

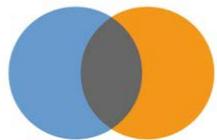
# Teaching quality

Theoretical foundations, effectiveness studies,  
and cross-national comparison

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**DIPF**

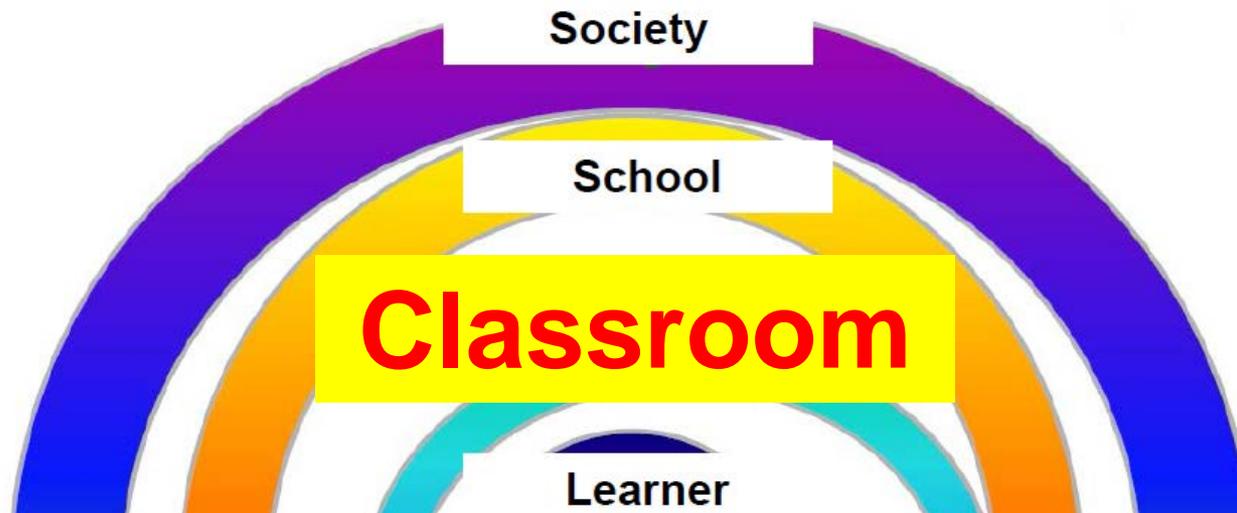
Educational Research  
and Educational Information



*Leibniz* - Netzwerk  
**Unterrichtsforschung**

**WERA Conference**  
**Cape Town, South Africa**  
**August 4, 2018**

Education: A multi-layer system constantly in move  
A pragmatic strategy for research: focusing one layer



**The classroom is *the* spatiotemporal, interactional and cognitive context where professionals create (and co-construct) an environment for kids supporting personal growth**

## School, from a pedagogical point of view, is ....

„... an optimized context of human development, where adults and children/adolescents are committed to „co-constructing“ human growth “

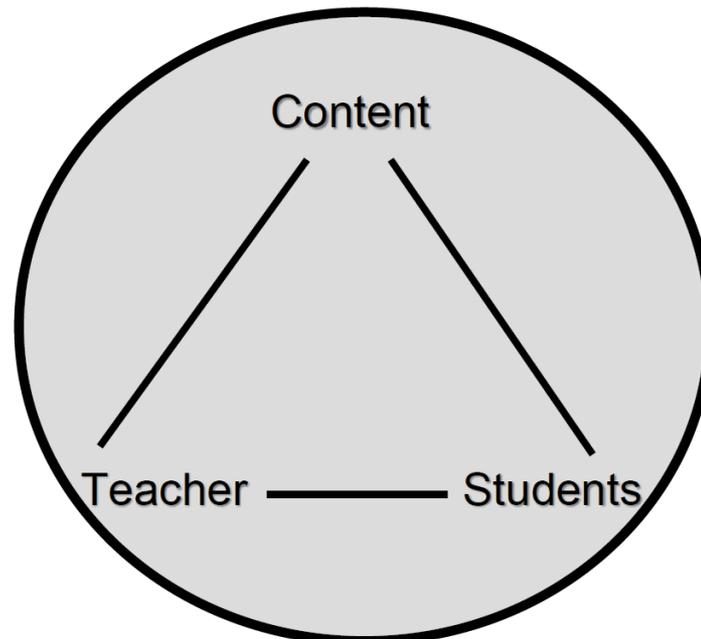
*Helmut Fend: Theory of Schooling (2000)*

## Teaching is ...

„ the act of using method x to enable students to learn y“

*Robin Alexander: Towards a Comparative Pedagogy (2009)*

...content-related interaction between students and teacher.



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*Robin Alexander: Towards a Comparative Pedagogy (2009)*

...content-related interaction between students and teacher.

## **Educational research on teaching, in order to support professionals (not just policy makers !), ...**

... reconstructs the patterns of professional activity, especially the patterns of teaching that shape student learning and personal growth.

# Research on Teaching international

Study	Year of fielding	Inter national	Video	Long itudi nal	Inter vention	Sub ject
SIMS	1980-82	X		X		Ma
TIMSS	1995-2015pp.	X	X			Ma
TIMSS-Video I (US,JP,GER)	1995, 1999	X				Ma
<i>TIMSS-Video Germany</i>	1995		X	X		Ma
TIMSS-Video II ( <i>NLD, CZR, CHE, HKG, AUS, US, JP</i> )	1999	X	X			Ma, S
<i>MET (US)</i>	2009-2010		X	X		Ma
„Pythagoras“ ( <i>GER, CHE</i> )	2003-04		X	X		Ma
Quality of Instruction in Physics ( <i>CHE, DEU, FIN</i> )	2008-09	X	X	X		Phy
<i>„IGEL“ (GER)</i>	2010-2011		X	X	X	Ma
<i>Co<sup>2</sup>Ca (GER)</i>	2010-2011		X	X	X	Ma
PISA	2012 pp	X				Ma,S,R
TALIS-Video ( <i>CHL, COL, MEX, ESP, ENG, GER, JP, CHN</i> )	2018	X	X	X		Ma

# Research on Teaching in international perspective

- 1) Teaching goals
- 2) Teaching content
- 3) Teaching practices
- 4) Teaching quality
- 5) Teaching effectiveness

# **Types of Teaching goals found in TALIS-Video**

*(Praetorius, Klieme, Opfer, Bell, McCaffrey, Stecher et al., in press)*

Subject matter knowledge and understanding

Subject-related strategies, skills and abilities

Subject-related attitudes and habits

Cross-curricular competencies (e.g., reasoning, ICT)

General attitudes and habits

Well-being, resilience

Norms, values, ethics

Sustainability

Reduction of inequalities

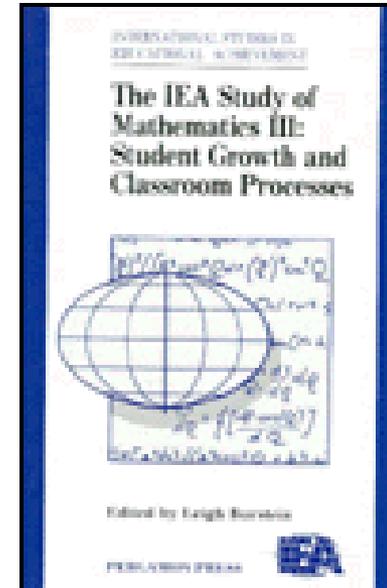
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# SIMS Longitudinal Add-On

Burstein et al. 1993

„The only classroom or school variable to be significantly related to achievement growth (controlling for other student and schooling variables) in more than one system was opportunity to learn the content represented on the test (OTL). Even for OTL the results are spotty and inconsistent.“(320)



## Opportunity to learn = Content Exposure

(Schmidt & McKnight 1995; Schmidt & Maier 2009)

- Content Coverage
- Content Exposure Variables:  
considering time and depth of teaching
- Content Emphasis Variables:  
e.g., lower vs. higher order skills



International Association  
for the Evaluation of  
Educational Achievement

# PISA 2012 (see Klieme et al., 2013)

## *Experience with applied tasks*

Have you been taught to do the following types of mathematics tasks during your time in school?

