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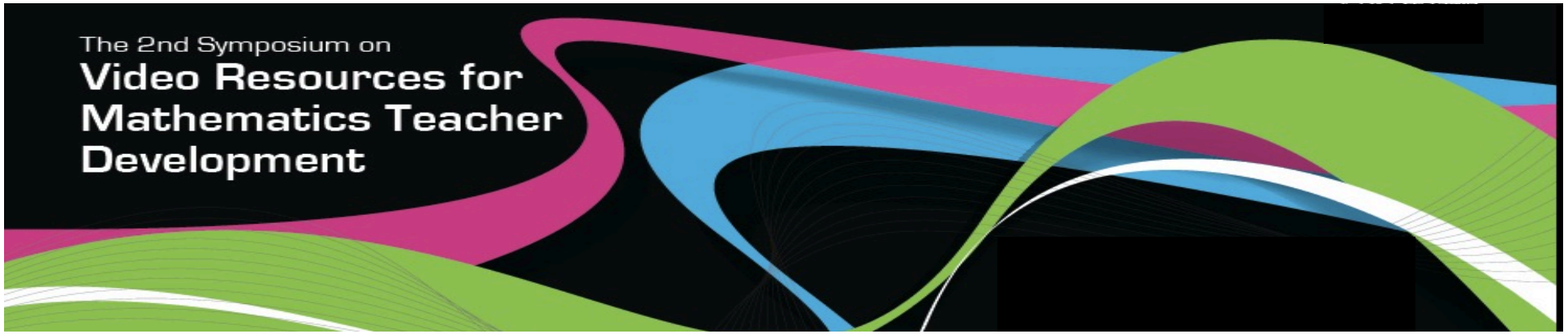
Education in Mathematics

Potentials and limits for the use of videos in professional development at scale:

The case of learning scaffolding



Specific challenge for the use of videos: Scaling up

Formerly in our work:

- often used videos for PD (professional development) in joint reflections of own practice (kind of lesson study) and simulations (Ball 1993, Sherin et al. 2009: Video clubs)

- successful "boutique projects" with face-to-face-facilitation and many intuitive ad hoc decisions

New challenge for us: PD at scale

- > 500 preservice teachers every year
- nation-wide programs, ideally for about 90 000 inservice math teachers and 500-1000 PD facilitators

- scaling up needs own strategies and considerations (Clark, Wilson, Hoyles, Noss 2013; Levin 2008; Schneider & MacDonald 2007)

→ need for **robust** video-assisted PD modules with more explicit support and a priori defined content

DZLM

Selected goal: learning scaffolding

Approach for research-based design of video-assisted modules:

- not „what can the technique do“ (as warned by Seago 2000, Sherin 2004)
- but starting from identifying a goal, subgoals and concrete demands

(as suggested by Blomberg, Sherin et al. 2013)

Selected goal: teachers learn to offer interactional scaffolding

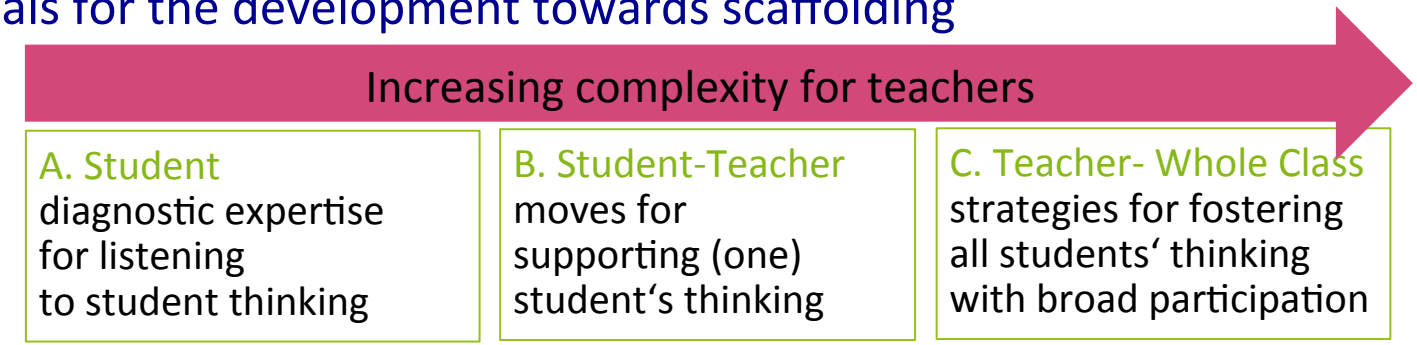
- Definition of interactional scaffolding:
  teachers' practice of supporting learning in interactions
  by which students gradually become more involved in practices or understandings

  (Wood, Bruner, & Ross, 1976, p. 90, Anghileri 2006, Sleep & Boerst 2013)
- not only in one-by-one-situations, but also in whole class discussions

Interactional scaffolding is a specific challenge for scaling up
since it is hardly material-based!!

Steps for research-based design of video-assisted PD modules

Three identified subgoals for the development towards scaffolding



Steps for each subgoal:

1. Step: Defining the general subgoal
2. Step: Specifying concrete professional demands
3. Step: Exploring teachers‘ perspectives and their change
4. Step: Drawing consequences for the role of video
5. Step: Adapting for video-assisted PD modules at scale

Structure of the talk

A. Student	B. Student-Teacher	C. Teacher- Whole Class
diagnostic expertise for listening to student thinking	moves for supporting (one) student's thinking	strategies for fostering all students' thinking with broad participation

math-didactical foundations (PCK & MFT)

