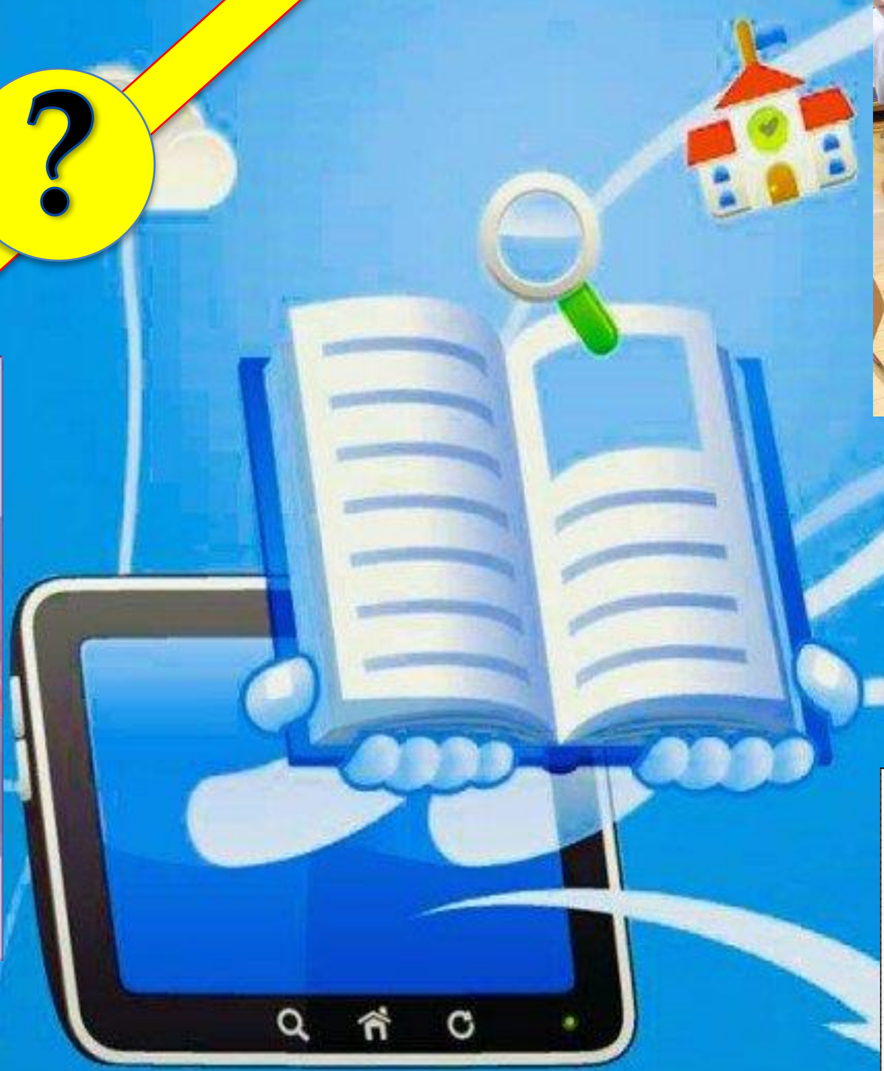
- *enhances mathematics learning ;*
- *supports effective mathematics teaching ;*
- *influences what mathematics is taught.*

Figure 4.5a ■ Frequency of use of computers at home and student performance in mathematics



Towards the digital school !

?



Energizers to connect the different components

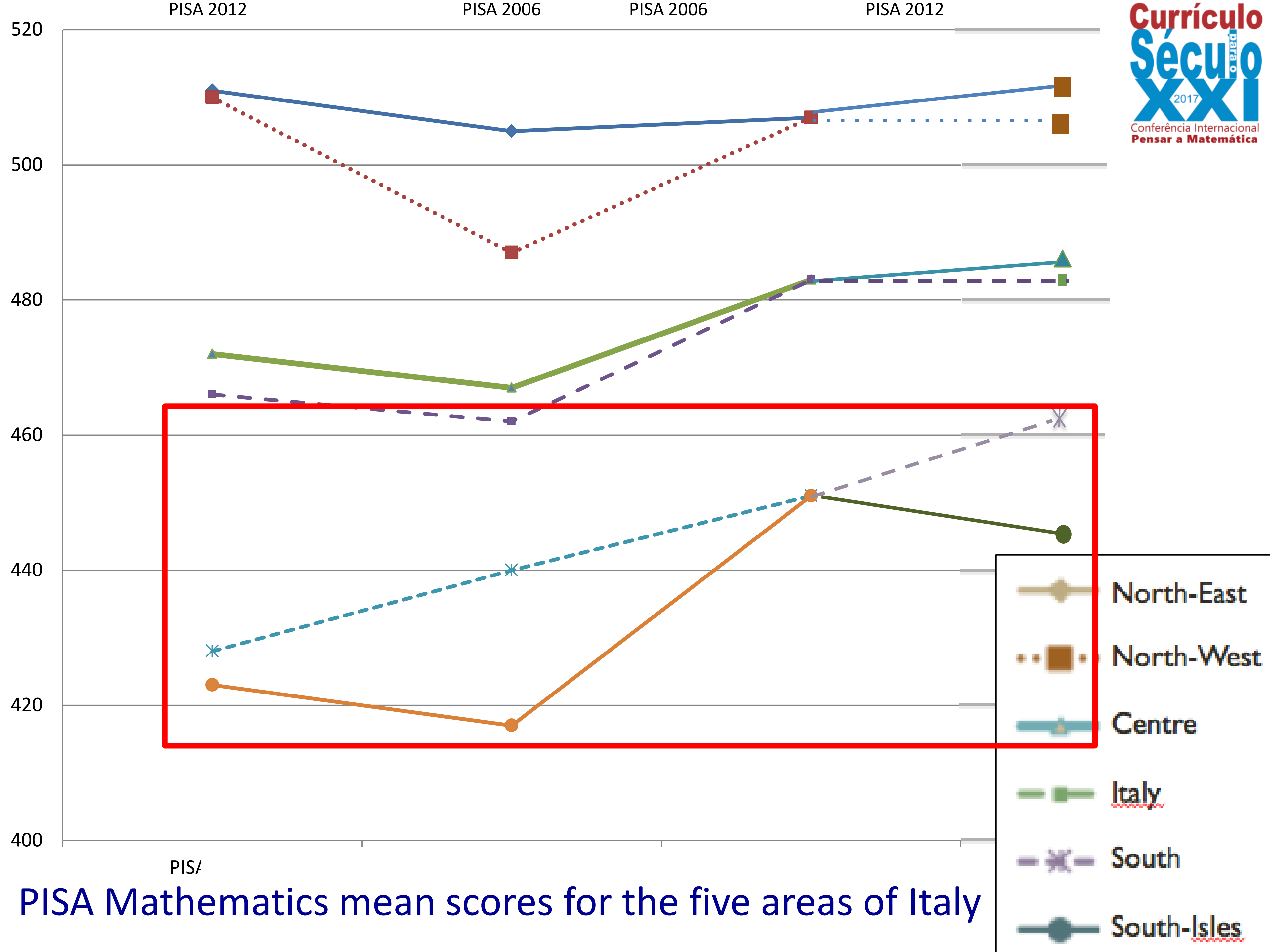
2a. Technology

2b. Assessment

2c. Teachers' Education Programs

CONS: The risk of an education test-oriented

PROS: Possible positive effects in schools’ practices



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PISA Mathematics mean scores for the five areas of Italy

Energizers to connect the different components

2a. Technology

2b. Assessment

2c. Teachers' Education Programs

From the UMI curriculum to the Digital school in Italy

1. 2001-2005: *Mathematics for the Citizen*: an intended curriculum with 200 examples of teaching situations (→ textbook curriculum)
2. 2006-2015: *M@t.abel*: interactive online activities with teachers for improving the implemented curriculum
3. 2012: the official National intended curriculum.
4. 2015: Towards the digital school

Ministero della Pubblica Istruzione

Direzione Generale Istruzione Classica Scientifica e Magistrale

Direzione Generale Istruzione di Primo Grado

Unione Matematica Italiana

QUADERNI 26/1

DOCUMENTI DI LAVORO

Grades 1-8

Ministero dell'Istruzione, dell'Università e della Ricerca

Direzione Generale per la Formazione

Unione Matematica Italiana

Società Italiana di Statistica

Mathesis

Liceo Scientifico Statale "A. Vallisneri" Lucca

La per

Att pro un

Grades 9-12

Ministero dell'Istruzione, dell'Università e della Ricerca

Direzione Generale Ordinamenti Scolastici

Unione Matematica Italiana

Società Italiana di Statistica

Liceo Scientifico Statale "G. Ricci Curbastro" Lugo di Romagna (Ravenna)