Using a train timetable, how long it would take to get from one place to another

Calculating how much more expensive a computer would be after adding tax

Calculating how many square metres of tiles you need to cover a floor

Understanding scientific tables presented in an article

Finding the actual distance between two places on a map with a 1:10,000 scale

Calculating the power consumption of an electronic appliance per week

# PISA 2012 (see Klieme et al., 2013)

## *Experience with algebra tasks*

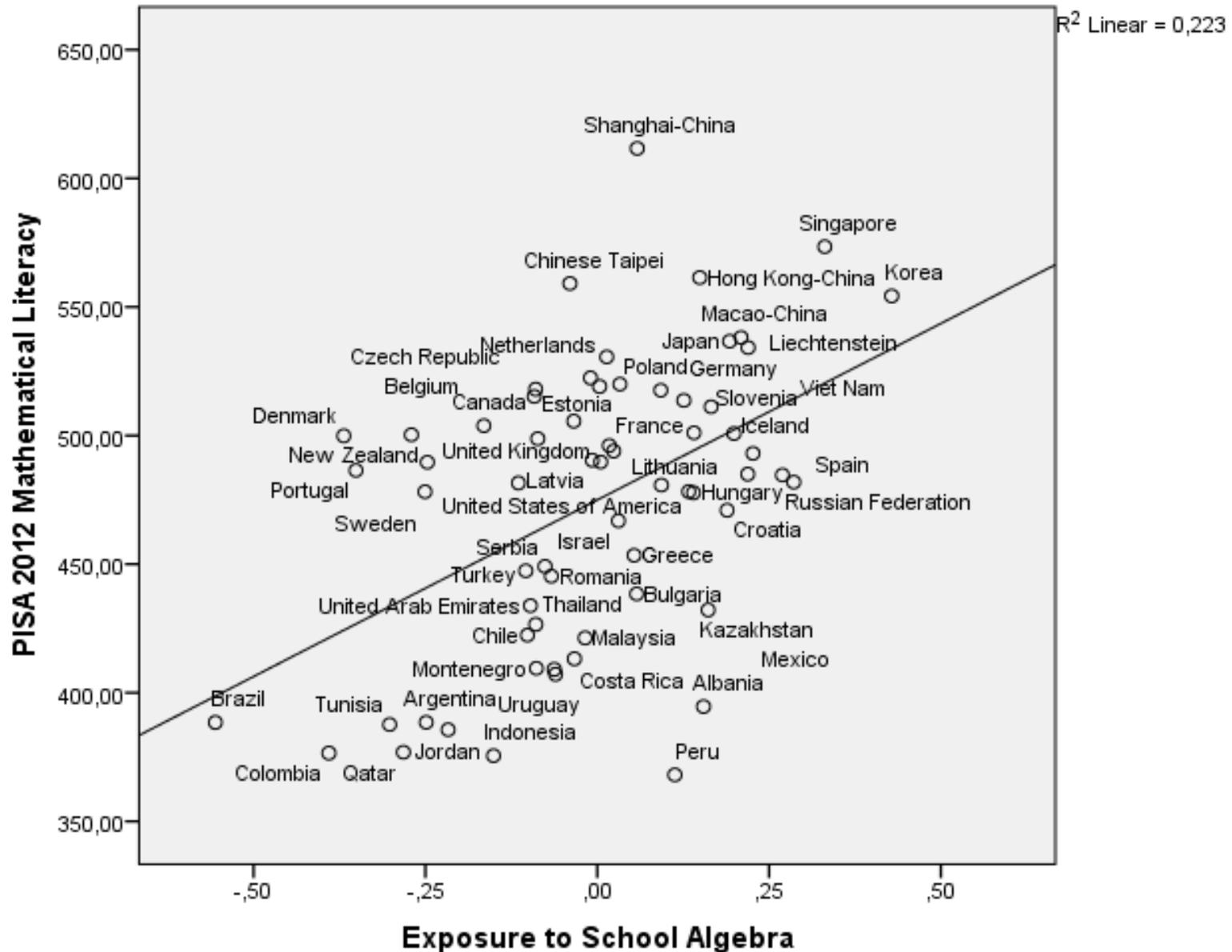
Have you been taught to do the following types of mathematics tasks during your time in school?

Solving an equation like  $3x+5=17$ .

Solving an equation like  
 $2(x+3) = (x+3)(x-3)$ .

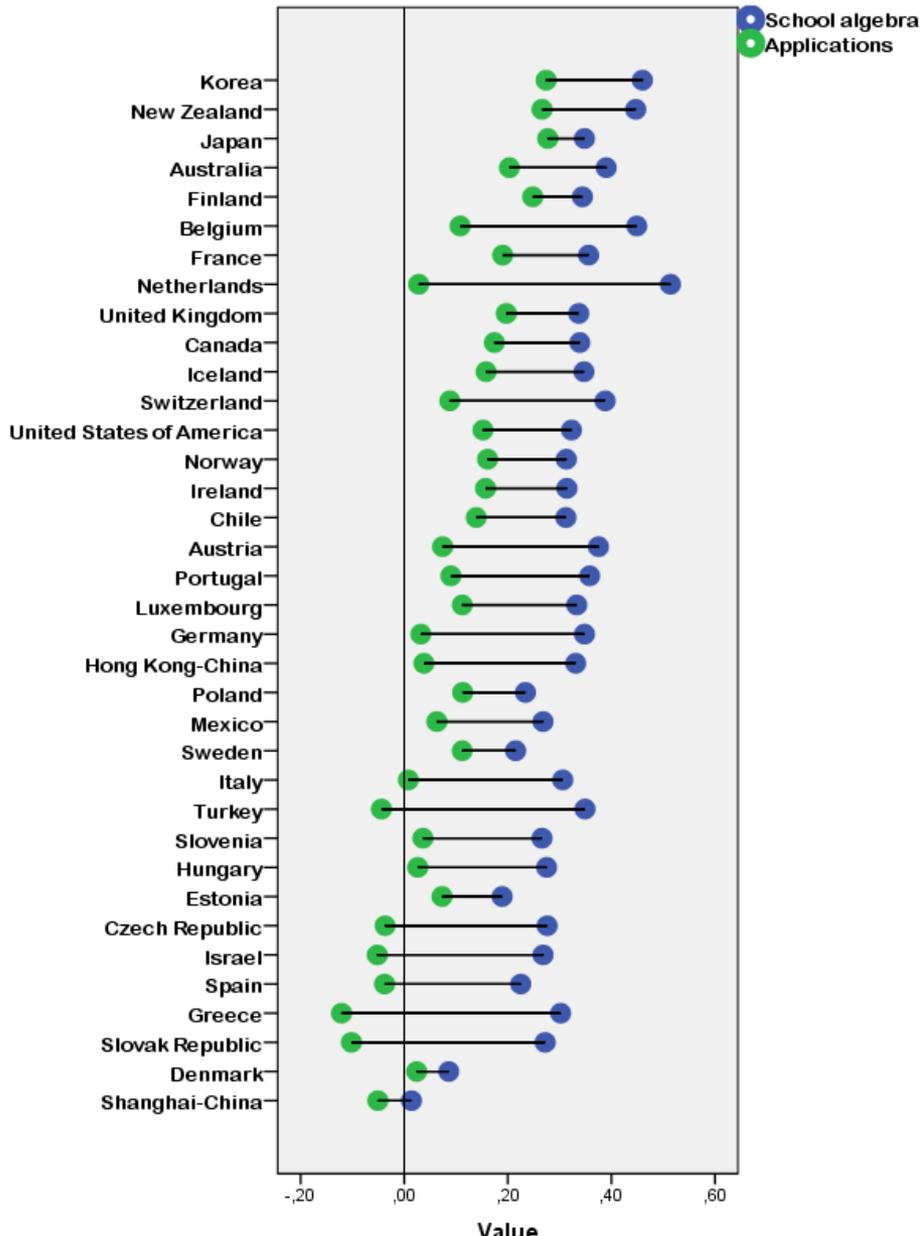
Solving an equation like  
 $3x+5=17$ .

