



NETWORK 3

NW 3



CURRICULUM INNOVATION

Workshop

# The Item-Oriented Approach

to International Large Scale

Assessments (ILSA)

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- The vast amount of data collected in ILSA of pupils' achievement is underused and can inform the evaluation of curricular frameworks and/or curriculum implementation.

# PISA 2015

Source: OECD

	Science		Reading		Mathematics	
	Mean score in PISA 2015	Average three-year trend	Mean score in PISA 2015	Average three-year trend	Mean score in PISA 2015	Average three-year trend
	Mean	Score dif.	Mean	Score dif.	Mean	Score dif.
OECD average	493	-1	493	-1	490	-1
Singapore	556	7	535	5	564	1
Japan	538	3	516	-2	532	1
Estonia	534	2	519	9	520	2
Chinese Taipei	532	0	497	1	542	0
Finland	531	-11	526	-5	511	-10
Macao (China)	529	6	509	11	544	5
Canada	528	-2	527	1	516	-4
Viet Nam	525	-4	487	-21	495	-17
Hong Kong (China)	523	-5	527	-3	548	1
B-S-J-G (China)	518	m	494	m	531	m
Korea	516	-2	517	-11	524	-3
New Zealand	513	-7	509	-6	495	-8
Slovenia	513	-2	505	11	510	2
Australia	510	-6	503	-6	494	-8
United Kingdom	509	-1	498	2	492	-1
Germany	509	-2	509	6	506	2
Netherlands	509	-5	503	-3	512	-6
Switzerland	506	-2	492	-4	521	-1
Ireland	503	0	521	13	504	0
Belgium	502	-3	499	-4	507	-5
Denmark	502	2	500	3	511	-2
Poland	501	3	506	3	504	5
Portugal	501	8	498	4	492	7
Norway	498	3	513	5	502	1
United States	496	2	497	-1	470	-2
Austria	495	-5	485	-5	497	-2
France	495	0	499	2	493	-4
Sweden	493	-4	500	1	494	-5
Czech Republic	493	-5	487	5	492	-6
Spain	493	2	496	7	486	1
Latvia	490	1	488	2	482	0
Russia	487	3	495	17	494	6

# Pupil oriented / Item-oriented

- To understand deeply the problems of curricula, however, the analyses need to go beyond the mean PISA or TIMSS scores
- Let us study the pupils' relative success rates in individual items (country subject profiles).
- This could identify the problematic curriculum areas for the subsequent scrutiny (e.g. by comparative analysis).

# Outline

- A story about the use of item TIMSS data for benchmarking of the national curricular framework in Czechia
- Data sources and available tools will be demonstrated.

# The method



„Pathological anatomy“  
of curriculum:

correlation of  
symptoms of illness  
(poor results)

with results of  
curriculum autopsy.

# TIMSS 1995

M: Fourth Grade*	
Country	Average Achievement
Singapore	625
Korea	611
Japan	597
Hong Kong	587
Netherlands	577
<b>Czech Republic</b>	<b>567</b>
Austria	559
<b>Slovenia</b>	<b>552</b>
Ireland	550
<b>Hungary</b>	<b>548</b>
United States	545
Canada	532
Israel	531
Latvia (LSS)	525
Scotland	520
England	513
Cyprus	502
Norway	502
New Zealand	499
Greece	492
Thailand	490
Portugal	475

# TIMSS 1995

M: Eighth Grade*	
Country	Average Achievement
Singapore	643
Korea	607
Japan	605
Hong Kong	588
Belgium (Fl)	565
Czech Republic	564
Slovak Republic	547
Switzerland	545
Netherlands	541
Slovenia	541
Bulgaria	540
Austria	539
France	538
Hungary	537
Russian Federation	535
Australia	530
Ireland	527
Canada	527
Belgium (Fr)	526
Thailand	522

# The problem: major decline of the Czech pupils' achievement

- **IN 2007 TIMSS Czech 4th graders:**
- The difference between average scale score 1995 and 2007 was **-54**. This was the **largest decrease** among all European or OECD countries that participated in both TIMSS assessments.
- Extremely negative trend also in PISA math results.