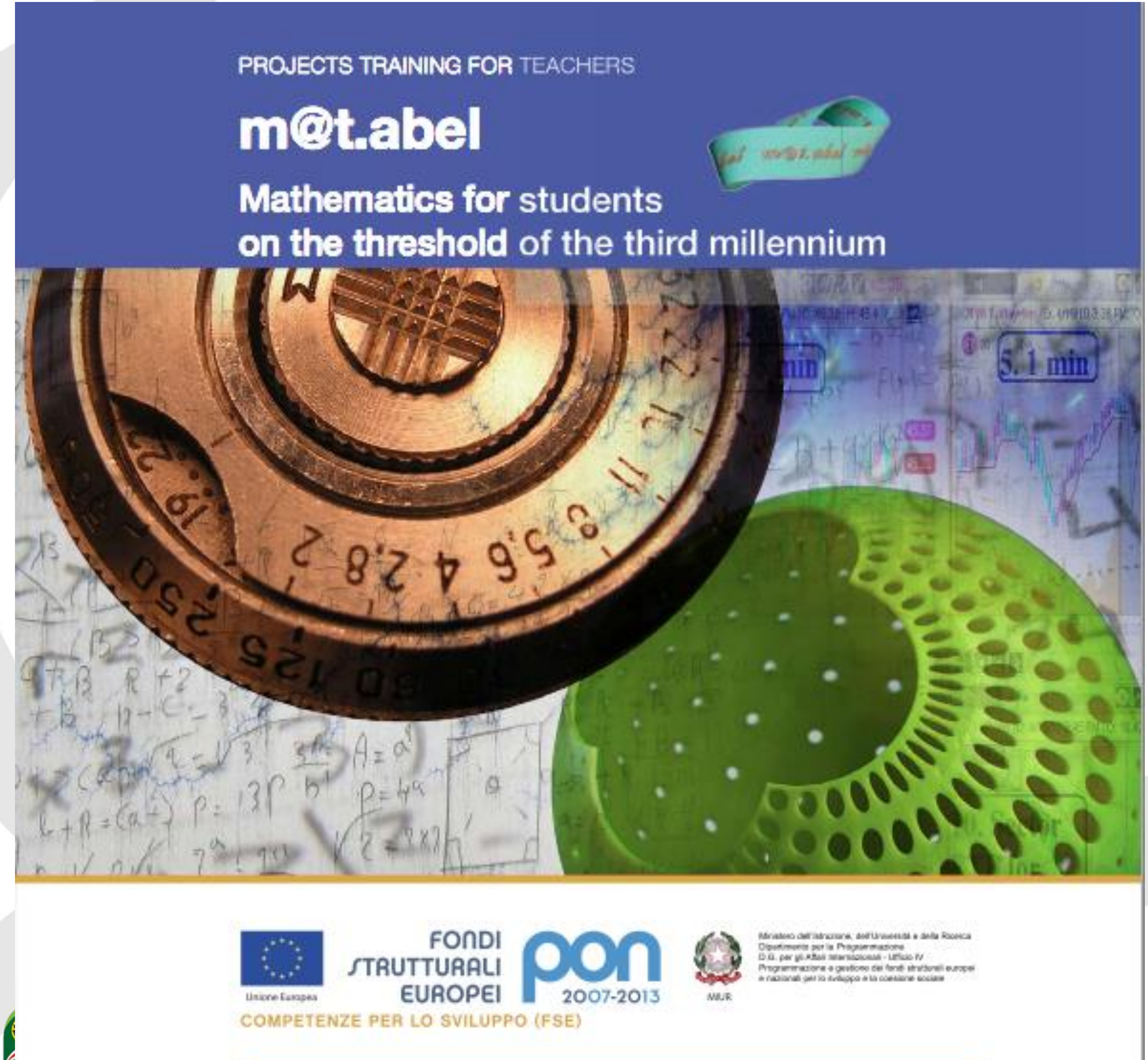
Grade 13

MATEMATICA 2004

La Matematica per il cittadino

Attività didattiche e prove di verifica per un nuovo curricolo di matematica

Quinta classe del ciclo secondario di secondo grado



http://mediarepository.indire.it/iko/uploads/allegati/M7PWITOE.pdf

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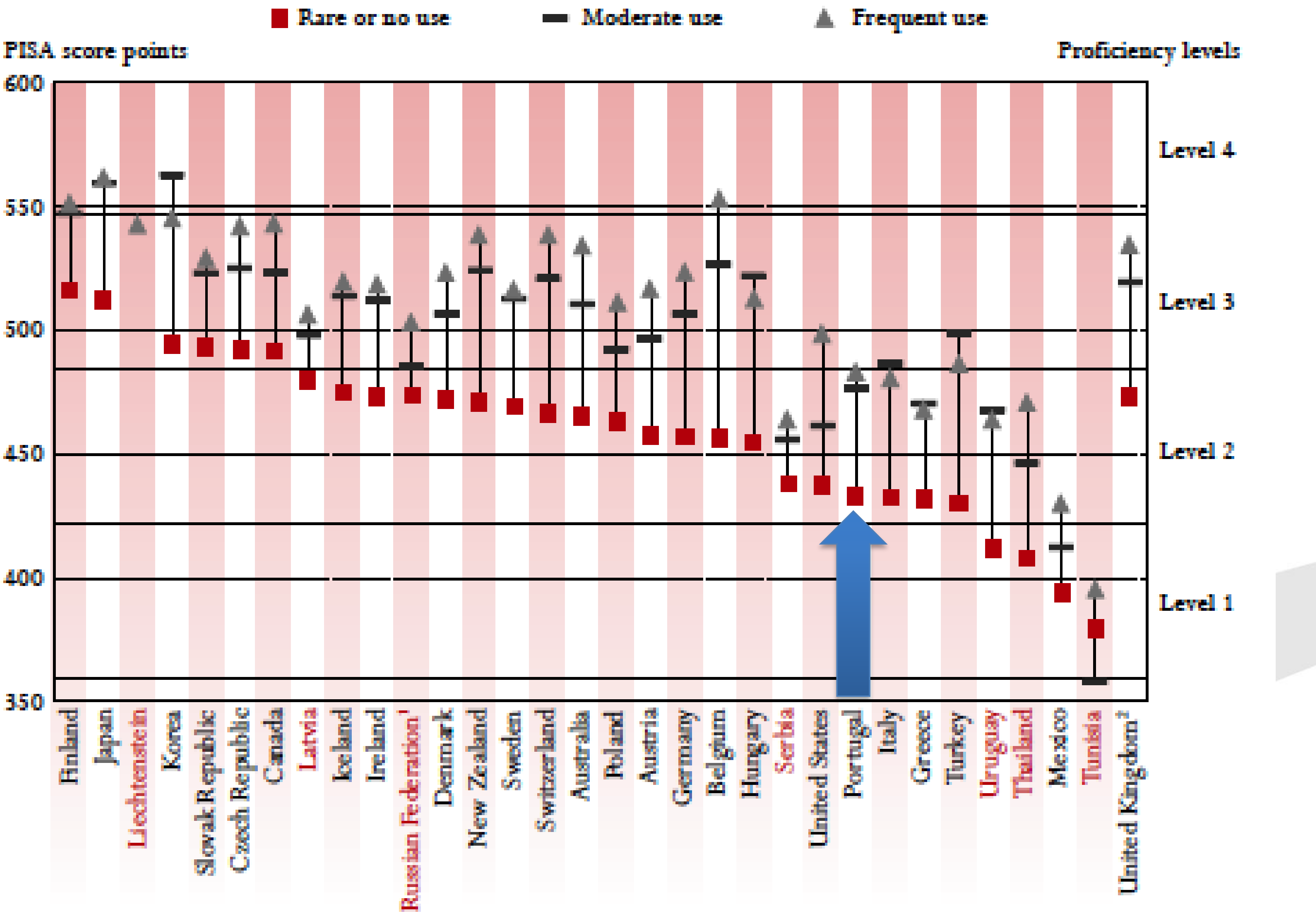
1