# Between Country Relationship: Math OTL with Math Achievement



# Within Country correlations:

## Math OTL with Math Achievement



Level of exposure to demanding school math (= algebra) is related to higher achievement

Correlations for application-based math are smaller, sometimes even negative

(Extreme cases: Shanghai, Netherlands.)

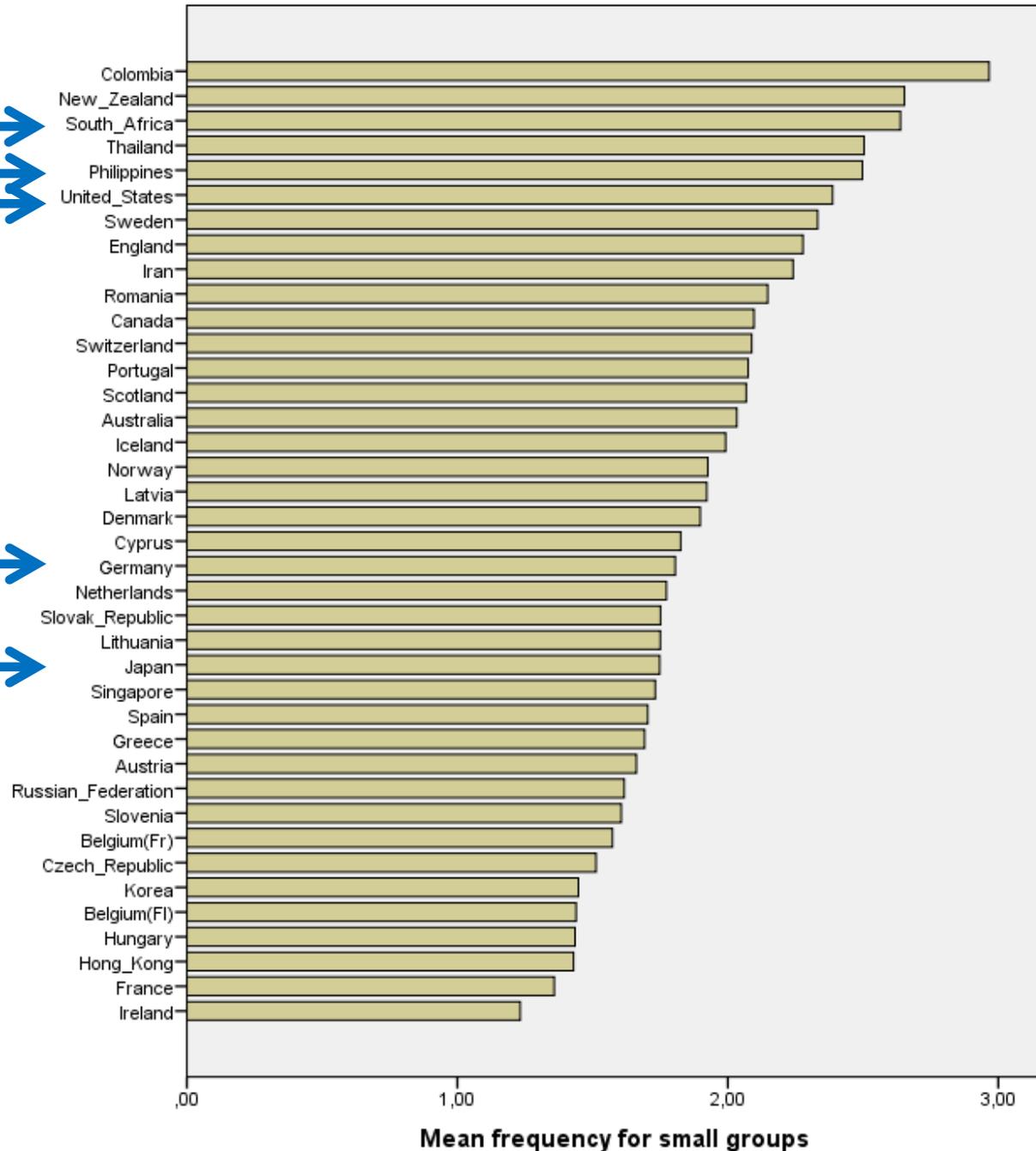
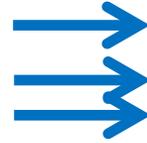
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# TIMSS 1995