1. Step: Defining the general subgoal
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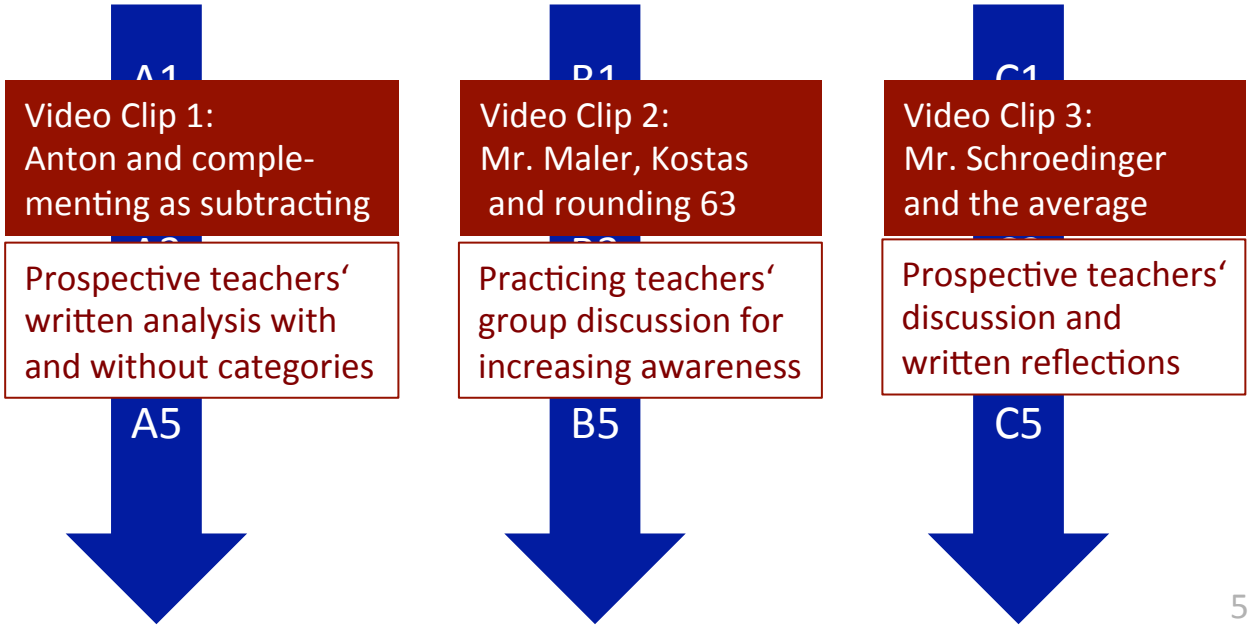
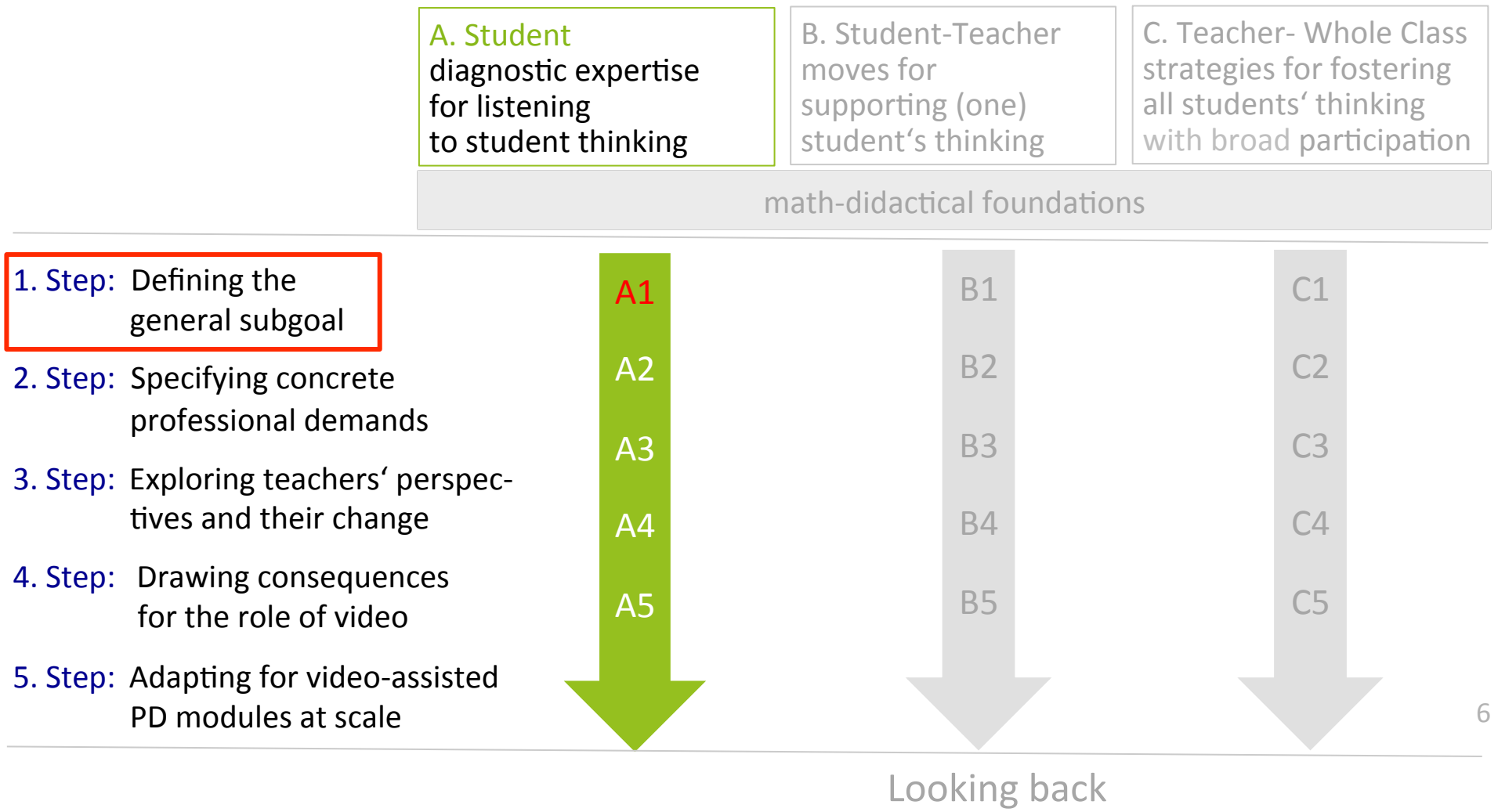


Structure of the talk



A1. Defining the subgoal “diagnostic expertise“

Diagnostic expertise (Prediger 2010)

(1) Interest in student thinking (not deficit-oriented)

(2) Interpretative attitude: (Jungwirth et al. 2001)

- nondirective listening (Empson & Jacobs 2008)
- decentering the judgments (Arcavi & Schoenfeld 2008)

(3) General knowledge on learning processes

(4) Domain-specific math-didactical knowledge:

- unpacking mathematical aspects (Morris, Hiebert, & Spitzer 2009)
- unpacking didactical aspects (Prediger et al. 2012)

math-didactical categories are needed to see, unpack and decenter thinking

A2. Specifying concrete professional demands re diagnostic expertise

The african grey parrot can grow up to 40 cm long.
A flamingo measures about 2 m, thus 200 cm.
How many times is the flamingo bigger than the grey parrot?

Video Clip 1:
Anton and
complementing as subtracting

1 A There... 40 · 200?
2 I How did you find that?
3 A No, or, I would, or 40 divided by 200.
4 A I have to watch, actually. Wait...
5 I Yeah, think about it.
6 A [*16 sec break*] well, 160, well 1,60 m is he bigger, the Flamingo. I know that.
I can remember that. [*writes* 160]
7 I Yes, write it down, though.
8 A And I have calculated this in ...
Well, I have ... complemented.
9 I Mhm.
10 A How do you make the complement sign?
11 I Either, you can write plus anyway...
12 A Ok, I can ... [*writes* 40 + 60 + 100 = ~~160~~ 200]

(Video by N. Renk 2008, 1:55 min, analysed in Prediger 2009)

A2. Specifying concrete professional demands re diagnostic expertise

Video Clip 1: Anton and complementing as subtracting

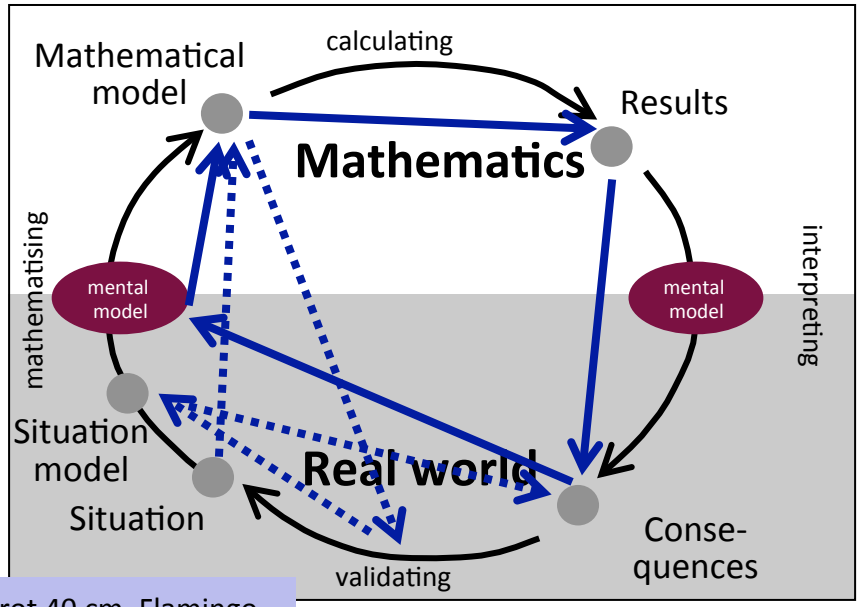
1 A There...40 · 200?
2 I How did you find that?
3 A No, or, I would, or 40 divided by 200.
4 A I have to watch, actually. Wait...
5 I Yeah, think about it.
6 A [*16 sec break*] well, 160, well 1,60 m is he bigger, the Flamingo. I know that.
I can remember that. [*writes* 160]
7 I Yes, write it down, though.
8 A And I have calculated this in ...
Well, I have ... complemented.
9 I Mhm.
10 A How do you make the complement sign?
11 I Either, you can write plus anyway...
12 A Ok, I can ... [*writes* 40 + 60 + 100 = 160]

...