**HAD CURRICULUM CONTRIBUTED  
TO THE DECLINE?**

# Complex relationship between the curricular documents and instruction

Curricular documents



Instruction



Pupils' knowledge  
and skills

Curricular documents



Instruction



Pupils' knowledge  
and skills

**STUDENT ORIENTED APPROACH**



Programme for International Student Assessment

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# Student results

```
graph TD; A[Student results] --- B[Item response theory (IRT)]; B --- C[Plausible values for individual students]; B --- D[Averages for countries / subgroups];
```

Item response theory (IRT)

Plausible values for individual students

Averages for countries / subgroups

## PISA Database

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The PISA database contains the full set of responses from individual students, school principals and parents. These files will be of use to statisticians and professional researchers who would like to undertake their own analysis of the PISA data. The files available on this page include background questionnaires, data files in ASCII format (from 2000 to 2012), codebooks, compendia and SAS™ and SPSS™ data files in order to process the data.

[2018](#) [2015](#) [2012](#) [2009](#) [2006](#) [2003](#) [2000](#)

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### **PISA Data Analysis Manual: SPSS and SAS, Second Edition**

These two publications are essential tools for researchers, as they provide all the information required to understand the PISA databases and perform analyses in accordance with the complex methodologies used to collect and process the data.

### **How to prepare and analyse the PISA database**

This note summarises the main steps of using the PISA database. It describes the PISA data files and explains the specific features of the PISA survey together with its analytical implications. This document also offers links to existing documentations and resources (including software packages and pre-defined macros) for accurately using the PISA data files.

### **IDB analyzer (quick reproduction of the PISA results)**

# PISA: 15-year-old students

## • Achievement

- Reading literacy
- Mathematics literacy
- Science literacy
  
- Problem solving
- Collaborative problem solving
- Financial literacy
- .....

## Questionnaires

### **Student Questionnaire:**

- Student background/demographic characteristics
- Home educational resources
- Self-perceptions, beliefs, and attitudes about learning
- Perceptions of teaching and instructional experiences
- School climate and safety

### **School Questionnaire:**

- Policies and practices
- Instructional time
- School resources and technology
- School climate and safety
- School enrollment and characteristics



International Data Explorer

IAP | PISA | PIRLS | TIMSS | PIAAC | TALIS

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# IDE

- Run statistical tests
- Run regression analyses
- Test for statistically significant gaps



*Create your own analyses and explore the results from international studies...*

## PISA

Program for International Student Assessment

[What does this IDE provide?](#)

## PIRLS

Progress in International Reading Literacy Study

[What does this IDE provide?](#)

## TIMSS

Trends in International Mathematics and Science Study

[What does this IDE provide?](#)

## PIAAC

Program for the International Assessment of Adult Competencies

[What does this IDE provide?](#)

## TALIS

Teaching and Learning International Survey

[What does this IDE provide?](#)