## Small groups

## Frequency



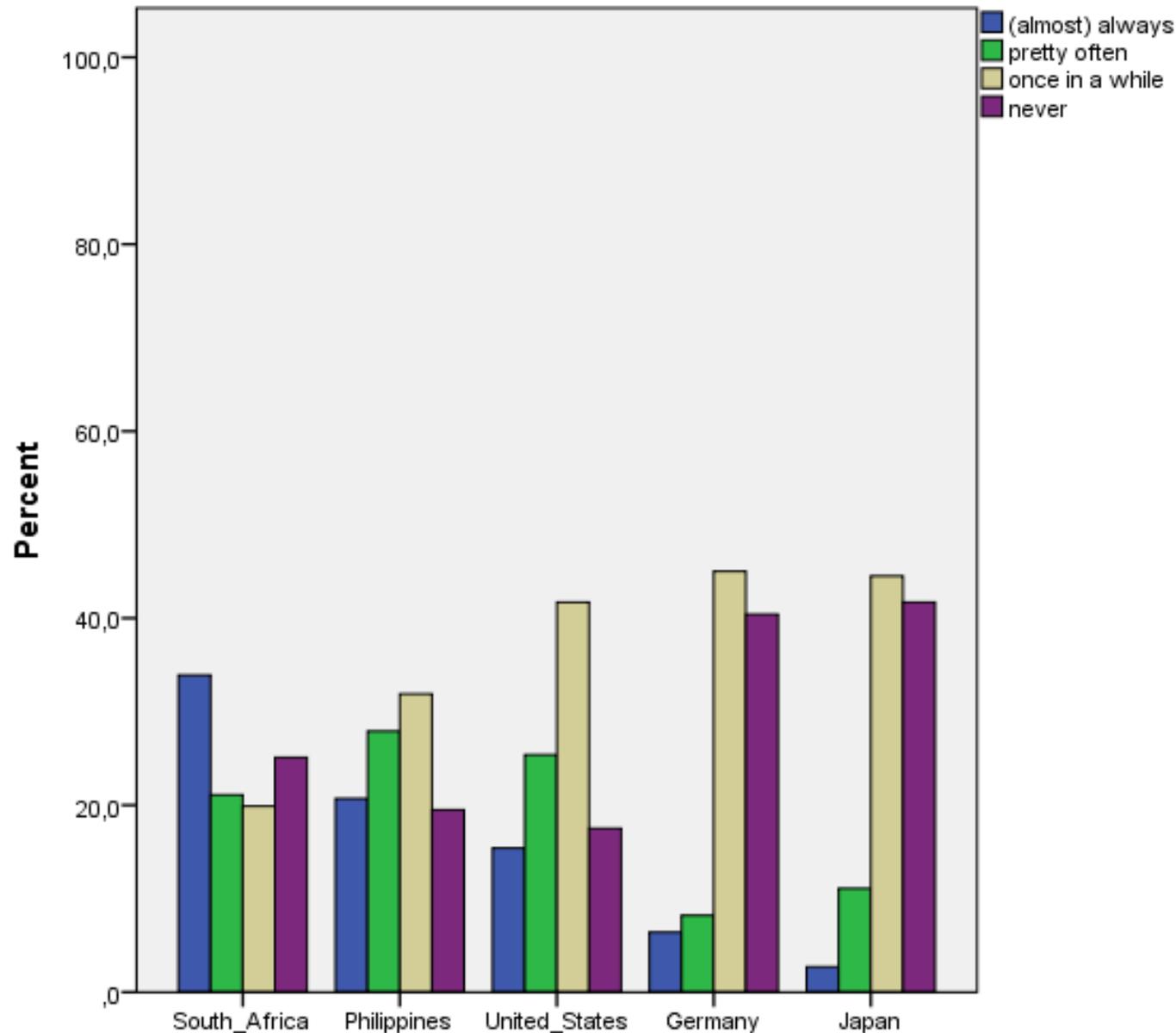
How often do you work together in pairs or small groups in your mathematics lesson?

4= (almost) always 3= pretty often 2=once in a while 1=never

# TIMSS 1995 Small groups

## Frequency

How often do you work together in pairs or small groups in your mathematics lesson?



# TIMSS-**Video** 1995 – Teaching practices

## **Japan: Setting up & managing group work**

This video can be found at

<http://www.timssvideo.com/japan-mathematics-lessons/>

as „JP1“

# TIMSS-**Video** 1995 – Teaching practices

## **Japan: Setting up & managing group work**

Practices=

Shared patterns of activity within a culturally shaped social, physical, and intellectual space –  
Combination of doing, saying, handling artefacts.

Teaching Practices=

Patterns of classroom activity – Chains of teacher and student activities which establish, represent, and negotiate subject matter understanding.

# TIMSS-**Video** 1995 – Teaching practices **Germany: Whole class discussion**

This video is unfortunately not available for public access.

# TIMSS-Video 1995 Follow Up – Teaching practices Germany: Mix = “Teacher-led group work”

This video clip has been shot for public use, but so far it is available on CD-ROM only.

You may request a file copy from the author.

# Summary: Teaching practices

1. Teaching is a “**cultural activity**” (Stiegler & Hiebert, 1999). Within a given (rather: constructed) cultural context, (qualitative) research may identify recurring patterns of teacher and student activities grounded in shared knowledge = **teaching practices**.
2. Teaching practices may **change** over the years, partly through adapting practices from other cultures.

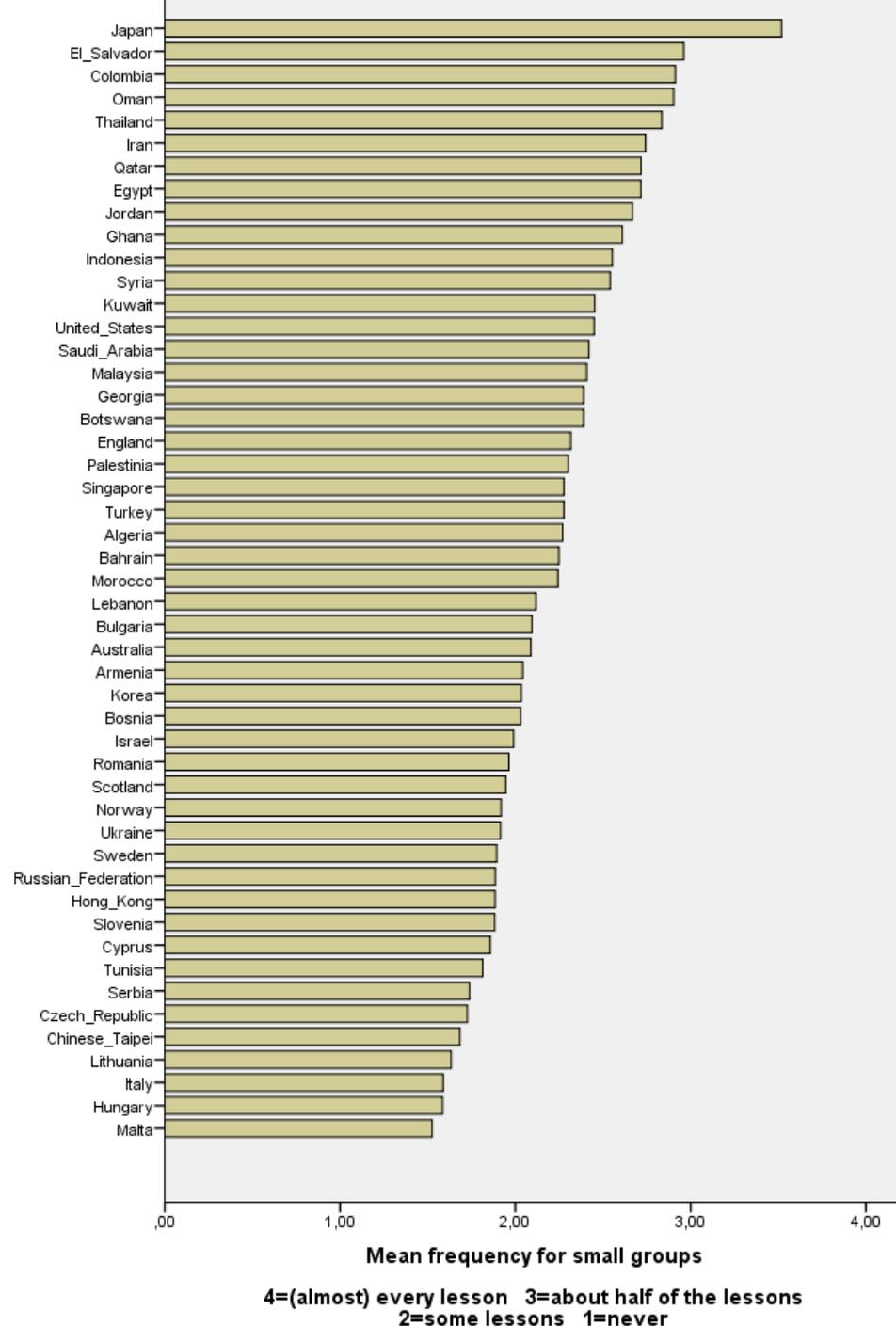
# TIMSS 2007

## Small groups

## Frequency

How often do you do these things in your mathematics lessons?