19 I Hm, the question was
"how many TIMES bigger"

200 - 40 = 160

40 + 60 + 100 = ~~160~~ 200



Grey parrot 40 cm, Flamingo 200 cm [...] How many times is the flamingo bigger than the grey parrot?

160 cm

A2. Specifying concrete professional demands re diagnostic expertise – job analysis

Video Clip 1: Anton and complementing as subtracting

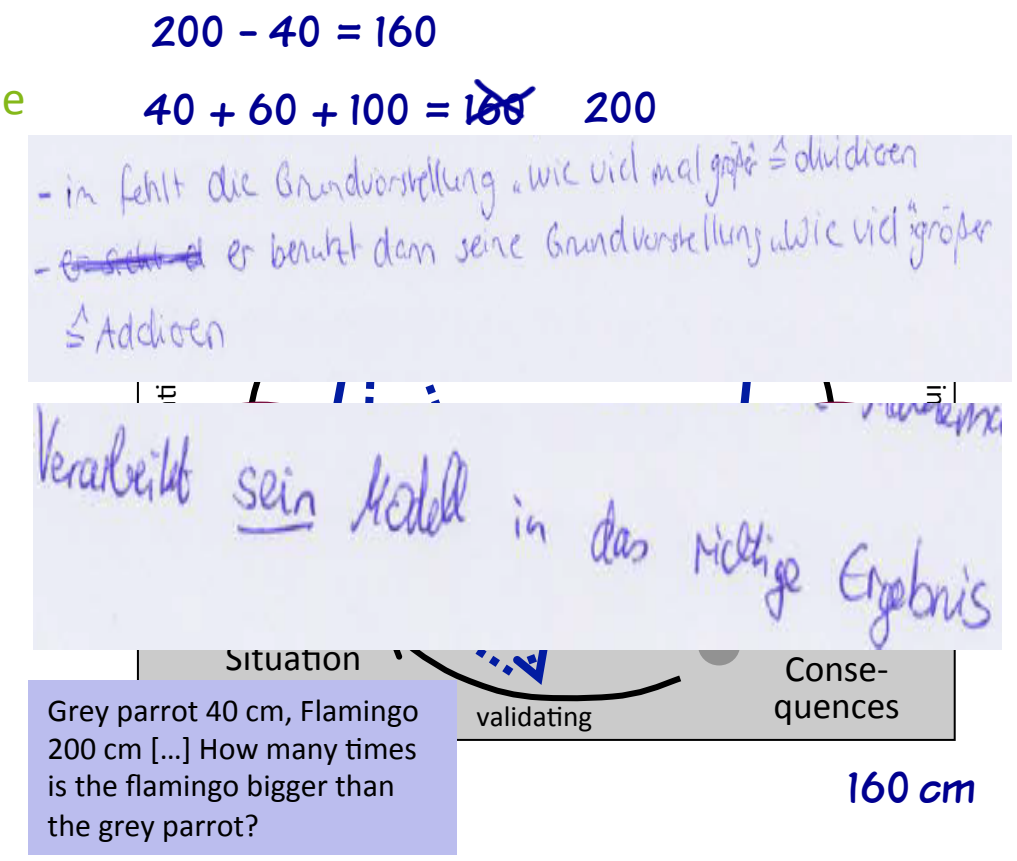
Math-didactical categories for

… unpacking student thinking

- Anton's iterative approach to solution
  ← cognitive activities in modelling cycle
- formalizing is more difficult for Anton than finding result 160
  ← missing mental model for complementing as subtracting

… decentering the judgments

- Anton's mathematization is coherent to his individual situation model "determining the distance"
- 40 + 60 + 100 = 160 as suitable protocol for thinking, but deviant meaning of equal sign



Grey parrot 40 cm, Flamingo 200 cm […] How many times is the flamingo bigger than the grey parrot?

(modelling cycle: Pollack 1979, situation model: Reusser 1898, model: Fischbein 1989)

A3. Exploring diagnostic judgments and their change

Sample of the study: n = 160 prospective math teachers (year 1 and 3)

Design:

Pre-Investigation	Intervention: 20 min lecture	Post-Investigation
Video Clip 1: Anton and complementing as subtracting 160 written diagnostic judgments for Anton‘s process	Math-didactical categories for … unpacking student thinking • modelling cycle • mental model for division, subtraction, … … decentering the judgments • individual situation model • meanings	Video Clip 1: Anton and complementing as subtracting 160 written diagnostic judgments for Anton‘s process

A3. Exploring diagnostic judgments and their change – selected findings

Pre-Investigation	Intervention: 20 min lecture	Post-Investigation
Video Clip 1: Anton and complementing as subtracting 160 written diagnostic judgments for Anton's process	Math-didactical categories for … unpacking student thinking • modelling cycle • mental models for division, subtraction, … … decentering the judgments • individual situation model • meanings	Video Clip 1: Anton and complementing as subtracting 160 written diagnostic judgments for Anton's process

Unpacking: Focus on mental aspects, not only superficial aspects: 64 % → 80 % **

Activating categories, e.g. identify Anton's mathematizing: 46 % → 61 % **

first findings of ongoing data analysis:

- teacher's diagnostic judgments can deepen when they activate didactical categories
- the activation can be promoted by a (minimal!) input of categories

A4. Drawing consequences for the role of video

- videos have a high potential to promote teachers‘ reflection about student thinking (Sherin et al. 2009, and others)
- but videos are not self-containing, due to need to focus attention on crucial aspects
- for this purpose, math-didatical categories are necessary (Prediger 2010 JMTE)

→ combine videos with substantial input in PD

Math-didactical categories for
… unpacking student thinking
- modelling cycle
- mental models for division, subtraction, …

… decentering the judgments
- individual situation model
- meanings

A5. Adapting for video-assisted PD modules at scale

Formerly: spontaneous joint analysis of self-made videos

- advantage: mobilizes highest individual involvement
- risk: not all PD facilitators see crucial aspects ad hoc
- limit: spontaenous discussion cannot cover all topics systematically