PISA and Technology

OECD **PISA**

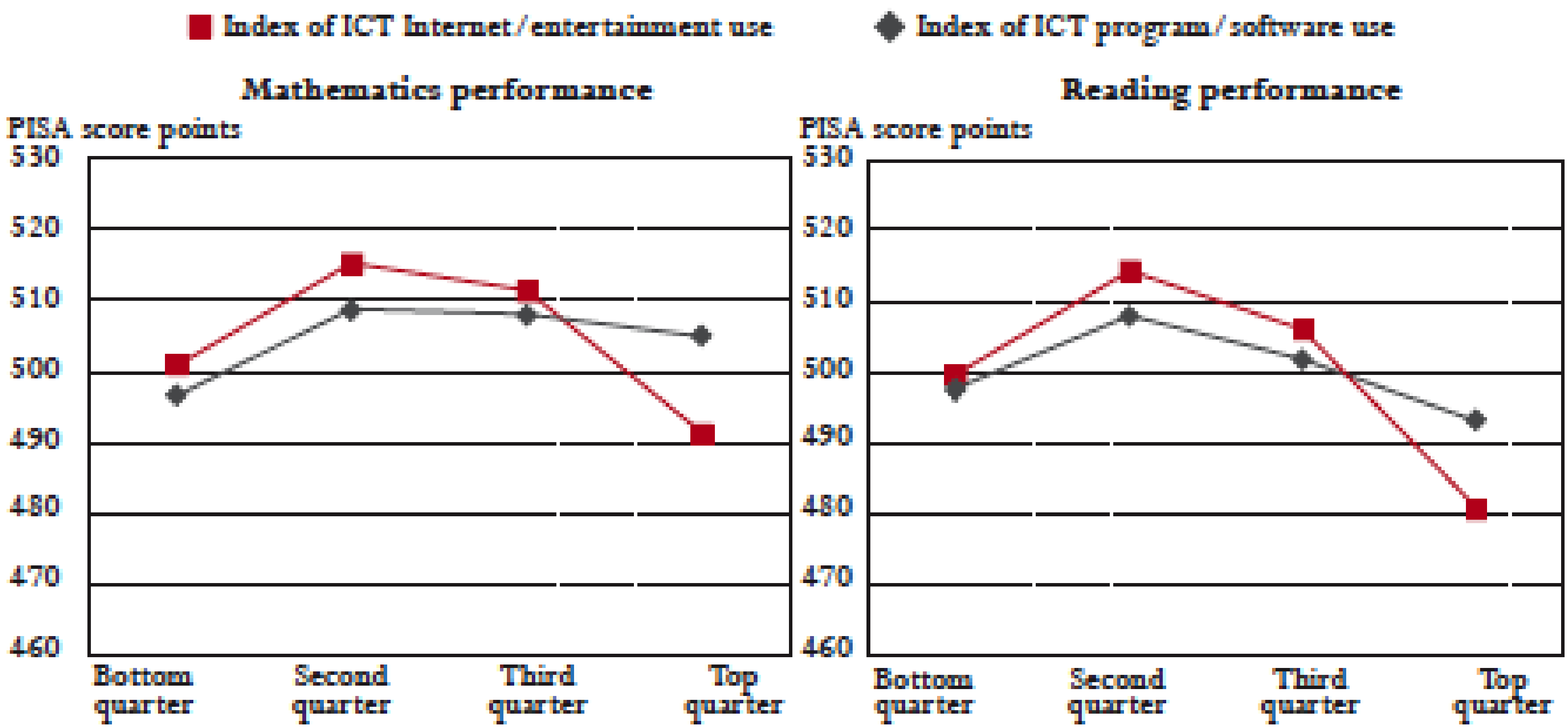
Programme for **I**nternational **S**tudent **A**ssessment

Figure 4.5a ■ **Frequency of use of computers at home and student performance in mathematics**



…however

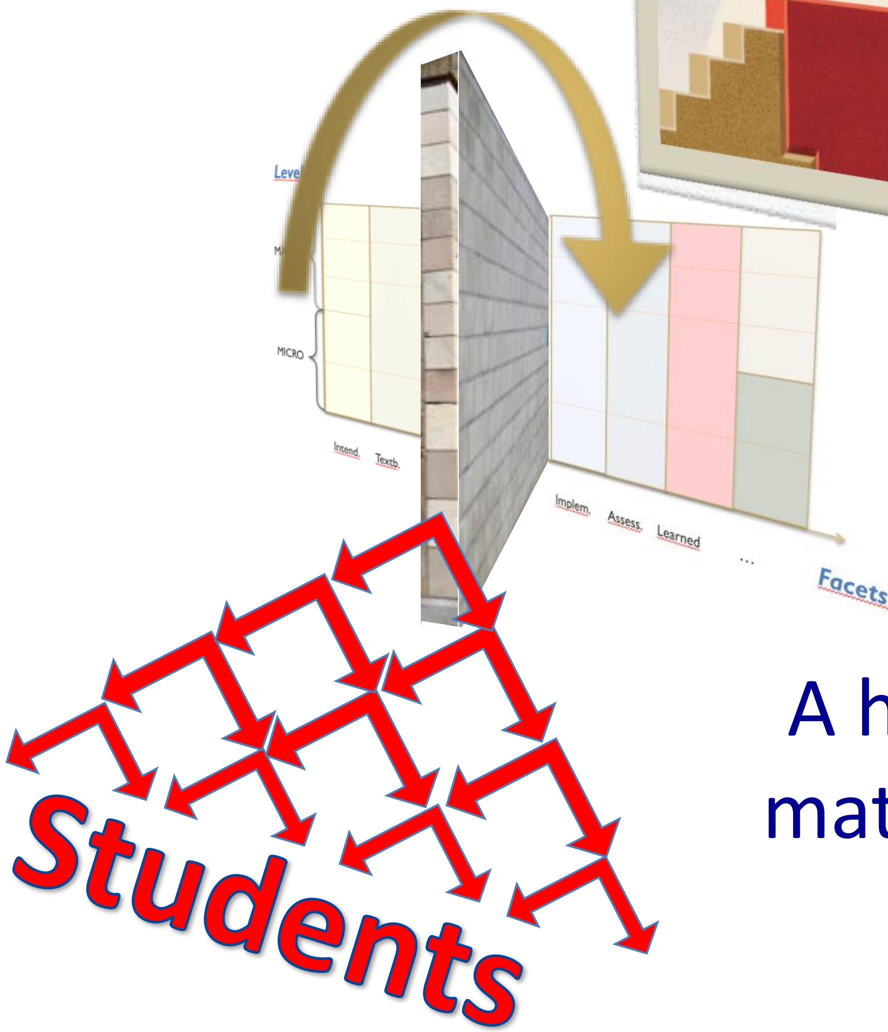
Figure 4.6 ■ **Students' use of ICT and OECD average performance in mathematics and reading, by quarter of the indices**



PISA shows that even when most students have easy access to new media, inequalities persist in the way they use these tools.
The use of online media depends on the student's own level of skills, motivation, and support from family, friends and teachers, which vary across socio-economic groups.

Ensuring that every child attains a baseline level of proficiency in reading will do more to create equal opportunities in a digital world than will expanding or subsidising access to high-tech devices and services.

2



A hindrance variable in mathematics curriculum development:
the gender gap

Boys keep doing better than girls in math tests. According to PISA, the average gender differential within OECD countries in mathematics at age 15 is 0.11 standard deviations in favour of males (OECD 2015).

TIMSS 2015 Mathematics 4th Grade

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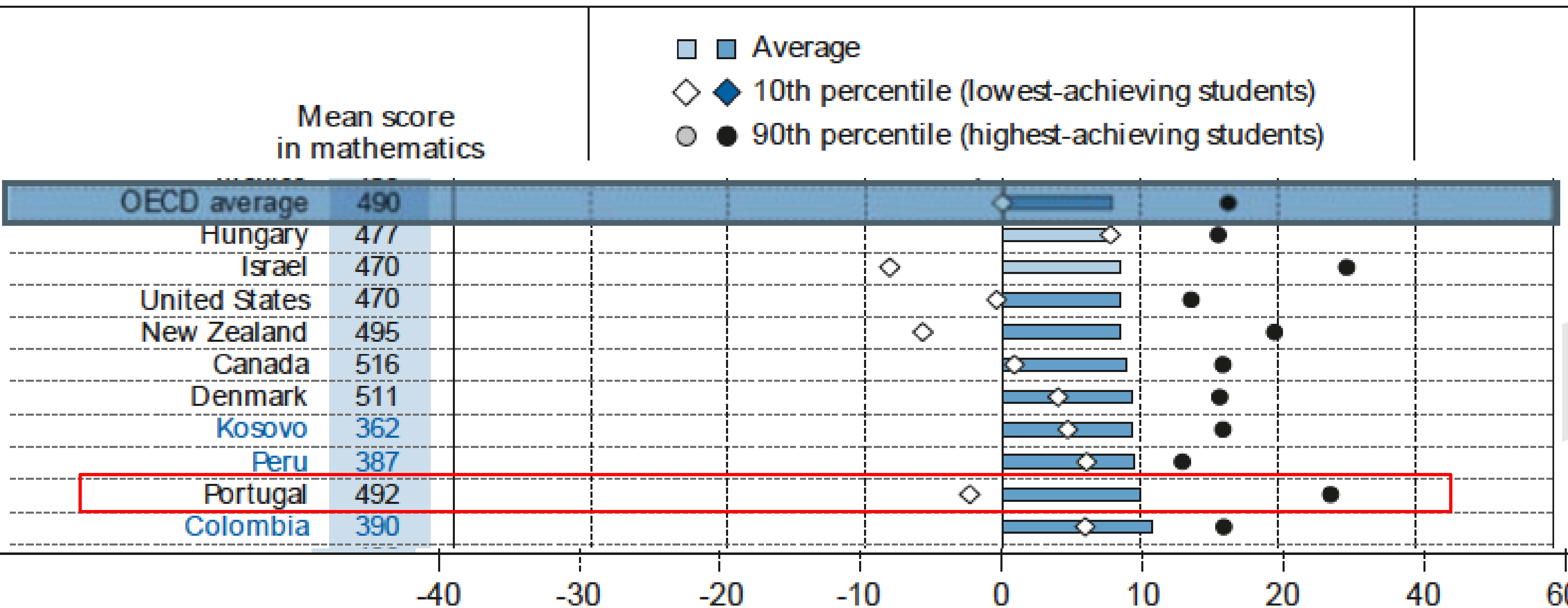
Exhibit 1.10: Average Mathematics Achievement by Gender