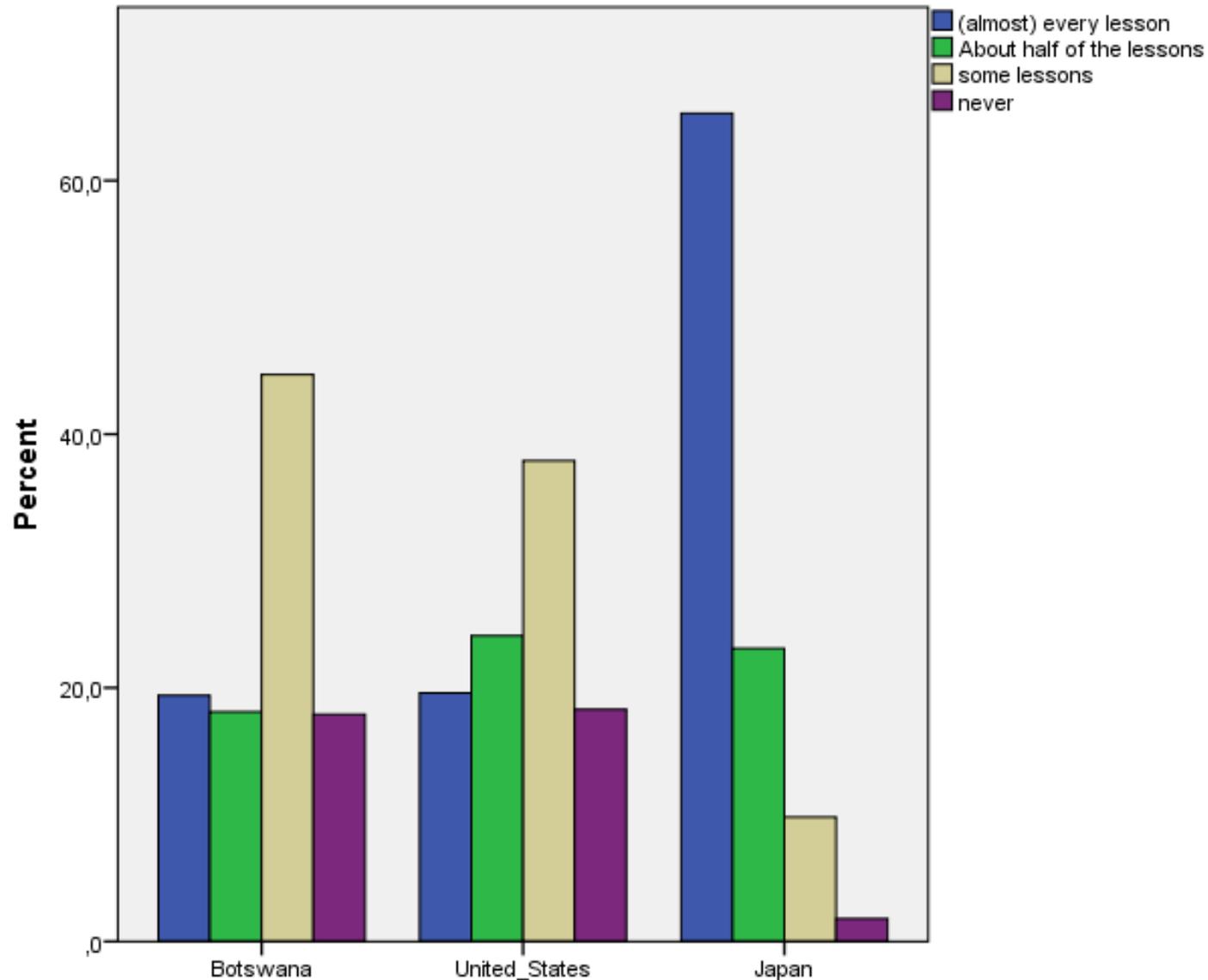
We work together in small groups



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# Summary: Teaching practices

1. Teaching is a “**cultural activity**” (Stiegler & Hiebert, 1999). Within a given (rather: constructed) cultural context, (qualitative) research may identify recurring patterns of teacher and student activities grounded in shared knowledge = **teaching practices**.
2. Teaching practices may **change** over the years, partly through adapting practices from other cultures.
3. International **surveys** inform about frequencies of teaching and learning activities (e.g., lecturing, small group work) that are obviously shaped by cultural/pedagogical background. The same activity structure (e.g., small groups) may have different meaning across cultures.
4. **Thesis:** (a) We need video data to understand teaching.  
(b) Rather than comparing PRACTICES across cultures, we may be able to compare QUALITY and EFFECTS of teaching.

# Research on Teaching in international perspective

- 1) Teaching goals
- 2) Teaching content
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David Berliner (2005)

Teaching quality:

(a) good teaching: normative

(b) successful teaching:  
factors shown to be effective, i.e.  
predicting student outcomes

-

# Promoting good teaching through „teaching philosophies“ or „intact patterns“ (Gage 1985)

- Support for personal growth (Reform pedagogics...)
- Open learning environments (Hannafin, Land & Oliver)
- Personalized learning
  
- Support for understanding (Constructivist teaching)
- Discovery learning (Bruner)
- Inquiry-based science education
- Cognitive apprenticeship (Collins et al.)
  
- Mastery Learning (Bloom)
- Direct Instruction (Rosenshine)
- Competency-based education

# Developing a basic structure across classroom factors: German extension to TIMSS-Video 1995

## Exploratory factor analysis of classroom practice

based on high-inference video-ratings

(see Clausen, 2002, Klieme/Schümer/Knoll, 2001)

(TIMSS-Video 1994 Germany: national sample, 100 + 86 lessons)

<b>Structure and Classroom Management</b>	<b>Supportive climate</b>	<b>Cognitive Activation</b>
<p><b>Effective treatment of interruptions</b>            „teacher intervenes immediately, before disturbance may evolve“</p> <p>Clarity of rules            Interruptions (-)            Waste of time (-)            Monitoring            Time on task            Teacher Unreliability (-)  <b>Clarity and structuredness of the Instruction</b></p>	<p>Social orientation:            „teacher takes care of his students‘ problems“</p> <p>Teachers diagnostic competence with regard to social behavior</p> <p><b>Individual reference norm in evaluation</b></p> <p>Rate of interaction (-)            Pressure on students (-)</p>	<p>Teacher’s ability to motivate students:            „can present even abstract content in an interesting manner “</p> <p><b>Errors as opportunities</b>  <b>Demanding tasks</b>            Practicing by repetition (-)</p>

# Measuring Teaching Quality: Either through high-inference observation or through Student Questionnaires e.g., PISA 2012)

## *Classroom discipline (structure)*

Students don't listen to what the teacher says (-)

There is noise and disorder (-)

The teacher has to wait a long time for students to quiet down(-)

Students cannot work well (-)

Students don't start working for a long time after the lesson begins (-)

## *Teacher support*

The teacher shows an interest in every student's learning.