Consequences

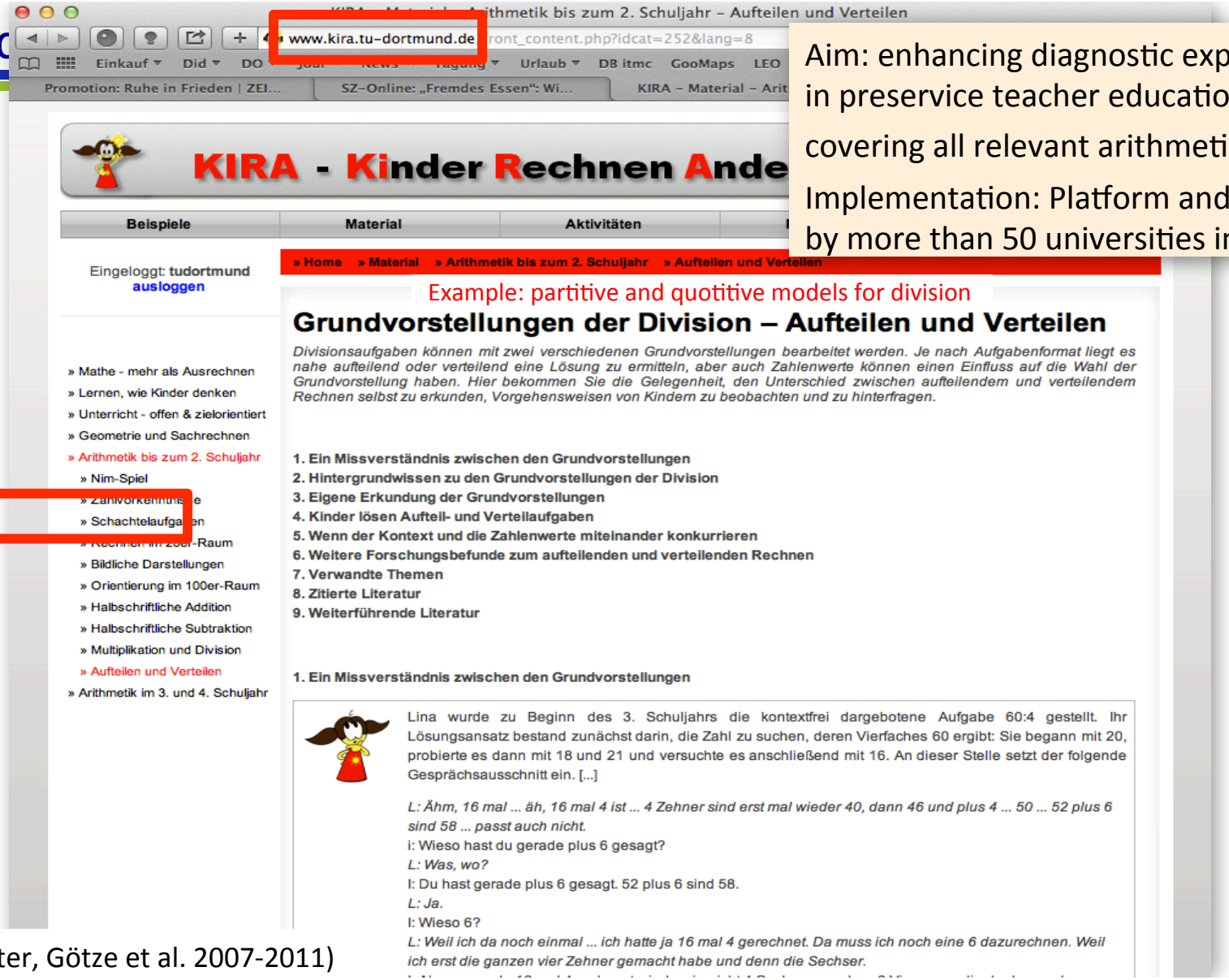
- more prepared video material with comments on meta-level
- systematic coverage of didactical categories for all crucial mathematical topics (← build coherent content-based programs, cf. Marongelle et al. 2013)

Examples from Dortmund projects

- preservice

inservice

A5. Ac



Example: partitive and quotitive models for division

Aim: enhancing diagnostic expertise in preservice teacher education

covering all relevant arithmetic topics

Implementation: Platform and DVD used by more than 50 universities in D, CH, A

(KIRA, Selter, Götze et al. 2007-2011)

A5. Adapting for video-assisted PD modules at scale

Topic specific categories

typical mistakes

Written material plus selected videos

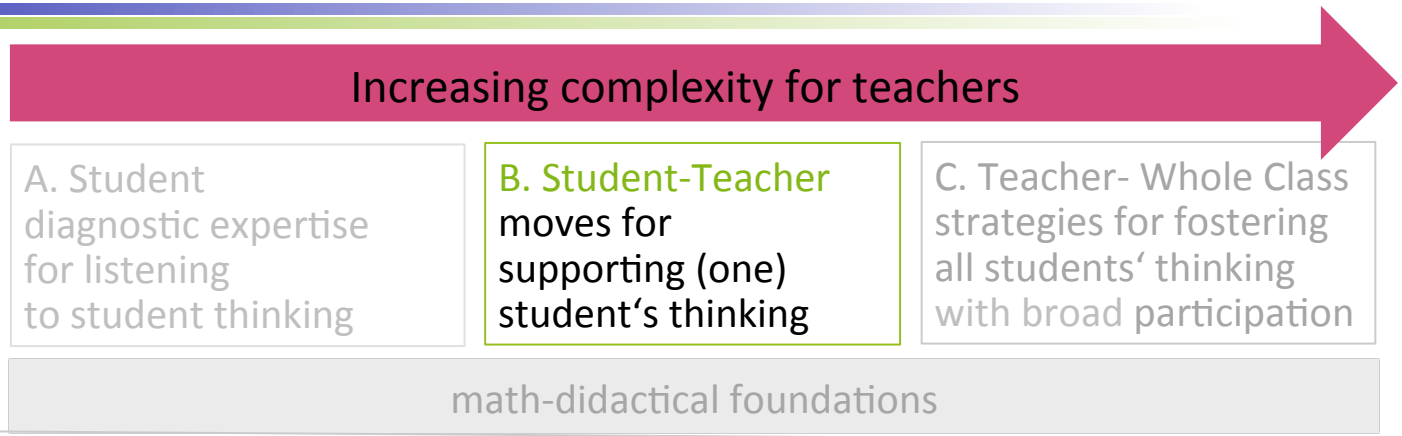
Aim: PD at scale for inservice teachers for fostering low achieving students

Implementation (starts Feb 2014) in 4 states, 65 schools with 20 multipliers

later further federal states

(Prediger, Selter et al. 2010-2017)

Structure of the talk



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B1. Defining the subgoal “moves for supporting one student‘s thinking“

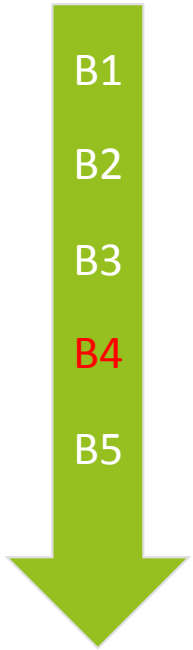
- empirical result of classroom studies: (Cobb & Bauersfeld 1995, Clarke et al. LPS) teacher-student interaction follows typical pattern with varying impact on students‘ cognitive involvement

→ teachers shall become aware and learn to apply moves that support student‘s thinking, e.g.

- initial posing
- eliciting student thinking
- rephrase, revoice, ...
- ~~leading~~
- ~~rejecting~~

(Sleep & Boerst 2013)

B. Student-Teacher moves for supporting (one) student‘s thinking



B4. Using video for becoming aware of supportive moves

Method “headstand“:

- first, consider a problematic video
- then, derive DOs and DON‘Ts for supportive moves

(Clarke & Hollingsworth 2000)

Experience:

- implicit knowhow of teachers can be made explicit
- works with every teacher group and every facilitator
- but only for evident moves, not for more subtle situations

Goal: support the individal process of thinking without disturbing it

DOs:

- *give enough time to reflect*
- *pose open questions*
- *elicit longer utterances*
- *…*

DON‘Ts:

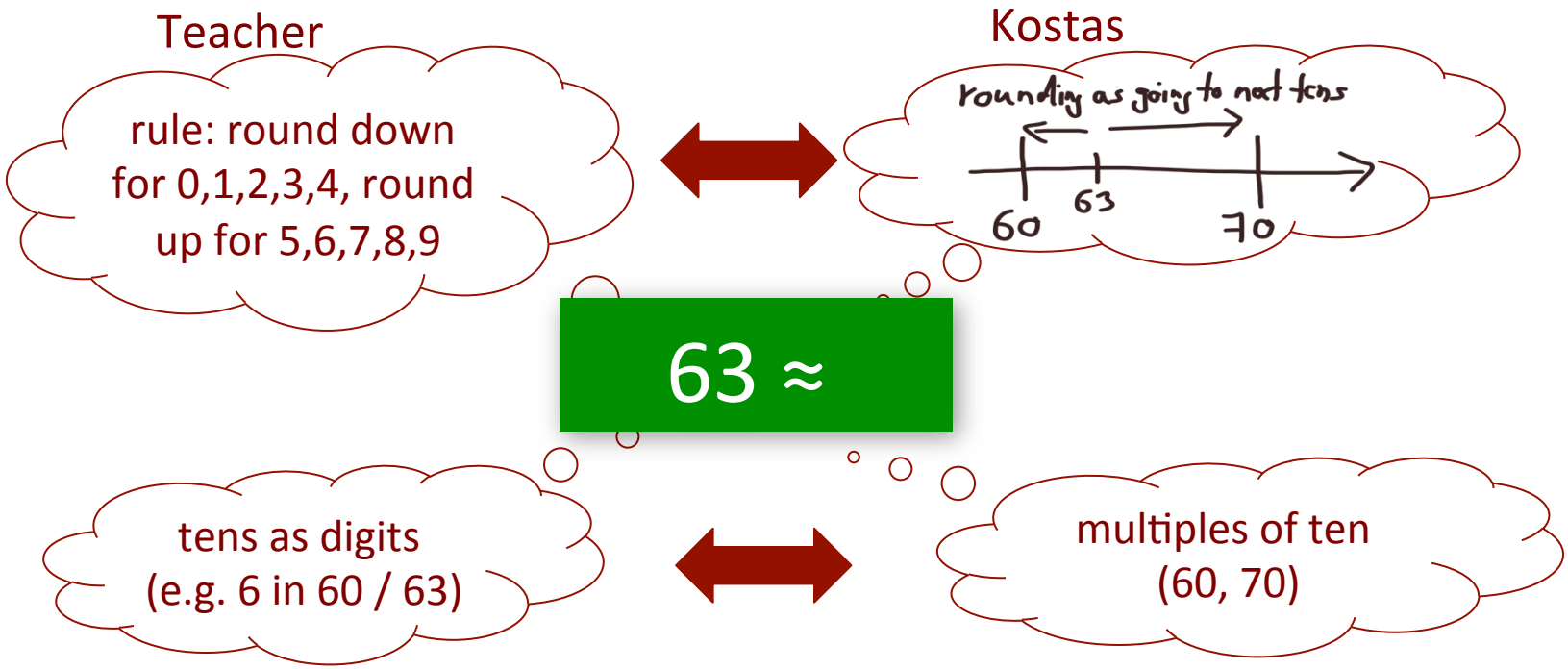
- *impose teacher‘s train of thought*
- *help without understanding*
- *evaluate every utterance*
- *…*

Example for a list collected in a teacher group

B2. Supportive moves – Specifying professional demands

- Same procedure: job analysis (Bass & Ball 2004)
- Video Clip 2:
  classroom interaction with one student, Grade 5
- Content: how to explain the procedure of rounding, e.g. 63 ≈ 60?

Video Clip 2:
Mr. Maler, Kosta and rounding 63



B2. Supportive moves – Specifying professional demands

Video Clip 2: Mr. Maler, Kosta and rounding 63

Teacher: KOSTAS.

Kostas: SIXTY.

Teacher: SIXTY. [*to the class*] Can we WRITE this down?

← rhetorical questions

Class: *[Shouts out different answers]*

Teacher: NO?

Class: *[Shouts out different answers]*

Teacher: Hm, LOOK. I'm WRITING it down, Kostas, and now YOU convince us, why the sixty can stand there and why this is CORRECT.

← eliciting longer answers

Kostas: °hhh. Well, if you are rounding DOWN the sixty-three on TENS; then it comes, it gets, there must be ALWAYS a zero at the end, it MUST be, when you are rounding.

← eliciting longer answers

Teacher: On TENS yes.

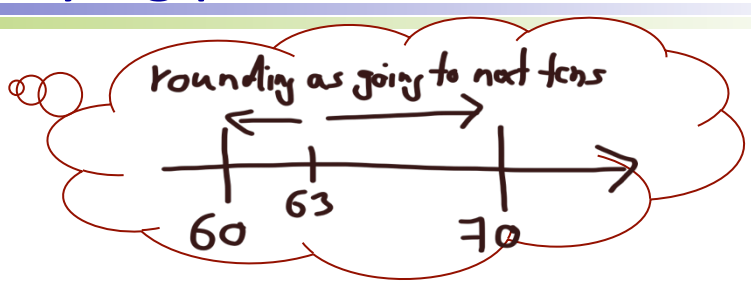
Kostas: And then there, if you take AWAY the three and shift the ZERO to it. So, you could DO that, but actually it's WRONG. You just have to round down and nea.. nearest number with a ZERO you have to write there.

Our way of presenting → transcripts to teachers

B2. Supportive moves – Specifying professional demands

Video Clip 2:
Mr. Maler, Kosta and rounding 63

unexpectedly,
answer goes back to meaning →



Yes, it is a SIXTY, isn't it?

Student

Teacher

KAY, I think I already UNDERSTOOD SOME parts,
of what you wanted to explain;
so FIRST of all I filtered OUT, you rounded on TENS;
what does that mean HERE, if you are rounding on TENS,
what ARE the TENS here actually?

Can you show that simply once in the front, Kostas?
I am not completely sure, if you DID round on tens;

← subtle rejection of answer

tens as digits (e.g. 6 in 60 / 63)

multiples of ten (60, 70)

B2. Supportive moves – Specifying professional demands

Video Clip 2:
Mr. Maler, Kosta and rounding 63

Teacher

But now there is an ABOUT there and you already implied WHY; but does any of you know a RULE, HOW one has to proceed here, and when one here, when the ten stays the SAME? In this case, and the place BEHIND, which is rounded, goes to ZERO? Ha; *[4.5 sec. break]* Katja.

← making expectations more explicit

With zero one two three FOUR you are rounding down and with five six seven eight NINE you are rounding (up).

Katja

← answer refers to procedural rule

Teacher

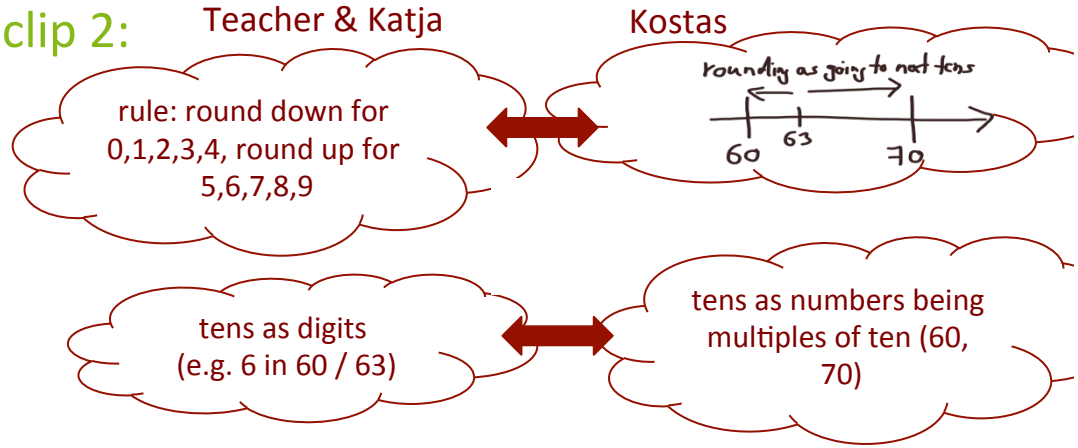
Has EVERYBODY understood that?

← implicit but very positive evaluation

B2. Supportive moves – Specifying professional demands

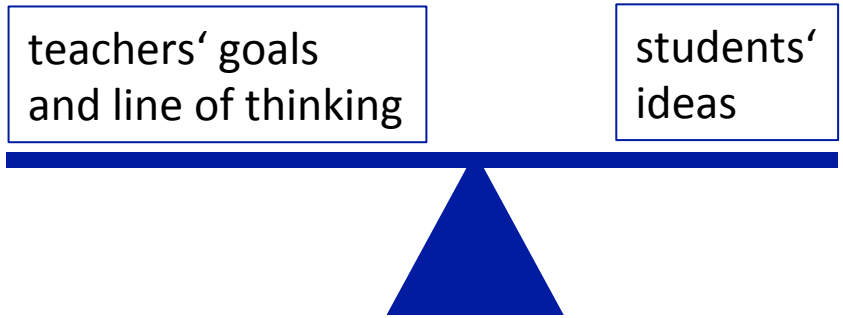
Math-didactical foundation of video clip 2:

- what is a suitable explanans in explanations?
  rules versus representations?
- core arithmetic concepts:
  numbers versus digits?