# IES Institute of Education Sciences

- <https://nces.ed.gov/surveys/international/ide/>

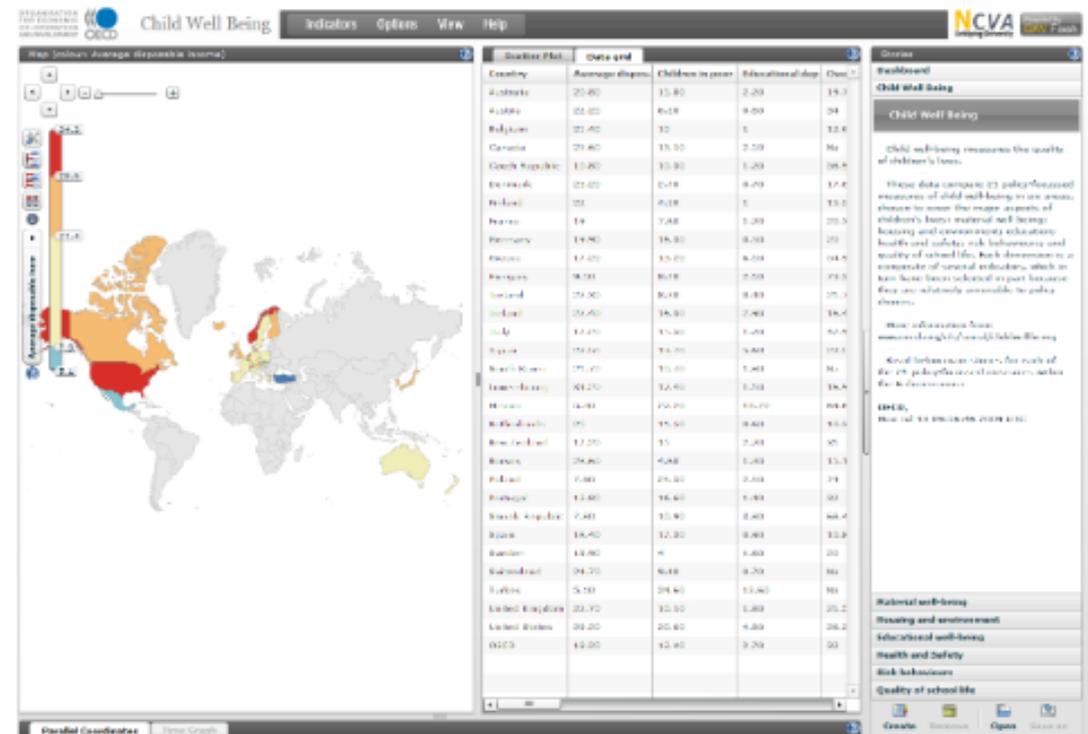
# PISA DATA Explorer

## PISA Data Explorer

The Data Explorer allows you to create your own analyses and build reports from the PISA data sets.

2015 2012

- Equivalent to IDE



# **ITEM ORIENTED APPROACH**

# Student results

```
graph LR; A[Student results] --- B["Item response theory (IRT)  
Plausible values for individual students  
Averages for countries / subgroups"]; A --- C["Classical test theory  
(p-value for individual items or groups of items)"]
```

Item response theory (IRT)  
Plausible values for individual students  
Averages for countries / subgroups

Classical test theory  
( $p$ -value for individual items or groups of items)

# Item compendium (PISA)

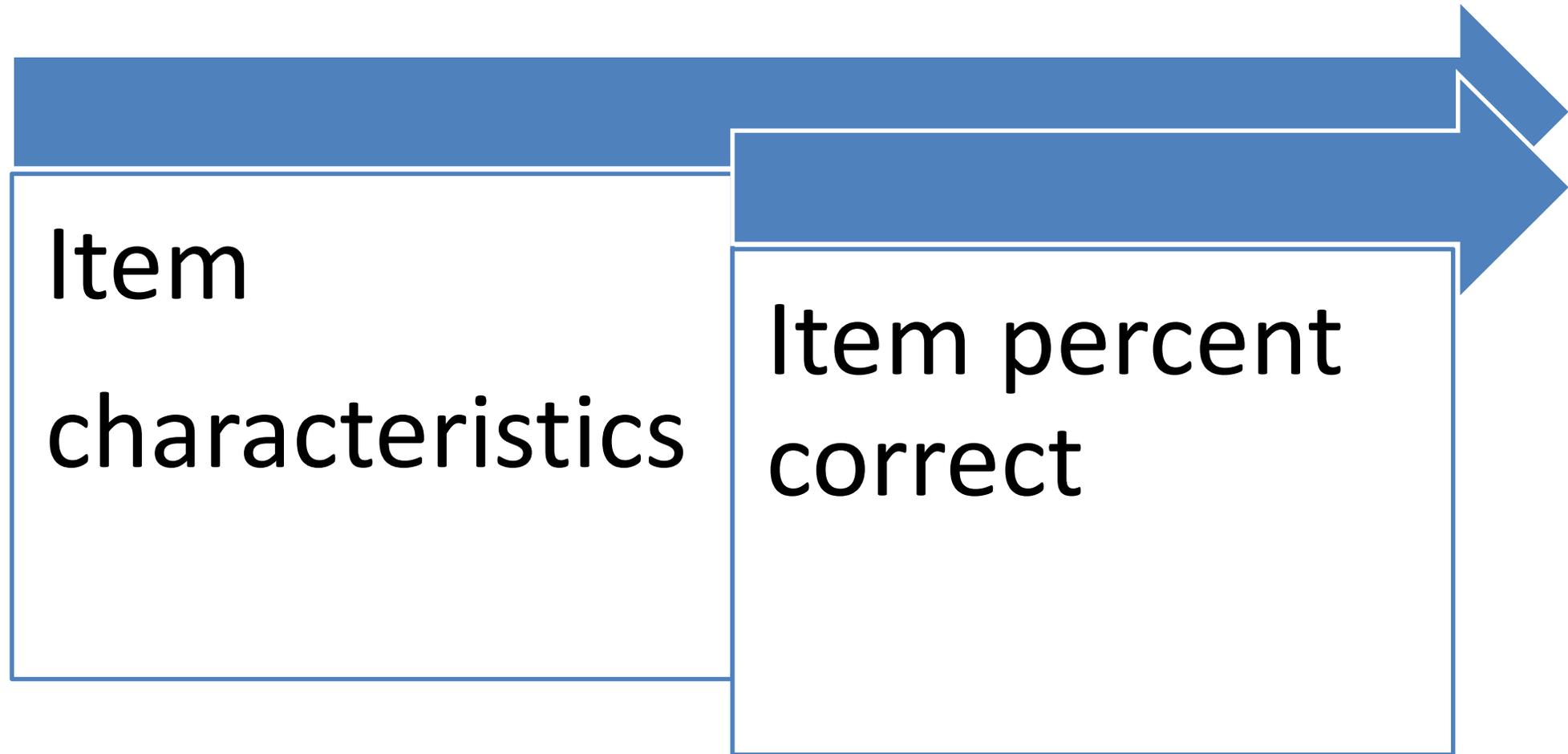
## Cognitive items: Overall Mathematics results