Country	Girls		Boys		Difference (Absolute Value)
	Percent of Students	Average Scale Score	Percent of Students	Average Scale Score	
† Hong Kong SAR	46 (1.5)	609 (3.8)	54 (1.5)	619 (2.8)	10 (3.3)
2 Portugal	49 (0.8)	536 (2.4)	51 (0.8)	547 (2.5)	11 (2.2)
Slovak Republic	48 (0.9)	493 (3.0)	52 (0.9)	504 (2.6)	11 (2.6)
2 Spain	49 (0.9)	499 (2.7)	51 (0.9)	511 (2.7)	12 (2.4)
Croatia	49 (0.8)	496 (2.1)	51 (0.8)	508 (2.3)	12 (2.7)
2 Italy	49 (0.7)	497 (2.7)	51 (0.7)	517 (3.0)	20 (2.7)
International Avg.	49 (0.2)	505 (0.5)	51 (0.2)	505 (0.5)	

Figure I.5.10 • Gender differences in mathematics performance

Score-point difference in mathematics (boys minus girls)



The presence of a substantial females' disadvantage in math is of particular importance, because it is likely to be a cause of the critically low share of women choosing STEM disciplines at university, of gender segregation in the labour market, and gender pay gaps (European Commission 2006, 2012, 2015).

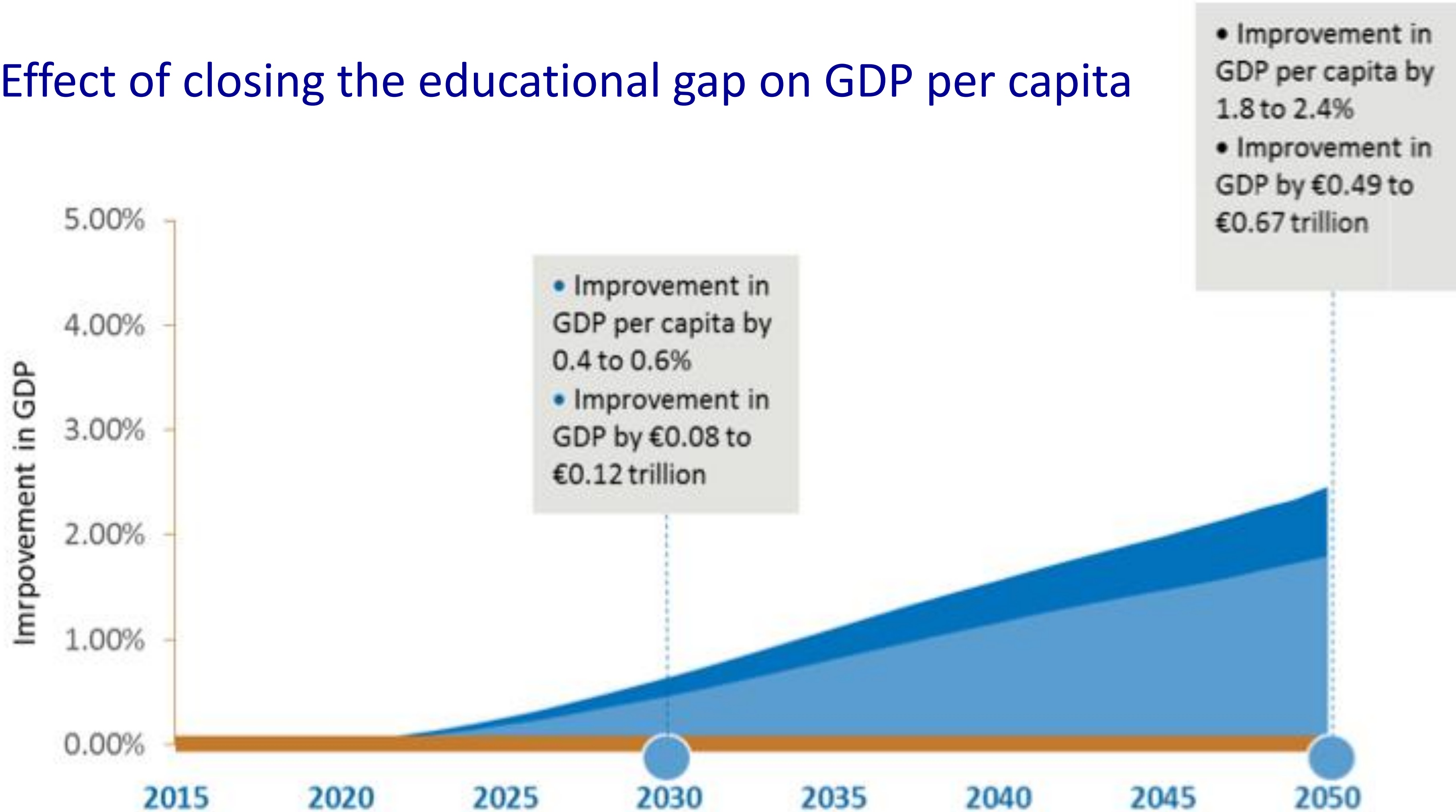
The main finding from researches in USA about primary school (confirmed by PISA surveys at 15 years) is that the math gender gap starts as early as in kindergarten and increases with the age of the child.

Another relevant result is that the math gender gap is higher for top performing students. Initially boys appear to do better than girls among well performers and worse at the bottom of the distribution. By third grade, the gender gap, still larger at the top, appears throughout the distribution.

Survey responses regarding self-concept in maths (year 5 and 6) and on the importance of math for their future life (year 10) show that boys are substantially more confident on their own abilities than girls are, and that they are more aware of the importance in math for their future.

Reducing the gender gap in STEM education and increasing the number of women graduating in STEM subjects leads an increase in labour supply, and in employment. This could help reduce bottlenecks in the labour market.