Supportive moves should:

- engage students into longer explanations
- mark (in-)correctness without ashaming
- do justice to valuable mathematical ideas of students
  ← diagnostic competence
- manage a difficult balance:
- ...



B3. Exploring professional perspectives and their development in group discussions

Aim of the qualitative study:

- explore professional perspectives
  on interactions and supportive moves
- and how these perspectives develop within a discussion

Video Clip 2:
Mr. Maler, Kosta
and rounding 63

Methods:

- data gathering: video-stimulated group discussions
  with 6 groups of 4-6 practicing teachers (90 min each)
- qualitative data analysis: categories for teachers‘ patterns of
  perception, interpretation and evaluation of interactions and supportive moves

B3. Exploring professional perspectives and their development in group discussions

what does the teacher want?

how do students' answers fit to expectations?

°hhh. Well, …OWN the sixty-three on TENS; then … must be ALWAYS a zero at the end, it MUST be, when you are rounding.
And then there, if you take AWAY the three and shift the ZERO to it. So, you could DO that, but actually it's WRONG. …ust have to round down and nea.. nearest number with …O you have to write there.

Video Clip 2: Mr. Maler, Kosta and rounding 63

Kostas' earlier explanation

Kostas does not speak straightly

Teacher

But now there is an ABOUT there and you already implied WHY; but does any of you know a RULE, HOW one has to proceed here, and when one here, when the ten stays the SAME? In this case, and the place BEHIND, which is rounded, goes to ZERO? Ha; *[4.5 sec. break]* Katja.

With zero one two three FOUR you are rounding down and with five six seven eight NINE you are rounding (up).

Katja

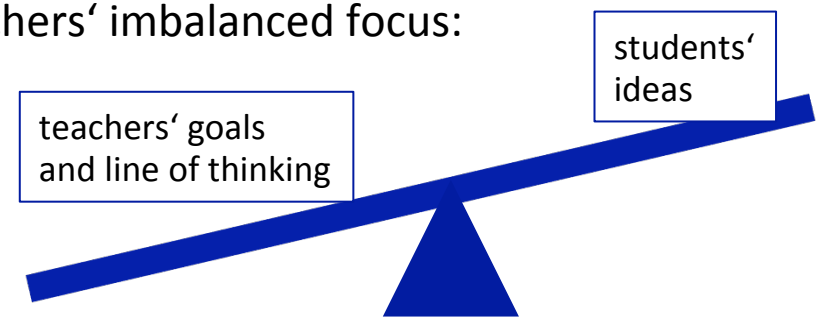
Teacher

Has EVERYBODY understood that?

B3. Exploring professional perspectives and their development in group discussions

Selected results (of the ongoing analysis, cf. Vogler 2014)

teachers‘ imbalanced focus:



Video Clip 2:
Mr. Maler, Kosta and rounding 63

- formal aspects (behaviour, language etc.) seem to be more important than content
- few focus on math-didactical foundation
- but also resources for becoming aware of deeper phenomena

potential for change of focus

- discussion slowly shifts the focus towards students
- but only if moderated into this direction

B4. Drawing consequences for the role of video in PD

Chances of video-use: (often shown, e.g. Clarke & Holingsworth 2000, Sherin 2004)

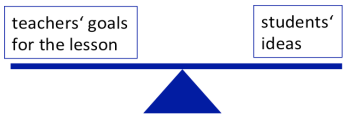
- raising awareness on relevance and effects of interactional moves
- evident interactional moments can be exploited by teachers in PD on their own (example headstand)

Challenges for video-use:

- teachers' selected focus
- no exploitation of potentials without discussion

  → careful moderation by the PD facilitators is needed to

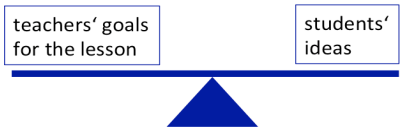
  - shift into a balance of focus
  - offer categories for reflection
  - make explicit the subtle, implicit mechanisms of IRE-sequences



(Mehan 1979, Voigt 1995)

B5. Adapting for video-assisted PD modules at scale

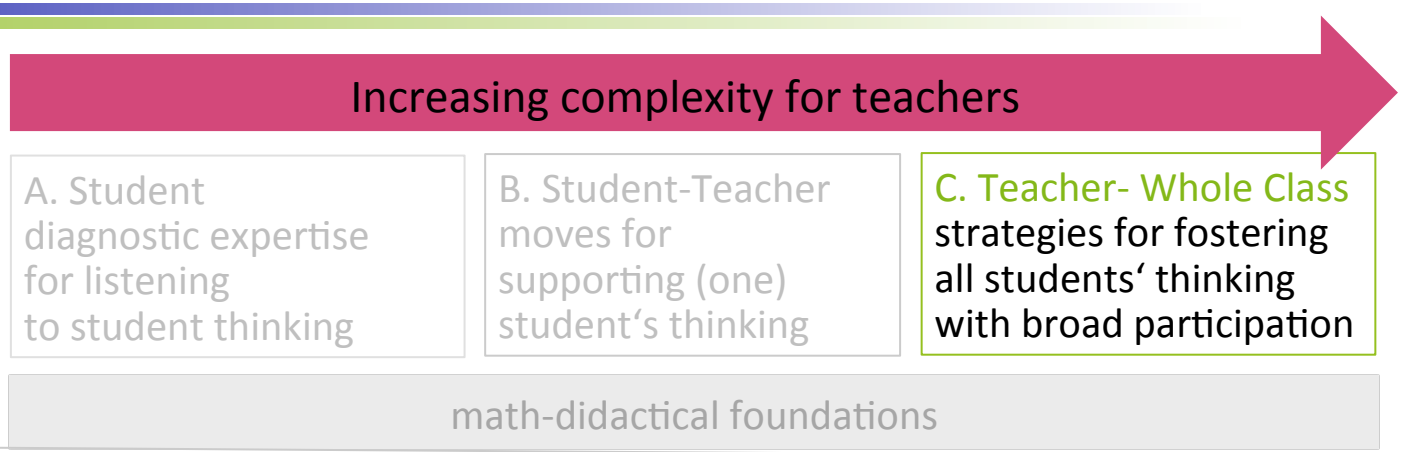
- videos of evident interactions can easily be used in PD since teachers can make sense of them alone
- for more subtle phenomena,
  - a facilitation pathway must be developed for capturing the subtle background
  - facilitators must be sensitized not for simple rules ("you must always value students' ideas")
  - but for difficulties of balancing different aims



- teachers' typical perspectives must be taken into account already in planning of video materials and their embedding
- for this, systematic comparison of subgoals with teachers' perspectives have to be conducted (← educational reconstruction, Duit, Gropengießer & Kattmann 2005, Komorek et al. 2013)