### DM155Q02C: Population Pyramids - Q02 (Coded Response)

	N	N	00 - No credit		21 - Full credit		No Response	
	All	Valid	%	(SE)	%	(SE)	%	(SE)
<b>OECD</b>								
Australia	14530	1832	20,32	(1,10)	57,40	(1,41)	6,35	(0,63)
Austria	7007	841	20,07	(1,75)	49,10	(1,89)	16,85	(1,30)
Belgium	9651	1148	12,65	(0,88)	62,19	(1,81)	10,35	(1,14)
Canada	20058	2422	16,95	(1,16)	63,56	(1,34)	4,75	(0,58)
Chile	7053	853	21,03	(1,63)	29,95	(1,66)	32,91	(1,75)
Czechia	6894	820	16,22	(1,70)	52,45	(2,06)	17,74	(1,45)
Denmark	7161	825	15,47	(1,38)	54,99	(2,27)	6,78	(0,95)

	00 - No credit		11 - Partial credit		12 - Partial credit		13 - Partial credit		21 - Full credit	
	%	(SE)	%	(SE)	%	(SE)	%	(SE)	%	(SE)
<b>OECD</b>										
Australia	20,32	(1,10)	5,49	(0,59)	7,51	(0,80)	2,39	(0,45)	57,40	(1,41)
Austria	20,07	(1,75)	6,60	(0,94)	5,94	(0,93)	1,24	(0,32)	49,10	(1,89)
Belgium	12,65	(0,88)	5,50	(0,75)	6,99	(1,03)	1,73	(0,42)	62,19	(1,81)
Canada	16,95	(1,16)	6,47	(0,73)	7,02	(0,74)	0,84	(0,22)	63,56	(1,34)
Chile	21,03	(1,63)	7,74	(1,15)	6,50	(0,90)	1,36	(0,50)	29,95	(1,66)
Czechia	16,22	(1,70)	5,02	(0,72)	7,11	(1,04)	1,14	(0,37)	52,45	(2,06)