Effect of closing the educational gap on GDP per capita



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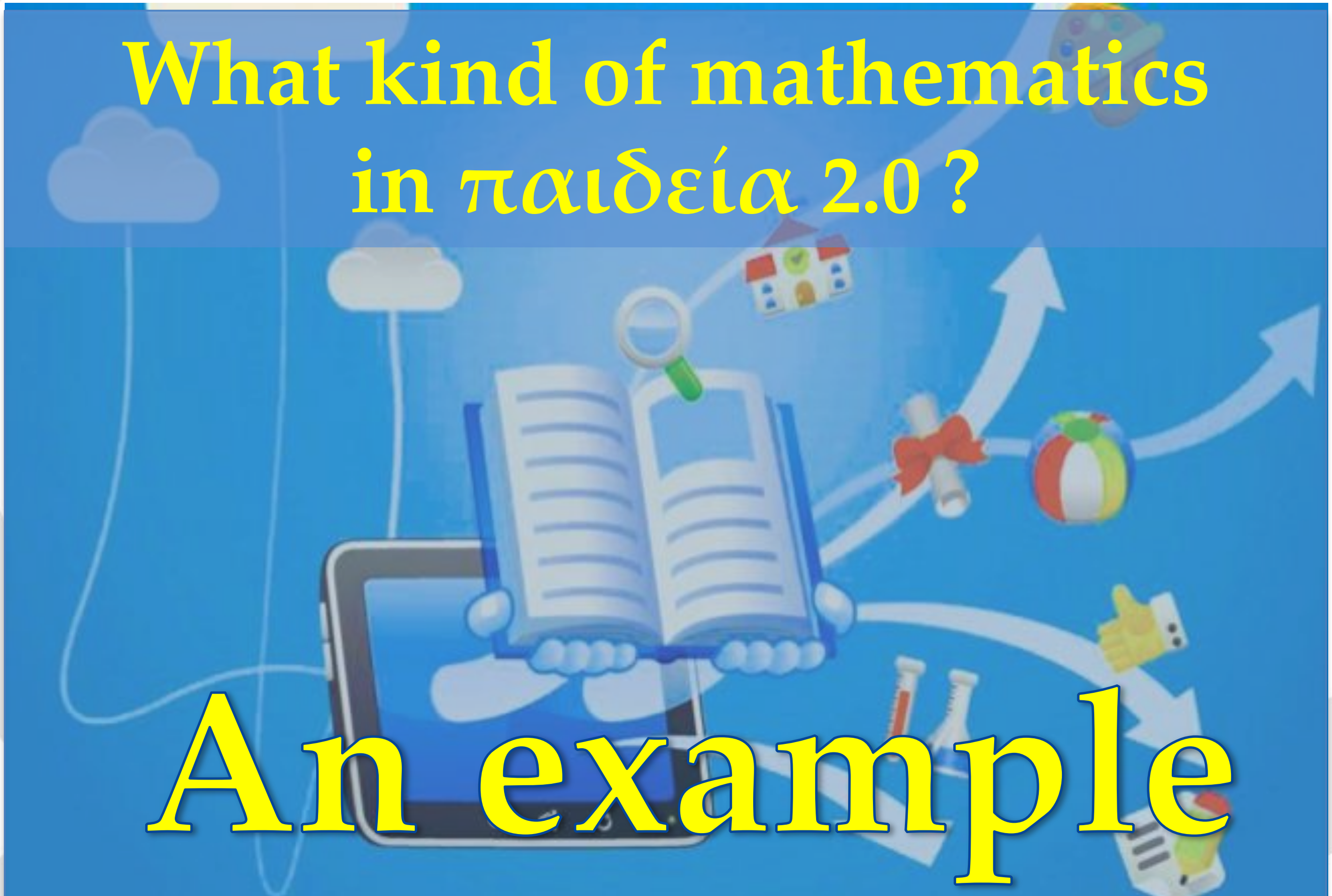
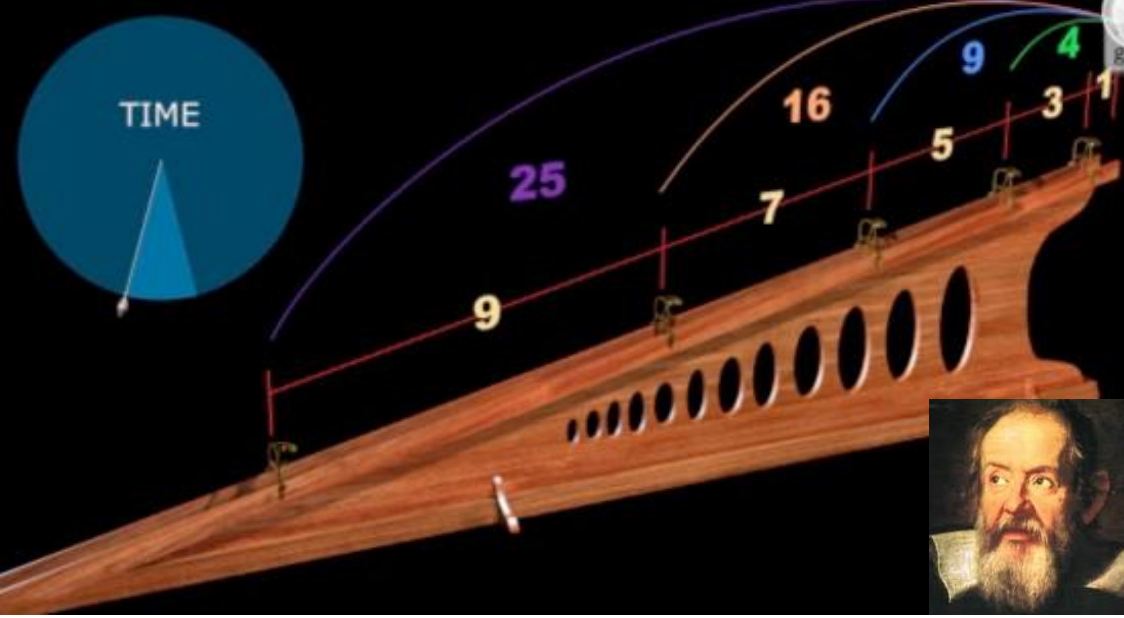
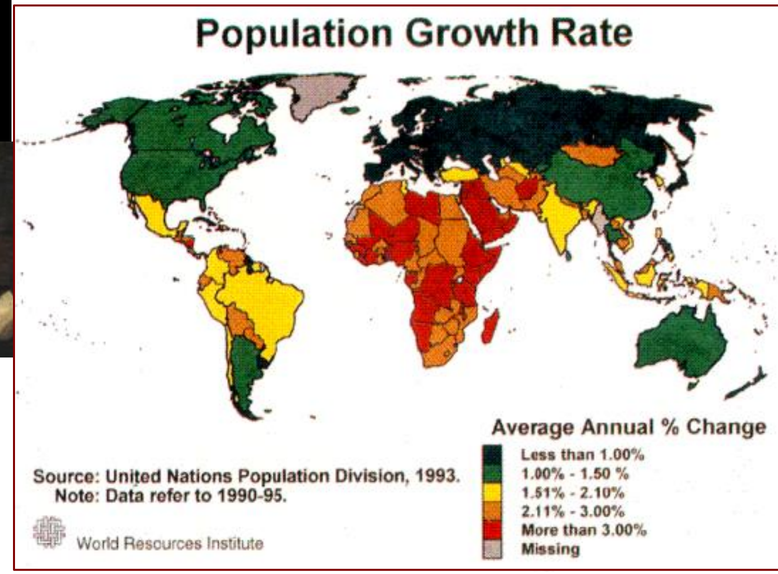

What kind of mathematics
in παιδεία 2.0 ?
An example

Processes of change





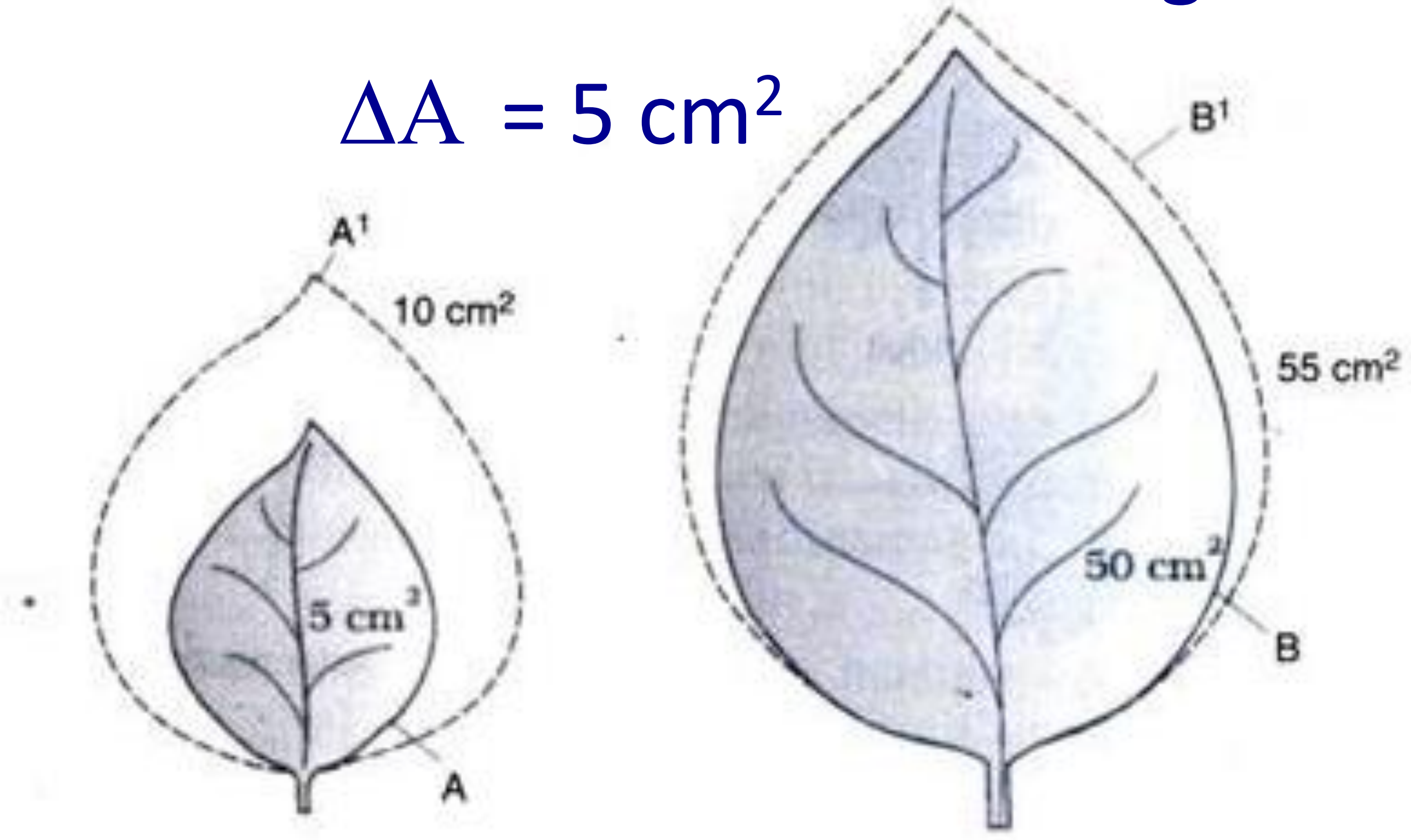
Modelling with mathematics

Change is crucial from many standpoints:

- Cognitively: it draws attention;
- Epistemologically: its analysis is the root of the scientific revolution → Calculus
- Culturally: understanding it in climate, economy,… is a crucial issue in XXI cent. society;
- Didactically: Finite differences are a powerful tool, which can easily be implemented with didactical software and allow modelling a variety of phenomena from early grades.