The teacher gives extra help when students need it

The teacher helps students with their learning

The teacher continues teaching until the students understand

# Cognitive activation (based on Baumert et al.: COACTIV-Study)

The teacher asks questions that make us reflect on the problem

The teacher gives tasks that involve calculations alone (-)

The teacher gives problems with definite solutions (-)

The teacher gives problems that require us to think about them for an extended time

The teacher asks us to decide on our own procedures for solving complex problems

The teacher presents problems for which there is no immediately obvious method of solution

The teacher presents problems in different contexts so that students know whether they have understood the concepts

The teacher helps us to learn from mistakes we have made

The teacher asks us to explain how we have solved a problem

# Theory of Schooling

(Diederich/Tenorth, 1997; Fend, 2005;  
Dreeben & Barr, 1988; Doyle, 1977/1986)

Classroom teaching and learning  
both requires and fosters

1. Being on task

2. Motivation

3. Understanding

# Psychological Foundations

## 1. Being on task

← classroom management, clarity and structure

Process-Product-Research; Behavioral learning theory

## 2. Motivation

← support, social embeddedness

Humanistic pedagogy and psychology;

Self determination Theory (Deci & Ryan)

## 3. Understanding

← deep content, challenging tasks, *cognitive* activation

Cognitive Theory (e.g. Brown 1997, Mayer 2004);

concepts from (moderate) constructivism

See also Capella, Aber & Kim (2016). Teaching Beyond Achievement Tests. In Gitomer & Bell (Eds.): Handbook of Research on Teaching, 249-347

# Pianta & Hamre: Classroom observation scales (CLASS)

- Classroom organization
- Emotional support
- Instructional support

# Tschannen-Moran, M. & Woolfolk Hoy, A. (2001): Ohio teacher efficacy scales (OSTES)

- Efficacy for classroom management
- Efficacy for student engagement
- Efficacy for instructional strategies

# Research on Teaching in international perspective

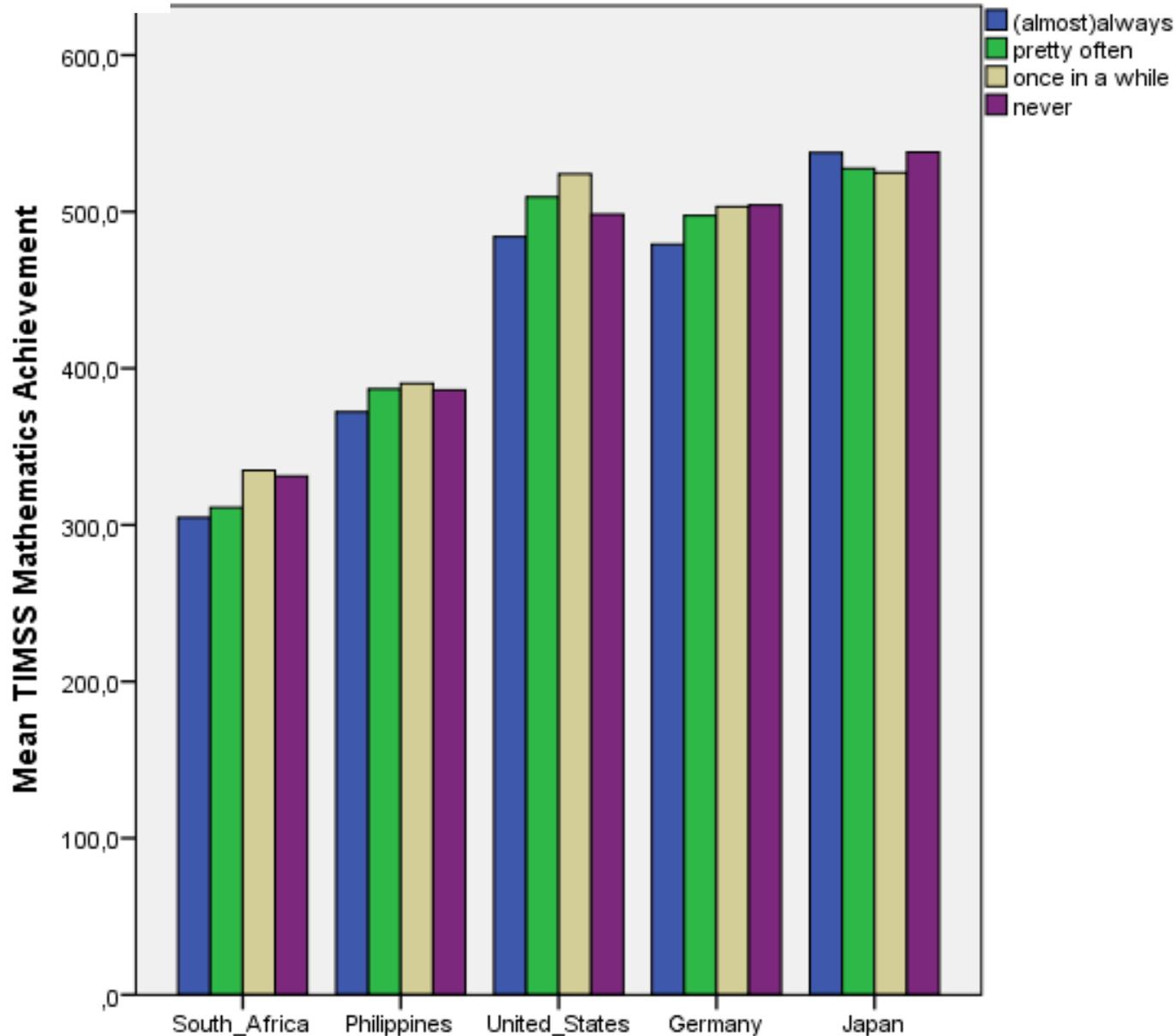
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# TIMSS 1995

## Small groups

## Relation with Math Achievement

How often do you work together in pairs or small groups in your mathematics lesson?