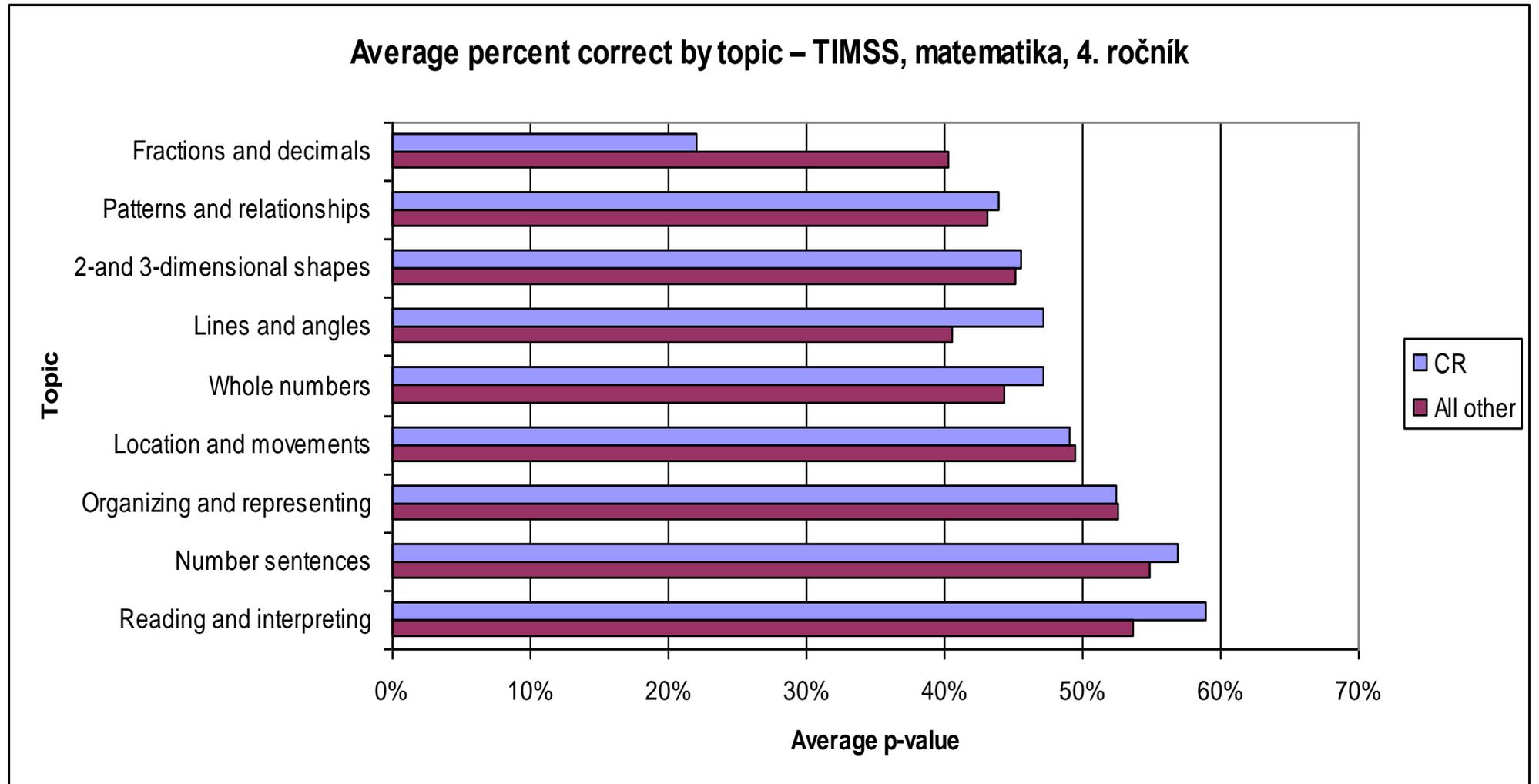
# Using big data is about merging databases