A finer idea of change

$\Delta A = 5\ cm^2$



The relative change $\Delta_r A = \Delta A / A$

$\Delta_r = 5\ cm^2 / 5\ cm^2$

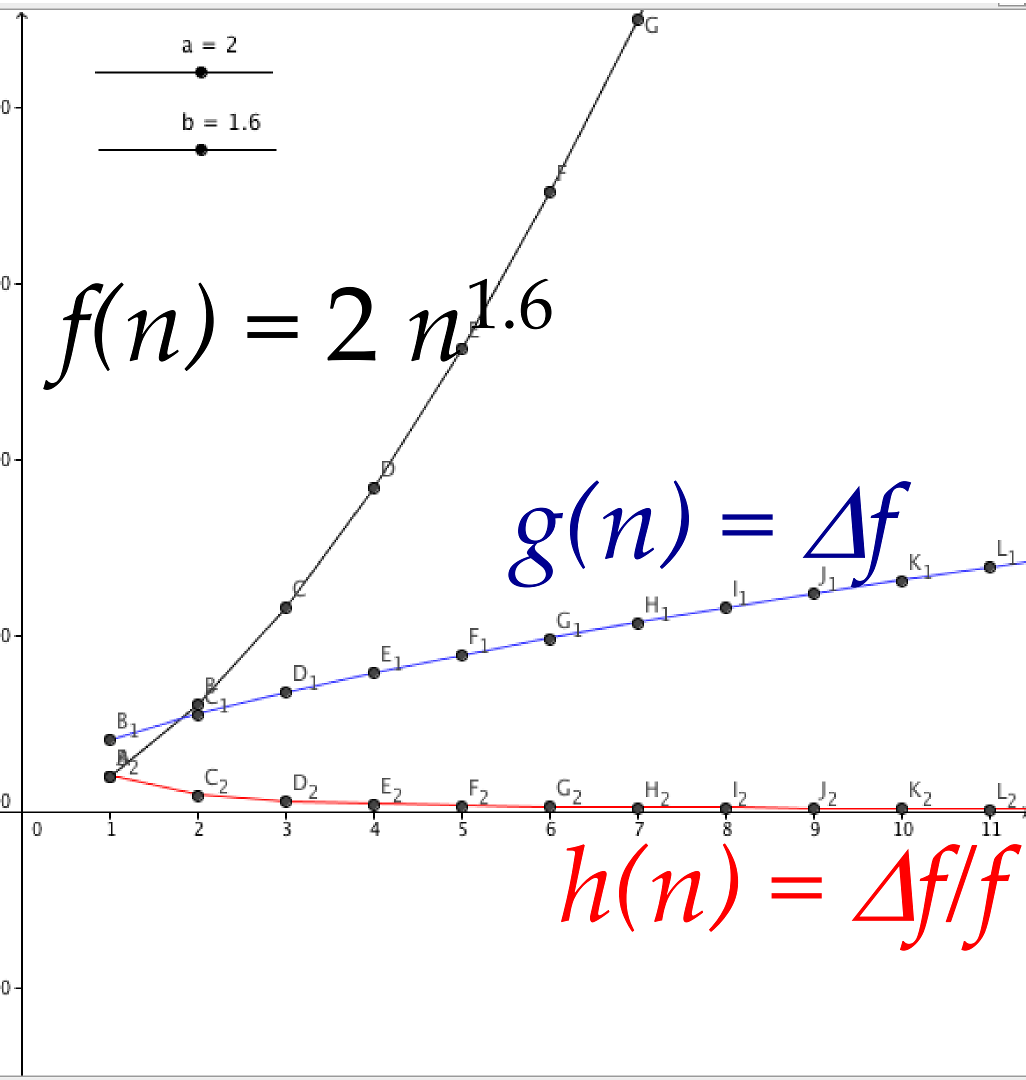
100%

$\Delta_r = 5\ cm^2 / 50\ cm^2$

10%

Relative differences: polynomes

$$y = a\, n^{b}$$

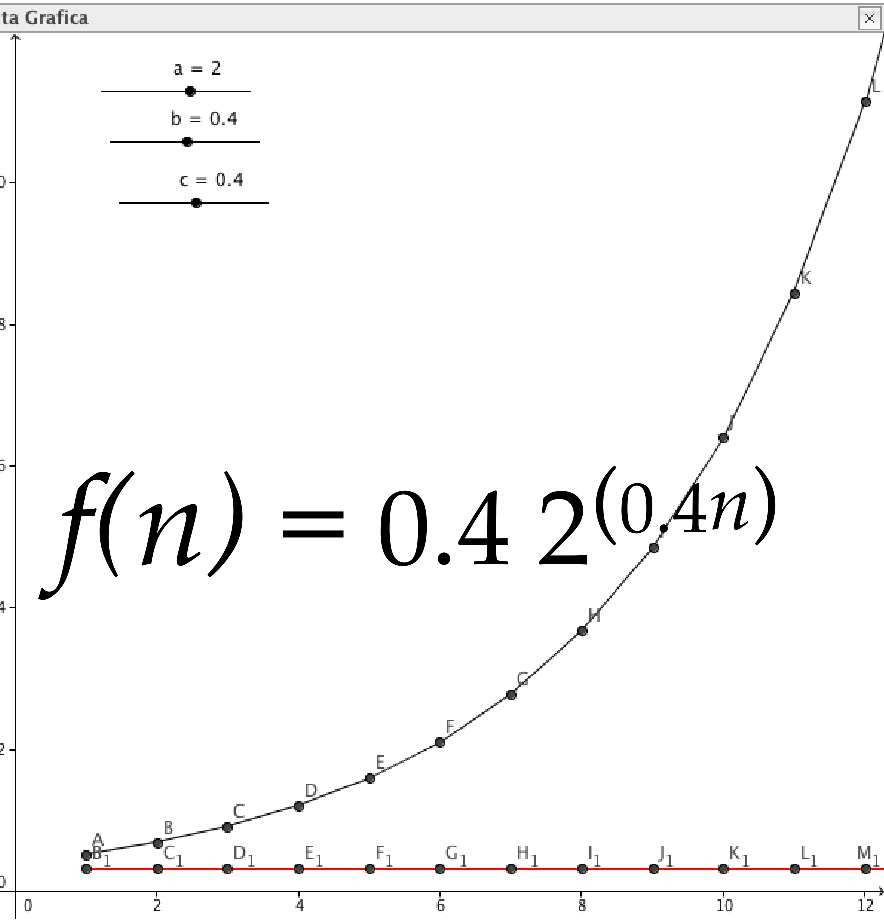


	A	B	C	D	E	F
1	n	a*n^b	n	DELTA B	n	DELTA B /B
2	1	2	1	4.06	1	2.03
3	2	6.06	2	5.54	2	0.91
4	3	11.6	3	6.78	3	0.58
5	4	18.38	4	7.89	4	0.43
6	5	26.27	5	8.9	5	0.34
7	6	35.16	6	9.84	6	0.28
8	7	45	7	10.72	7	0.24
9	8	55.72	8	11.55	8	0.21
10	9	67.27	9	12.35	9	0.18
11	10	79.62	10	13.12	10	0.16
12	11	92.74	11	13.85	11	0.15
13	12	106.59	12	14.56	12	0.14
14	13	121.15	13	15.25	13	0.13
15	14	136.41	14	15.92	14	0.12
16	15	152.33	15	16.57	15	0.11
17	16	168.9	16	17.2	16	0.1
18	17	186.1	17	17.82	17	0.1
19	18	203.92	18	18.43	18	0.09
20	19	222.35	19	19.02	19	0.09
21	20	241.37	20	19.6	20	0.08
22	21	260.96	21	20.17	21	0.08
23	22	281.13	22	[illegible]	[illegible]	[illegible]
24	23	301.85	23	[illegible]	[illegible]	[illegible]
25	24	323.12	24	[illegible]	[illegible]	[illegible]
26	25	344.93	25	[illegible]	[illegible]	[illegible]

INSTR.