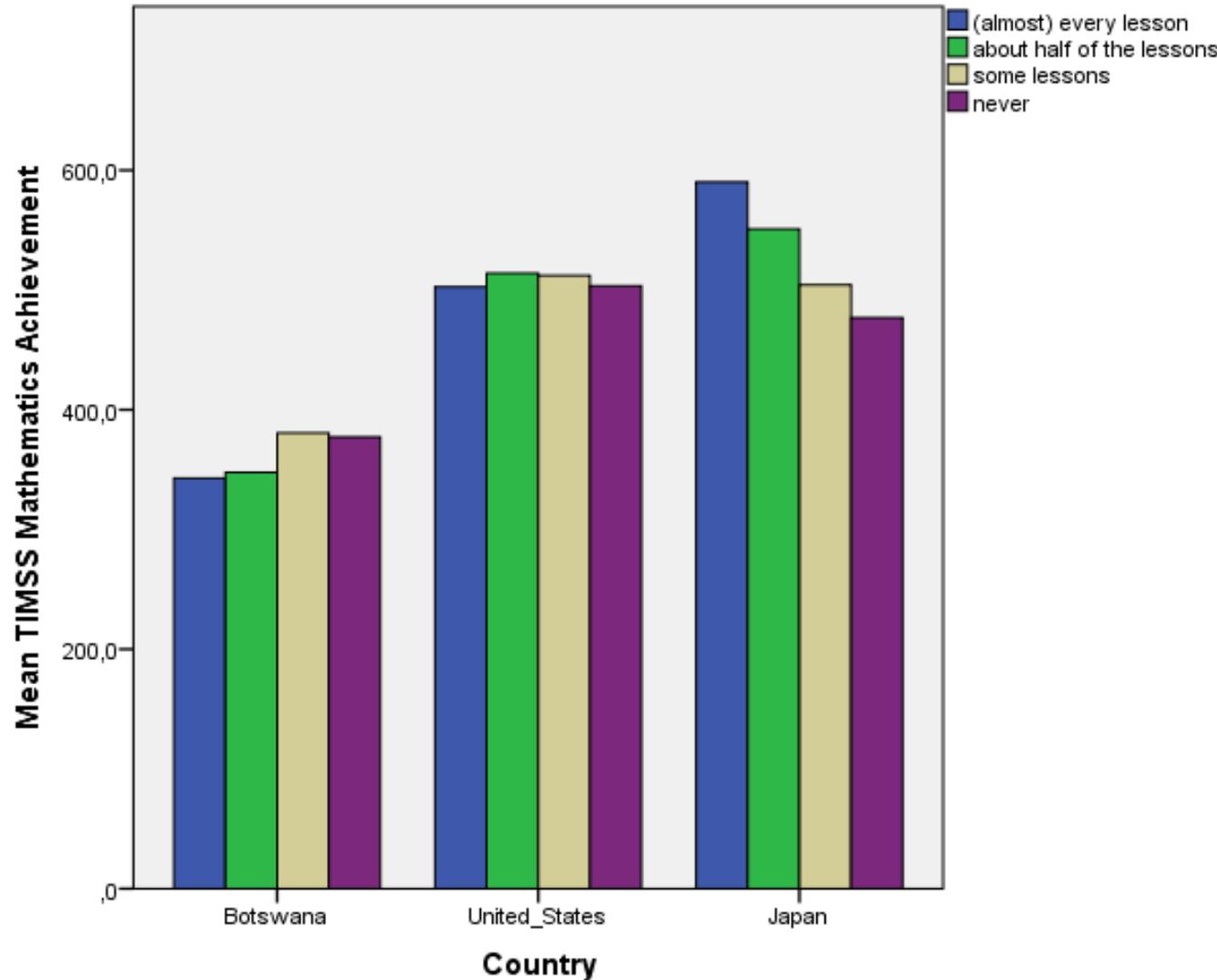
# TIMSS 2007

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How often do you  
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We work together  
in small groups



## Problem with Large Scale Assessment data:

- Cross-sectional data (e.g., TIMSS or PISA) do not allow any conclusion about direction of impact or causality.
- Even with longitudinal designs (such as TIMSS-Video/Germany, the MET-Study in der US), teaching variables (whether Content, Practices, or Quality) are oftentimes ill-defined.
- video-based, *single topic micro-genetic design* with explicit intervention

# Single Topic, micro-genetic design

as developed in the “Pythagoras” study (Klieme/Pauli/Reusser 2009),

- The study is tied to one specific topic of instruction. The “focal unit” has a well-defined starting point and covers all content taught until a different topic is addressed.
- All participating teachers teach the focal unit as they usually do.
- Tests/Questionnaires administered closely before/after the unit.
- All measures of teaching and learning (OTL, Teaching Practices, Teaching Quality, outcomes, predictors) are related to the unit

## with intervention

as developed in the “IGEL” (Decristan, Hardy, Klieme et al.) and “Co<sup>2</sup>Ca” (Klieme, Rakoczy, Blum, Leiss et al.) studies

# IGEL- Early science education in primary schools

## Intact pattern: Inquiry-based science education

- 4,5 lessons (1,5 hrs each) on Floating and Sinking
- Based on learning materials developed for inquiry-based science education<sup>1</sup>
- Adaptive elements (student experiments, individualised assignments) + treatments (e.g., formative assessment)

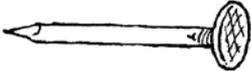


1) Jonen, A. & Möller, K. (2005). *Klasse(n)kisten für den Sachunterricht. Ein Projekt des Seminars für Didaktik des Sachunterrichts im Rahmen von KiNT „Kinder lernen Naturwissenschaften und Technik“*. Thema: Schwimmen und Sinken. Essen: Spectra Verlag.

# Add-on: Discrete practices - focus: formative assessment

Diagnostic tool:  
„Food for Thought“  
on conceptual  
understanding

1. Was schwimmt, was geht unter?

Dieses <b>kleine</b> Stück Wachs schwimmt. 	Dieses <b>große</b> Stück Wachs  <input type="checkbox"/> geht unter. <input type="checkbox"/> schwimmt.
Dieser <b>große</b> Eisennagel geht unter. 	Dieser <b>kleine</b> Eisennagel  <input type="checkbox"/> geht unter. <input type="checkbox"/> schwimmt.
Diese <b>große</b> Glaskugel geht unter. 	Diese <b>kleine</b> Glaskugel  <input type="checkbox"/> geht unter. <input type="checkbox"/> schwimmt.