# Item information (TIMSS M4)

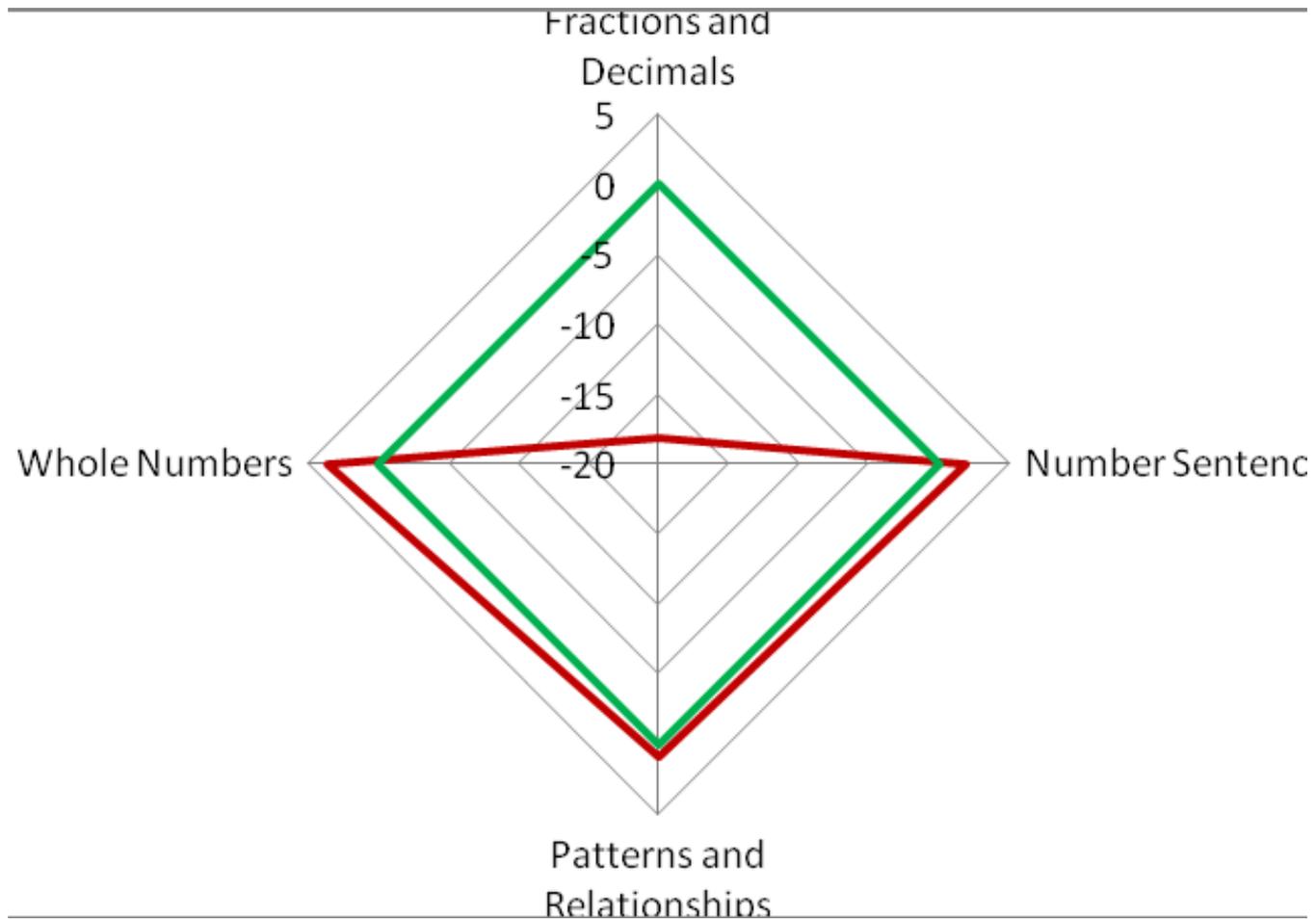
Item ID	Content Domain	Topic Area	Topic	Cognitive Domain	Item Type	Label
M041023	Number	Whole Numbers	3	Knowing	MC	Trees Jan plant altogether
M041034	Number	Whole Numbers	5	Knowing	MC	Multiples of 3
M041087	Number	Fractions and Decimals	3	Knowing	CR	Add $0.36 + 0.77$
M041124	Number	Expressions, Simple Equations, and Relationships	3	Applying	CR	Use the rule to complete the table
M041302A	Geometric Shapes and Measures	Two- and Three-dimensional Shapes	1	Knowing	MC	What shape is made
M041302C	Geometric Shapes and Measures	Two- and Three-dimensional Shapes	1	Reasoning	CR	Draw a 6-sided shape

# Detailed analysis of topics (TIMSS 2007 Math 4th grade)



# What's wrong with the fractions in the Czech schools?

Are they taught too late and/or too little?



# M05\_01 (M041291): Subtract 428 - 176

## Constructed Response (1 Point)

Northern Ireland	76 (2.4)	🏆
Cyprus	74 (2.1)	🏆
Slovenia	72 (2.2)	🏆
England	70 (2.1)	
Slovak Republic	69 (1.7)	
Czech Republic	69 (2.2)	
<b>International Avg.</b>	<b>67 (0.3)</b>	
Denmark	66 (2.5)	
Norway (5)	65 (2.5)	
Canada	64 (2.2)	
Germany	62 (2.3)	🏆
Poland	62 (2.1)	🏆
Qatar	60 (1.9)	🏆
Netherlands	60 (2.5)	🏆

# We use **residuals** instead of per cent correct

The p-values are transformed by deducing average performance for a country across all items and/or average difficulty for an item across all countries (Olsen, 2005).