Relative differences: exponentials

$$y = c\,a^{(bn)}$$



$$f(n) = 0.4\ 2^{(0.4n)}$$

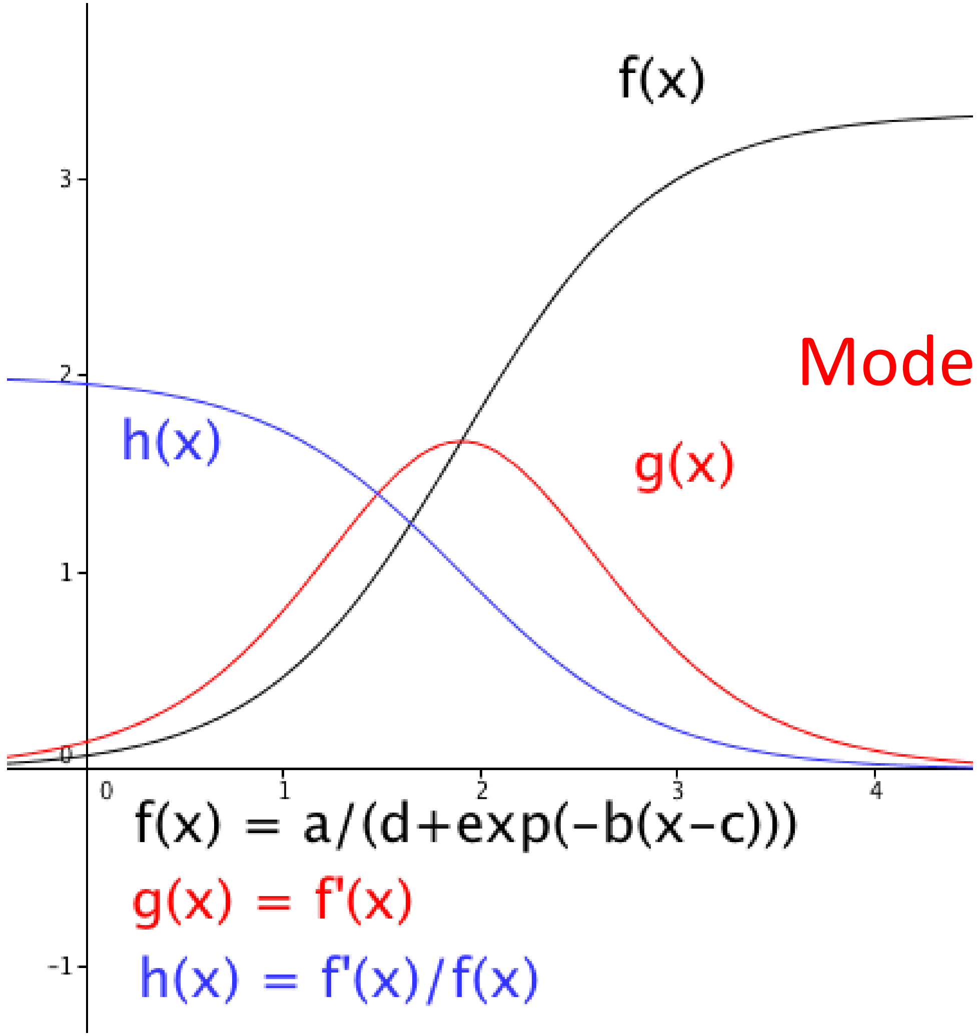
$$h(n) = \Delta f / f$$

Vista Foglio di calcolo

	A	B	C	D	E	F	G	H
1	n	a^n	a^(bn)	n	c*a^(b*n)	DELTA E	n	DELTA E/E
2	1	2	1.32	1	0.53	0.17	1	0.32
3	2	4	1.74	2	0.7	0.22	2	0.32
4	3	8	2.3	3	0.92	0.29	3	0.32
5	4	16	3.03	4	1.21	0.39	4	0.32
6	5	32	4	5	1.6	0.51	5	0.32
7	6	64	5.28	6	2.11	0.67	6	0.32
8	7	128	6.96	7	2.79	0.89	7	0.32
9	8	256	9.19	8	3.68	1.17	8	0.32
10	9	512	12.13	9	4.85	1.55	9	0.32
11	10	1024	16	10	6.4	2.04	10	0.32
12	11	2048	21.11	11	8.44	2.7	11	0.32
13	12	4096	27.86	12	11.14	3.56	12	0.32
14	13	8192	36.76	13	14.7	4.7	13	0.32
15	14	16384	48.5	14	19.4	6.2	14	0.32
16	15	32768	64	15	25.6	8.18	15	0.32
17	16	65536	84.45	16	33.78	10.79	16	0.32
18	17	131072	111.43	17	44.57	14.24	17	0.32
19	18	262144	147.03	18	58.81	18.79	18	0.32
20	19	524288	194.01	19	77.6	24.8	19	0.32
21	20	1048576	256	20	102.4	32.72	20	0.32
22	21	2097152	337.79	21	135.12	43.17	21	0.32
23	22	4194304	445.72	22	178.29	56.96	22	0.32
24	23	8388608	588.13	23	235.25	75.17	23	0.32
25	24	167772...	776.05	24	310.42	99.18	24	0.32
26	25	335544...	1024	25	409.6			

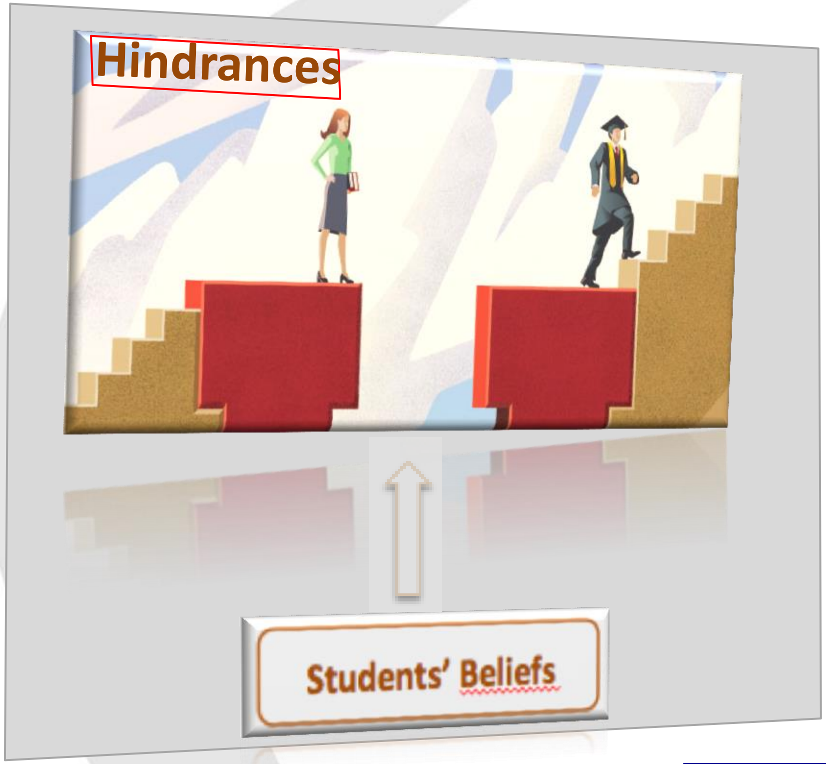
INSTR.

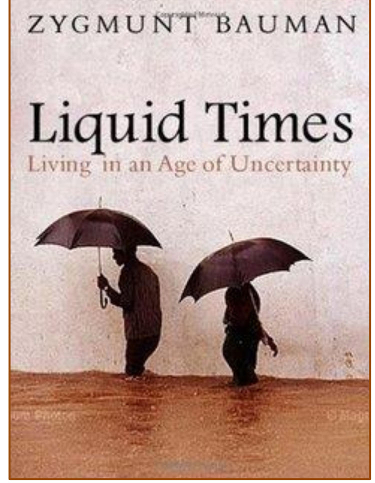
Growth phenomena in Biology and Economy: reasoning about changes as education to rational decisions