more research needed

Structure of the talk



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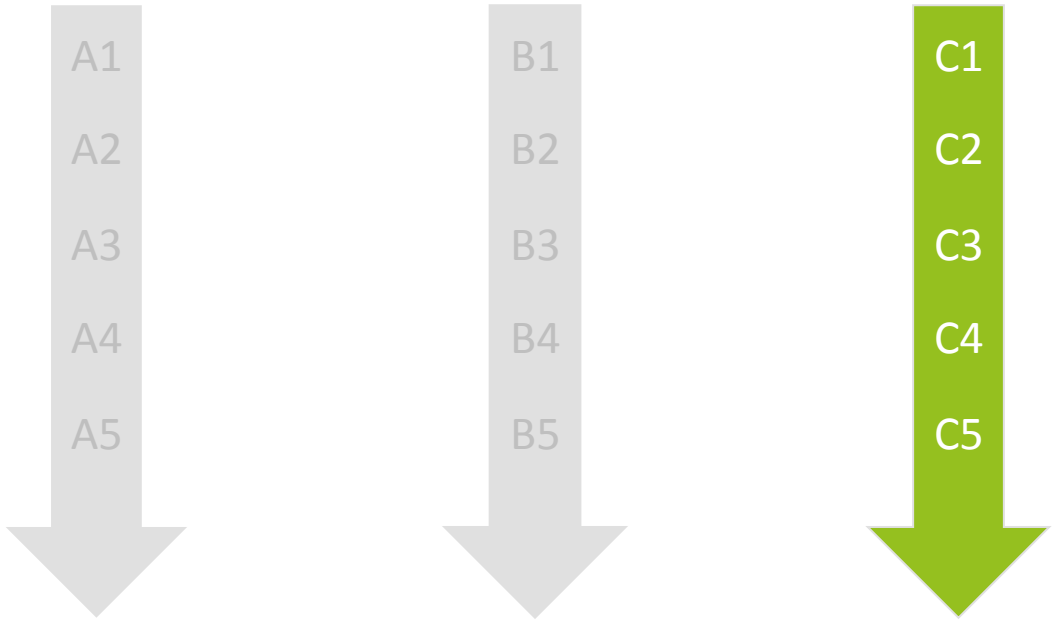
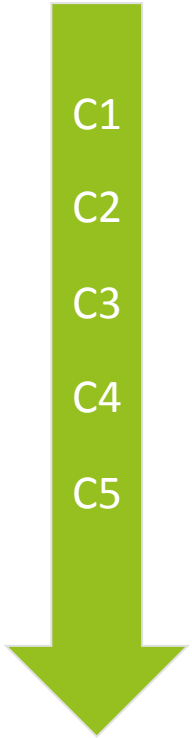


C1. Defining the general subgoal „fostering broad participation“

B. Student-Teacher moves for supporting (one) student‘s thinking

C. Teacher- Whole Class strategies for fostering all students‘ thinking with broad participation

- supporting one student‘s thinking
  needs supportive moves
- involving the whole class into the discourse
  needs an overall choreography
- typical challenges:
  - how to deal with multiple student solutions?
  - how to built upon individual ideas for constructing meanings?
  - how to deal with only partially correct ideas?



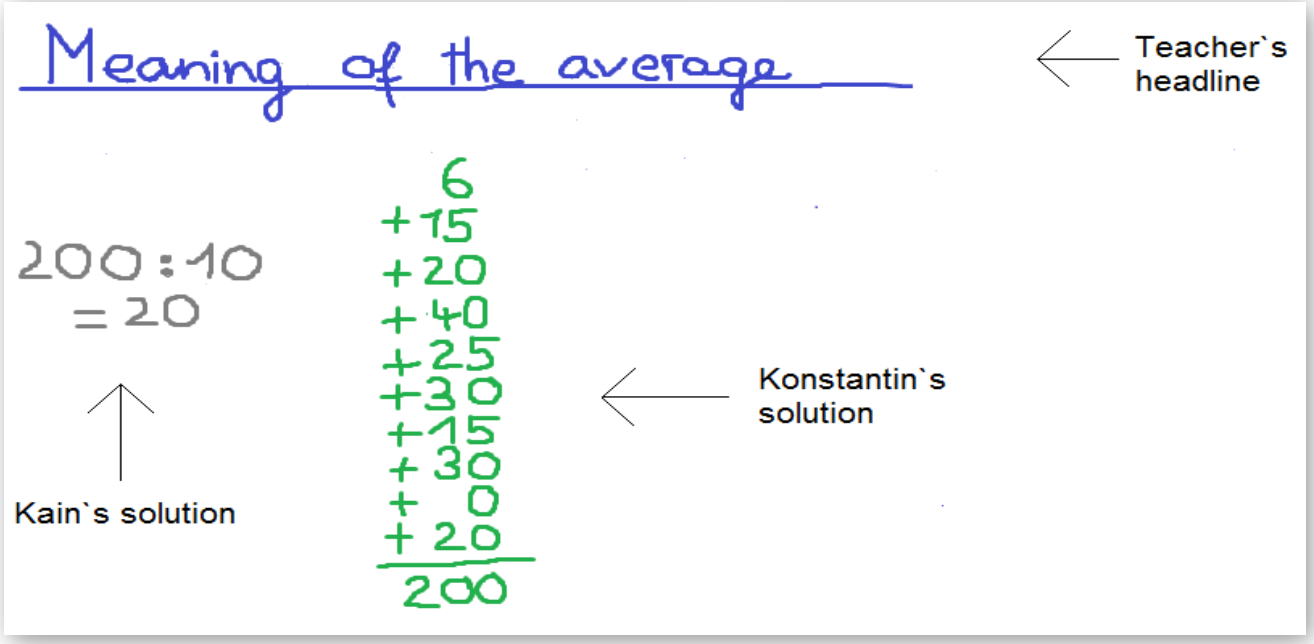
C2. Specifying concrete professional demands

(Grade 5, video clip 3 from project Interpass, Prediger & Erath 2014)

Video Clip 3:
Mr. Schroedinger
and the average

Calculate the average pocket money
15 € / 15 € / 20 € / 40 € / 15 € /
30 € / 15 € / 30 € / 0 € / 20 €

What does each step mean
in the procedure
for calculating the average?



Video starts when students had written their answers

and teacher builds upon it

C2. Specifying concrete professional demands

Video Clip 3:
Mr. Schroedinger and the average

Calculate the average pocket money

15 € / 15 € / 20 € / 40 € / 15 € /
30 € / 15 € / 30 € / 0 € / 20 €

(Grade 5, video clip from project Interpass, Prediger & Erath 2014)

C2. Specifying concrete professional demands

Video Clip 3:
Mr. Schroedinger and the average

Teacher: What is more HANDY in the way Konstantin wrote it *[points at writings on the blackboard]* than in Kain's way? I KNOW, there is missing a small step here, but what is more handy in THIS version here [*points at Konstantin's calculation*] than in THIS one. [*11.5 sec. break*]
Evan, you're looking COMPLETELY puzzled now; like you wanted to SAY, it's different but ANYWAY no idea;

← comparing two solutions

Evan: no IDEA;

Teacher: hm_hm; it's not yet CLEAR what they are doing and WHY; [*points at the two calculations*]

Evan: no IDEA;

Teacher: OKAY, [*2.5 sec. break*] Nahema;

← allowing not to know

Nahema: With Kain's way, you have to calculate it all in your HEAD, and Konstantin has a more HANDY because he calculated all one BELOW the other, that was EASIER.

Eric: Summed up in a written way.

C2. Specifying concrete professional demands

Video Clip 3:
Mr. Schroedinger and the average

Teacher

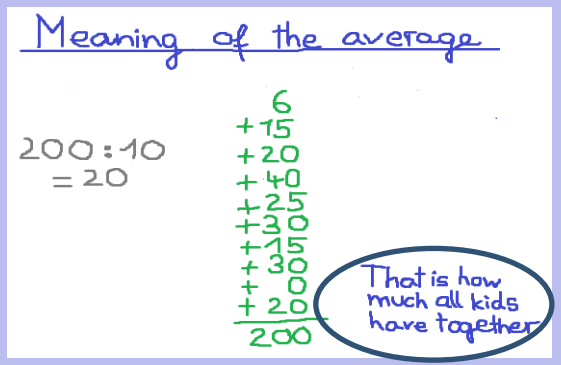
EXACTLY. As a START, you can say what these two hundred here, what else these two HUNDRED indicate. [*points at the result of the calculation*]
Then it's possibly going to be clearer soon for Evan, WHAT one has to do. WHAT else do these two hundred indicate? *[4.5 sec break]* Lilja. *[4.7 sec break]* What does one KNOW, what do these two HUNDRED indicate?

← new task: meaning of average

How much MONEY this is all calculated together. — Lilja

Teacher

[writes on the blackboard:]



← treating the incomplete solution as a first step in the procedure

You see, THIS is very important at the first step that you have THIS value.

C2. Specifying concrete professional demands

Video Clip 3:
Mr. Schroedinger and the average

Teacher

Well, I just asked Lilja what these two HUNDRED mean; she described it COMPLETELY correct. Now, what do these TWENTY Euro tell us that come out here and that also got out here at Kain's? Two hundred Euro, all kids have together who told their pocket money. Now, what do these TWENTY Euro tell us?