- Olsen, R.V. (2005). *Achievement tests from an item perspective. An exploration of single item data from the PISA and TIMSS studies, and how such data can inform us about students' knowledge and thinking in science.* (Thesis). Universitetet i Oslo: Unipub.

# Residuals

kod1	kod2	usp_cr	usp_vse	usp_r	Content	Dc Topic Area	Topic Area	Cognitive	Item Label
M041046	M12_05	7,2	44,7179	-37,5179	Number	Fractions a	3	Knowing	
M041059	M12_04	2,9	40,4	-37,5	Number	Fractions a	1	Knowing	
M041298	M12_01	34,8	65,21194	-30,41194	Number	Fractions a	1	Knowing	
M031029	M07_01	23,7	53,24857	-29,54857	Number	Fraction an	4	Knowing	4/5 minus 1/5
M041076	M04_04	7,9	37,19039	-29,29039	Number	Fractions a	4	Knowing	Fraction of money Joe spent
M041320	M10_05	17,4	43,99991	-26,59991	Number	Fractions a	3	Knowing	
M031325	M11_09	5,1	28,63843	-23,53843	Geometric	Lines and /	3	Applying	
<b>M031317</b>	<b>M11_05</b>	15,2	38,10113	-22,90113	Number	Number Se	1	Knowing	
M041151	M08_10	40,9	61,81808	-20,91808	Geometric	2-and 3-dir	4	Reasoning	
M041152	M04_08	23,5	42,15054	-18,65054	Geometric	2-and 3-dir	5	Applying	Area of the fence to be painted
M041250	M02_05	25,3	43,89216	-18,59216	Number	Fractions a	6	Knowing	Subtract 5.3 - 3.8
M041148	M10_09	11,4	29,69307	-18,29307	Geometric	2-and 3-dir	3	Knowing	
M041069	M04_03	6,7	24,96463	-18,26463	Number	Fractions a	3	Knowing	Fraction equal to 2/3
<b>M031183</b>	<b>M09_03</b>	4,9	22,96216	-18,06216	Number	Whole Nun	7	Applying	
M041006	M02_04	23,2	40,70311	-17,50311	Number	Fractions a	1	Knowing	Fraction of the rectangle shaded
M041165	M14_10	9,7	26,3107	-16,6107	Geometric	Location ar	2	Applying	
M031245	M05_03	10,3	26,67378	-16,37378	Number	Number Se	1	Applying	Number in box of number sentenc
M041064	M06_03	40,4	56,75902	-16,35902	Number	Fractions a	2	Applying	
M041169	M12_07	33,1	49,34556	-16,24556	Geometric	Location ar	3	Knowing	

## Looking at curricula

(to be exact, intended curricula, curricular frameworks)

- **Curriculum benchmarking**

(Donnelly et al., 2005)

- Looking for „any significant discrepancies or differences of treatment“ between the Czech and other curricular documents along several lines (key strands and their first introduction, allocated time, rigour etc.)

# So what we realised

- Unlike in the curricula of other countries and also in previous Czech curricula, after recent curriculum reform fractions and decimals not introduced in the Czech primary school

# England / Year

1.	2.	3.	4.	5.	6.
Use the vocabulary of halves and quarters in context	Find one half, one quarter and three quarters of shapes and sets of objects	Read and write proper fractions , interpreting the denominator as the parts of a whole and the numerator as the number of parts; identify and estimate fractions of shapes; use diagrams to compare fractions and establish equivalents.	Use decimal notation for tenths and hundredths and partition decimals; relate the notation to money and measurement; position one-place and two-place decimals on a number line. Recognise the equivalence between decimal and fraction forms of one half, quarters, tenths and hundredths Use diagrams to identify equivalent fractions (e.g. and , or and ); interpret mixed numbers and position them on a number line (e.g. 3 ) (EOY – end-of-year)	Explain what each digit represents in whole numbers and decimals with up to two places, and partition, round and order these numbers . Express a smaller whole number as a fraction of a larger one (e.g. recognise that 5 out of 8 is ); find equivalent fractions ; relate fractions to their decimal representations Understand percentage as the number of parts in every 100 and express tenths and hundredths as percentages	Use decimal notation for tenths, hundredths and thousandths; partition, round and order decimals with up to three places, and position them on the number line. Express a larger whole number as a fraction of a smaller one (e.g. recognise that 8 slices of a 5-slice pizza represents or 1 pizzas); simplify fractions by cancelling common factors; order a set of fractions by converting them to fractions with a common denominator. Express one quantity as a percentage of another (e.g. express £400 as a percentage of £1000); find equivalent percentages, decimals and fractions