2. Schwimmt ein großer, schwerer Baumstamm im Wasser?  
Fünf starke Männer können ihn nicht tragen.



Der **Baumstamm**  geht unter,  schwimmt,

# Evaluation Design

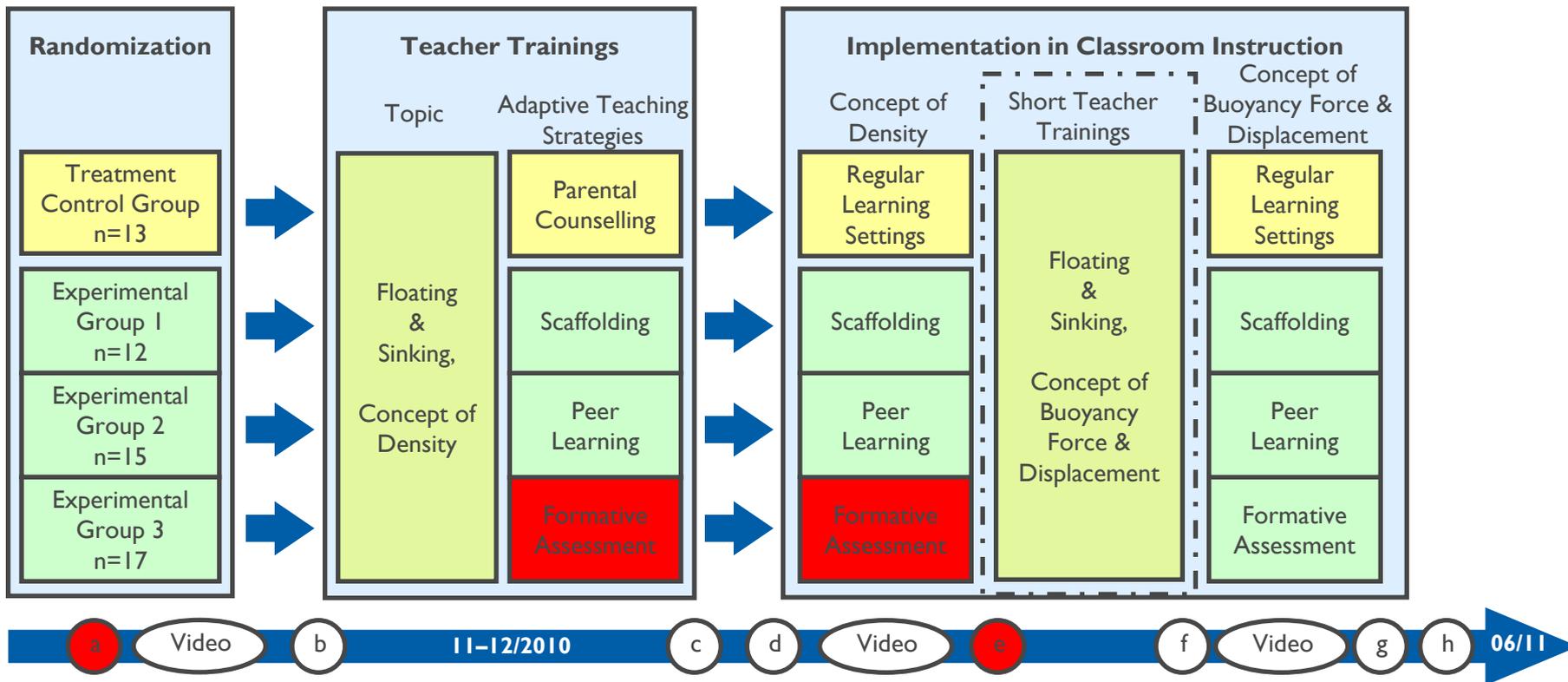
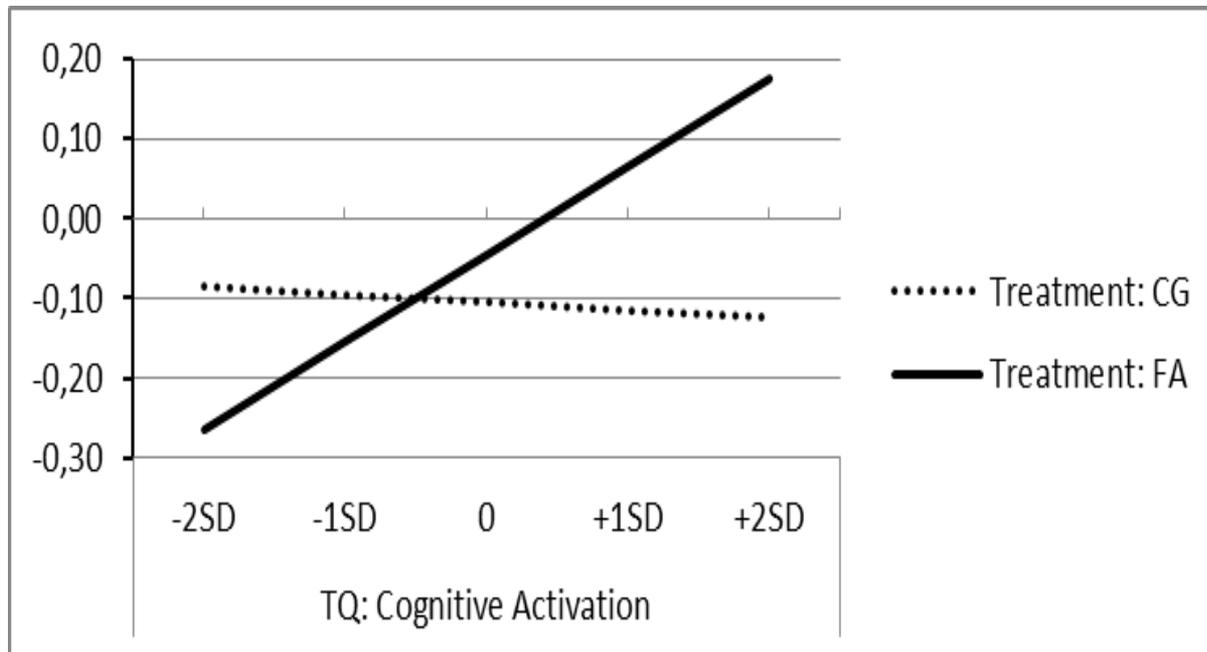


Figure: Design of the IGEL-project, a-h: time points of measurement at student level and/or at teacher level.

N = 54 teachers (12 SC, 14 PL, 17 FA, 11 PC), 1070 students

# Major Findings from IGEL: Predicting conceptual understanding of floating and sinking

1. Main positive effect for Formative Assessment intervention.
2. Interaction: Effect of Formative Assessment is stronger if Cognitive Activation is high.



# Major Findings from IGEL: Predicting conceptual understanding of floating and sinking

1. Main positive effect for Formative Assessment intervention.
2. Interaction: Effect of Formative Assessment is stronger if Cognitive Activation is high.
3. Moderation: Effect of formative assessment is stronger for students with language problems
4. Main positive effect for Classroom management.
5. Moderation: Supportive Climate and Cognitive Activation do have a positive Effect in heterogeneous classrooms.

# Major Findings from IGEL: Predicting student interest in science

1. Main positive effect for Formative Assessment intervention.
2. Mediation by perceived competence
3. Main positive effect of Supportive Climate and Cognitive Activation.

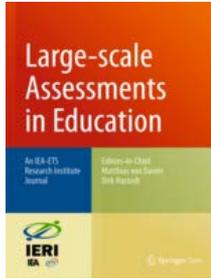
*(Decristan et al. 2014, 2015a,b, 2017a,b; Fauth et al. 2014, 2018; Hondrich et al. 2016, 2018)*

# Limitations of IGEL

- No integrated model available. (Partly because of small sample size.)
- Unexpected direct effect of Cognitive Activation on student motivation.
- Teaching quality mainly assessed through student perceptions.
- No add-on effects for other practices (peer learning, scaffolding).
- Content matter and teaching pattern (=didactical approach) were kept constant → further research needed
- German context only.

“What works where? The relationship between instructional variables and schools' mean scores in mathematics and science in low-, medium-, and high-achieving countries”

**Ruth Zuzovsky (2013)**



**Based on TIMSS 2007:**

HLM analyses

run separately for individual practice items

including 7,201 schools from 48 countries,

controlling for individual student background

**Finding:** Constructivist practices (e.g., “We work on problems on our own.”) will be more beneficial for students only in high-achieving countries.

# Research on Teaching in international perspective

→ Challenge:

Running video-based

- a) longitudinal surveys (such as MET),
- b) single-topic micro-genetic studies (Pythagoras),
- c) intervention studies (IGEL)

in multiple countries in order to understand the role of culture in teaching, support professional development in a given country, and prevent simple “borrowing” across countries.

TALIS-Video (ongoing) is a first step for type b).

# Research on Teaching in international perspective

## → Challenge:

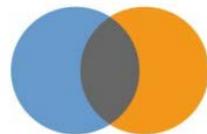
In line with Felice Levine's remarks at the Presidential Session, we as a research community need to

- collaborate across nations,
- take all kinds of goals into account (subject-related&personal)
- combine research disciplines in theory and empirical studies,
- establish rich data sets (involving video data)
- get into dialogue with practitioners.

# Thank you for your attention !

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