It's *the* *[expressed in wrong grammatical gender: das Durchschnitt]* AVERAGE of the money.

Dilai

Teacher correcting → without ashaming

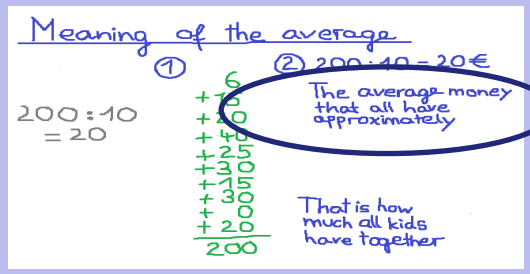
Hm, the *[expressed in correct grammatical gender: der Durchschnitt]* AVERAGE of the money. Eric.

It's the average of the POCKET money that all have APPROXIMATELY.

Eric

Teacher

[writes on the blackboard:]



Larissa, is this calculation UNDERSTANDABLE so far?

[pretending enthusiasm] YES.

Larissa

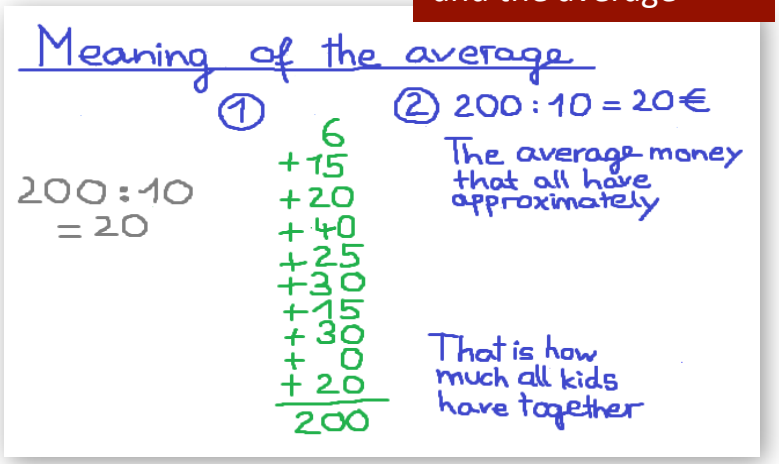
Teacher

FIRST think about WHAT everybody has together *[points at Konstantin's written addition]* and THEN afterwards coming up with such a sharing? *[points at Kain's division]*

C2. Specifying concrete professional demands

Video Clip 3:
Mr. Schroedinger and the average

- math-didactical foundation: (Erath & Prediger 2014)
  - not only calculation, but also meanings for the average
  - distinguish meaning and rule for procedure as different epistemic modes
  - meanings for each step in the calculation procedure for the average
- interaction:
  - many students involved
  - interaction builds with many answers
- teacher‘s evaluation of students‘ partial answers:
  - evaluated as intermediate step, not as wrong
  - combined for complete calculation procedure

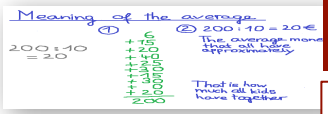


“orchestrated explaining“ as a joint practice with broad participation (Morek 2012)

C3. Exploring teachers‘ perspectives and their change

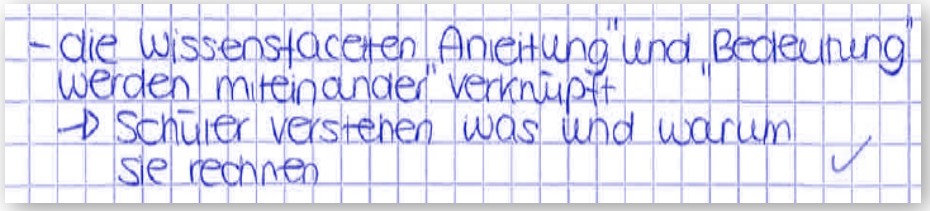
Video Clip 3:
Mr. Schroedinger and the average

Prospective teachers‘ discussion and written reflections



math-didactical foundations: (Erath & Prediger 2014)

- not only calculation, but also meanings for the average
- distinguish meaning and rule for procedure as different epistemic modes
- meanings for each step in the calculation procedure for the average



didactical categories can be applied

interaction:

- many students involved
- interaction builds with many answers

teacher‘s evaluation of students‘ partial answers:

- evaluated as intermediate step, not as wrong
- combined for complete calculation procedure

subtle evaluations not identified
→ need to be analysed together

“orchestrated explaining“ as a joint practice with broad participation (Morek 2012)

C4. Drawing consequences for the role of video

- ‘good practice‘ videos can be used in PD,
  but necessitate systematic reflections, especially for more subtle aspects

C5. Adapting for video-assisted PD modules at scale

different strategies in different projects:

- best practice classrooms with comments in project PikAS;
  e.g. for new classroom methods etc. (Selter et al. 2009-2016)
- for more subtle aspects: authentic, non-polished
  videos for my KOSIMA and MuM-projects (Prediger in progress)
- background and reflections are
  most crucial, no video without discussions

Looking back: Double research-base for design

Research on student thinking and classroom interaction

A. Student	B. Student-Teacher	C. Teacher- Whole Class
diagnostic expertise for listening to student thinking	moves for supporting (one) student's thinking	strategies for fostering all students' thinking with broad participation

α and Ω: math-didactical foundations (PCK & MFT)

1. Step: Defining the general subgoal
2. Step: Specifying concrete professional demands
3. Step: Exploring teachers' perspectives and their change
4. Step: Drawing consequences for the role of video
5. Step: Adapting for video-assisted PD modules at scale

A1	B1	C1
Video Clip 1: Anton and comple-menting as subtracting	Video Clip 2: Mr. Maler, Kostas and rounding 63	Video Clip 3: Mr. Schroedinger and the average
Prospective teachers' written analysis with and without categories	Practicing teachers' group discussion for increasing awareness	Prospective teachers' discussion and written reflections
A5	B5	C5

Looking back: Relevance of math-didactical foundations

too important to be adressed only accidentally, needs systematic coverage

nd Ω: math-didactical foundations (PCK & MFT)

(Kirsch 1976, van den Heuvel-Panhuizen & Treffers 2009, Shulman 1989, Bass & Ball 2004)

Video Clip 1: Anton and comple-menting as subtracting

- cognitive activities in the modelling cycle
- different mental models (meanings) for subtraction: complementing versus taking away (Selter, Prediger, et al. in ESM2012)
- diverging meanings for the equal sign (Kieran 1981, Prediger JMTE2010)

Video Clip 2: Mr. Maler, Kostas and rounding 63

- meanings for rounding 63 ≈ 60
- representations on the number line
- distinguishing arithmetic core concepts (numbers vs. digits)
- explaining by meanings vs. by rote procedures (Prediger & Erath 2014)

Video Clip 3: Mr. Schroedinger and the average

- meanings for the average
- meanings of steps in the calculation procedure for average
- epistemic modes for "explaining" (Prediger & Erath 2014)

Looking back: possible role of videos for three subgoals

A. Student
diagnostic expertise
for listening
to student thinking

- student videos as object of study

B. Student-Teacher
moves for
supporting (one)
student's thinking

- bad practice for "headstand":
  making explicit unconsciously known aspects
- complex, subtle practice as starting point for reflection
- own videos as most involving starting point for reflection

C. Teacher- Whole Class
strategies for fostering
all students' thinking
with broad participation

- good and polished practice as model
- good but non-polished practice
  as starting point for reflection

Looking back: pedagogical settings for the use of videos

individual work (e.g. distance learning, PikAs)	teacher's small group discussion without facilitation	systematic analysis with concrete questions	discussion with facilitation

Looking forward to four days of further discussion!

Thank you for your attention!

Challenges for video-assisted modules in PD at scale

- written materials with substantial activities and background
- self explaining video-assisted moduls
- education of the teacher educators!