## The items that were omitted by Czech students more often than international average

Item	p CR	p other	omitted CR	omitted all	Difference	Released	Topic Area
M11_09	5,1	28,6	56,7	27,8	28,9	No	Lines and Angles
M01_04	6,1	15,4	57,1	28,7	28,4	Yes	Pattern & Relationships
M07_01	23,7	53,2	31,9	10,3	21,6	Yes	Fraction and Decimal
M08_04A	18,8	34,6	32,1	11,5	20,6	No	Fractions and Decimals
M07_02	0,3	14,7	33,5	14,7	18,8	Yes	Fraction and Decimal
M11_01	28,7	44,5	24,1	5,4	18,7	No	Fraction and Decimal
M14_10	9,7	26,3	43,1	24,9	18,2	No	Location and Movements
M04_04	7,9	37,2	34,9	16,7	18,2	Yes	Fractions and Decimals
M06_03	40,4	56,8	28,3	11,0	17,3	No	Fractions and Decimals
M10_08	34	44,1	35,5	19,3	16,2	No	Location and Movements
M12_04	2,9	40,4	25,2	9,5	15,7	No	Fractions and Decimals
M02_05	25,3	43,9	28,0	12,3	15,7	Yes	Fractions and Decimals
M02_04	23,2	40,7	21,4	6,6	14,8	Yes	Fractions and Decimals
M04_03	6,7	25,0	20,4	5,7	14,7	Yes	Fractions and Decimals
M10_05	17,4	44,0	19,3	5,3	14,0	No	Fractions and Decimals
M08_04B	5,2	17,6	48,6	34,8	13,8	No	Fractions and Decimals
M06_06	11,3	23,5	22,7	10,2	12,5	No	Fractions and Decimals
M03_04	24,1	26,0	38,5	28,0	10,5	Yes	Pattern & Relationships
M02_08D	26,1	25,3	35,2	25,1	10,1	Yes	2-and 3-dimensional shapes

Item disproportionately often omitted by Czech kids

**TIMSS2007**

**Mathematics**

**Fourth Grade**

**Content Domain**  
Number

**Cognitive Domain**  
Reasoning

MG31227

The diagram shows four rows, each representing an application of 'Sean's Rule'. On the left, a triangle contains a number. An arrow labeled 'Sean's Rule' points to a square on the right containing a result. The rows are: 4 in a triangle to 9 in a square; 5 in a triangle to 11 in a square; 8 in a triangle to 17 in a square; 11 in a triangle to 23 in a square.

Sean used the same rule to get the number in the  from the number in the  $\triangle$ .  
What was the rule?

Answer: \_\_\_\_\_

# Is it „trendy“ to base a research on International Large-Scale Assessment (ILSA), i.e. TIMSS or PISA data?

- ILSA perceived as a potentially threatening, dangerous, or even fundamentally bad.
- There are many methodological and conceptual problems in ILSA tests, indeed.
- Even when conceived by the powerful, PISA still can measure „powerfull knowledge“ (Young).
- In some contexts, it could have liberating effects (underserved children).

# Two oppinions

„The appropriate function of cross-national work is to inform us, it is not to direct us.“

Heyneman (2004)

„Local school improvement is a key purpose to be served by international test results.“

*Leithwood* (2004)

A focused local analytic work is necessary.

- The explorative analysis can be done using relatively simple tools.
- It should be followed by a more rigorous analysis using advanced tools (e.g. DIF...).

# Some references

- Olsen, R.V. (2005). *Achievement tests from an item perspective. An exploration of single item data from the PISA and TIMSS studies, and how such data can inform us about students' knowledge and thinking in science.* (Thesis). Universitetet i Oslo: Unipub.
- Olsen, R. V. (2006). A Nordic profile of mathematics achievement: Myth or reality? In: Mejdning, J.& Roe A. (eds.) *Northern lights on PISA 2003 – a reflection from the Nordic countries.* Copenhagen: Nordic Council of Ministers.
- Rutkowski, L., Rutkowski, D. (2009). Trends in TIMSS responses over time: Evidence of global forces in education? *Educational Research and Evaluation*, 15, č. 2 s. 137–152.