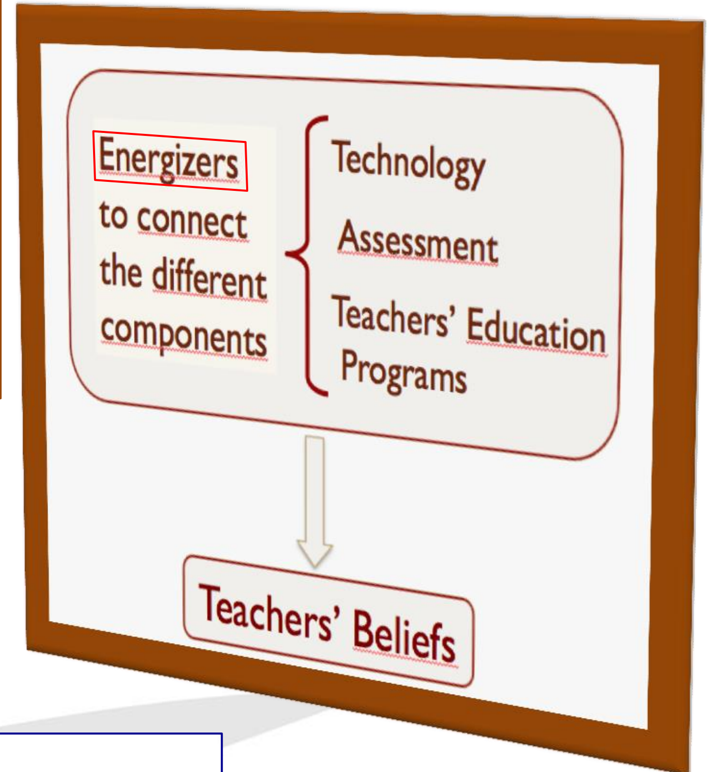


Model of Verhulst

http://mediarepository.indire.it/iko/uploads/allegati/M7PWITOE.pdf







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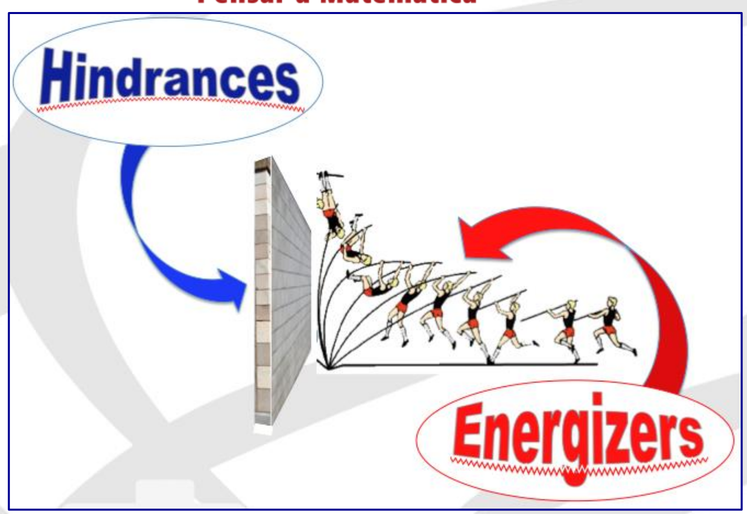

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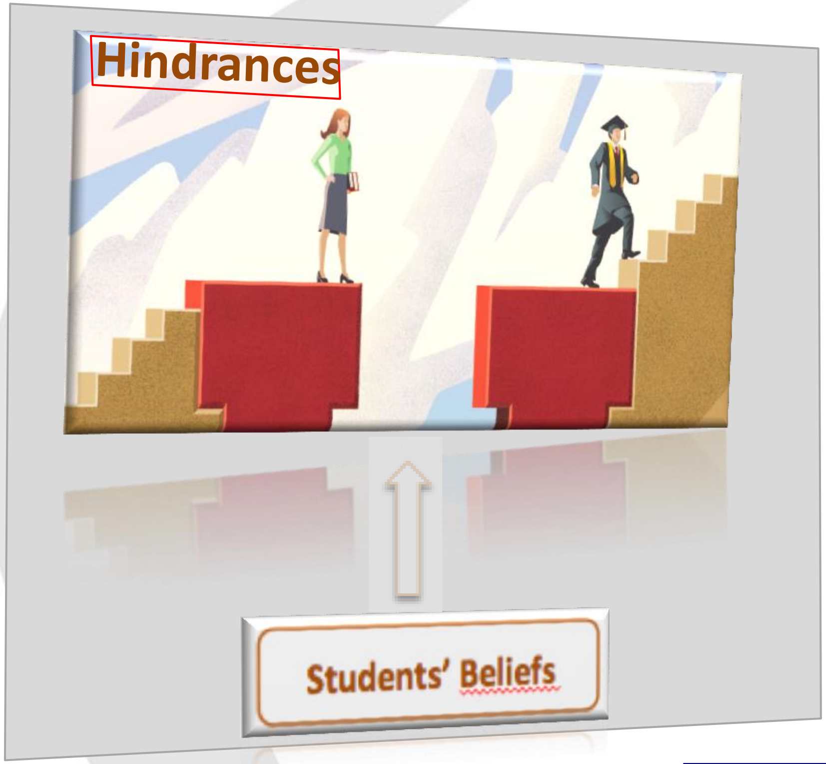

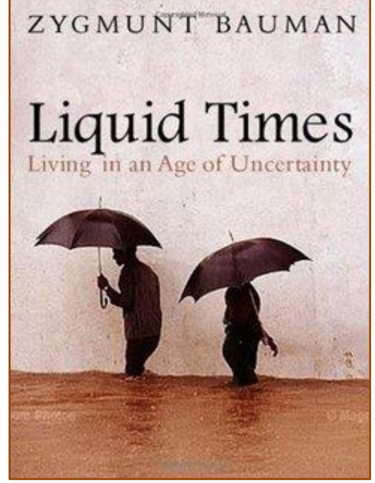

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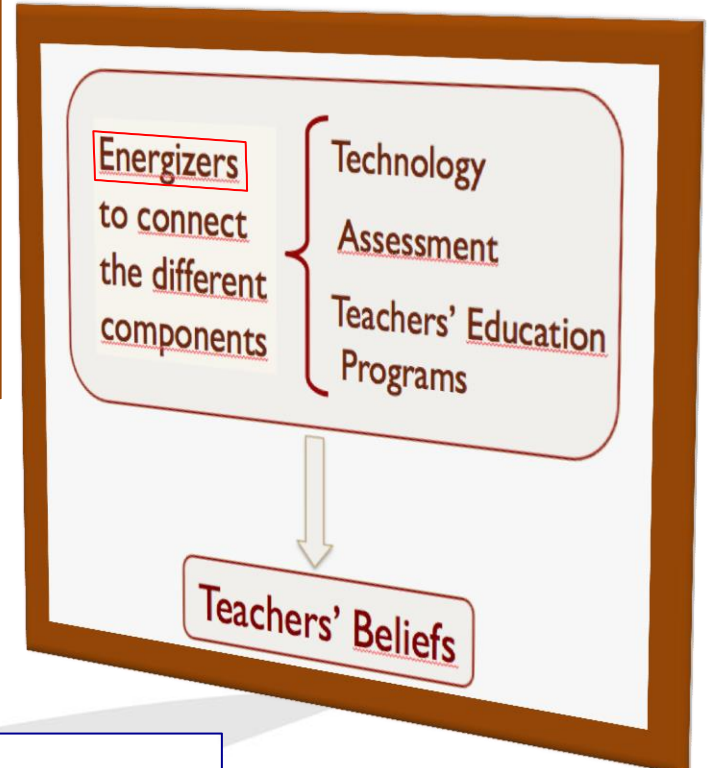
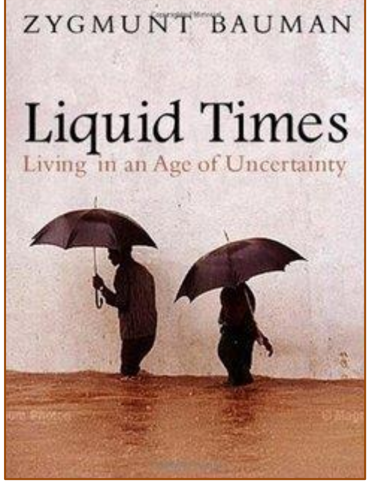
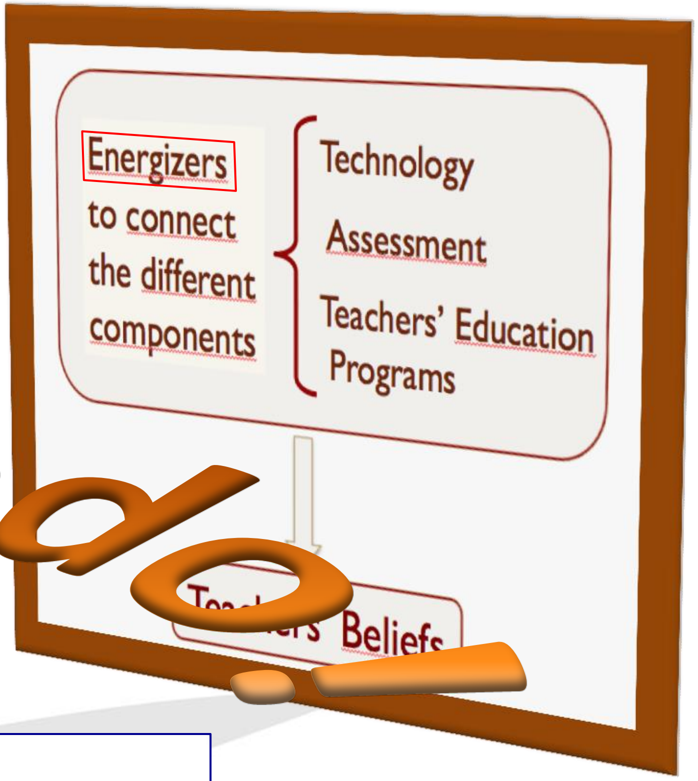


The moral of my talk:

To break hindrances and transform them into energizers we need a critical attention to the ongoing changes in society and a careful action on teachers and students beliefs. Otherwise also the best intended curriculum will produce little change in the implemented and learned ones.





Obrigado!

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