Reflections on a ten-year content-specific research linked professional development project for levering educational change

Professor Jill Adler

And the WMCS project team **2010 – 2019+**

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DZLM/ ICMI International Colloquium

Content-specific Mathematics Teacher Education Research: Approaches and Findings.

1 July, 2022

Outline of the talk

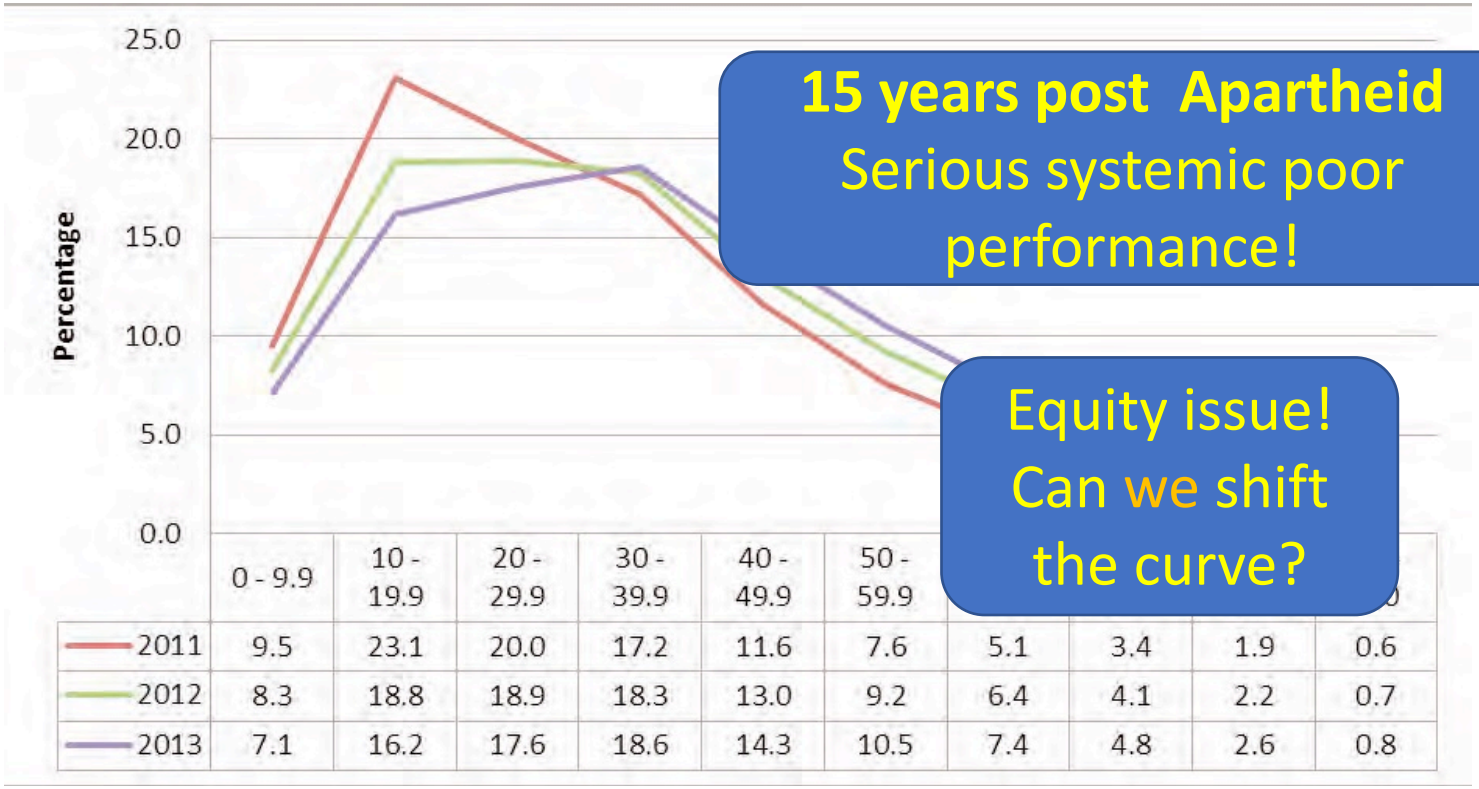
- The ‘PROBLEM’ for the WMCS project
- The INTERVENTION to lever change
  - The approach and model that evolved
  - Key practices and processes
- RESEARCH (related to impact)
- Reflections, Q and A

The ‘problem’ in context 2009-

The Problem

Access for all, learning for some – Gr 12 NSC

Performance distribution curves Mathematics (2011 - 2013), National Senior Certificate Diagnostic report. (DBE, 2013, p. 126)



	0 - 9.9	10 - 19.9	20 - 29.9	30 - 39.9	40 - 49.9	50 - 59.9				
2011	9.5	23.1	20.0	17.2	11.6	7.6	5.1	3.4	1.9	0.6
2012	8.3	18.8	18.9	18.3	13.0	9.2	6.4	4.1	2.2	0.7
2013	7.1	16.2	17.6	18.6	14.3	10.5	7.4	4.8	2.6	0.8

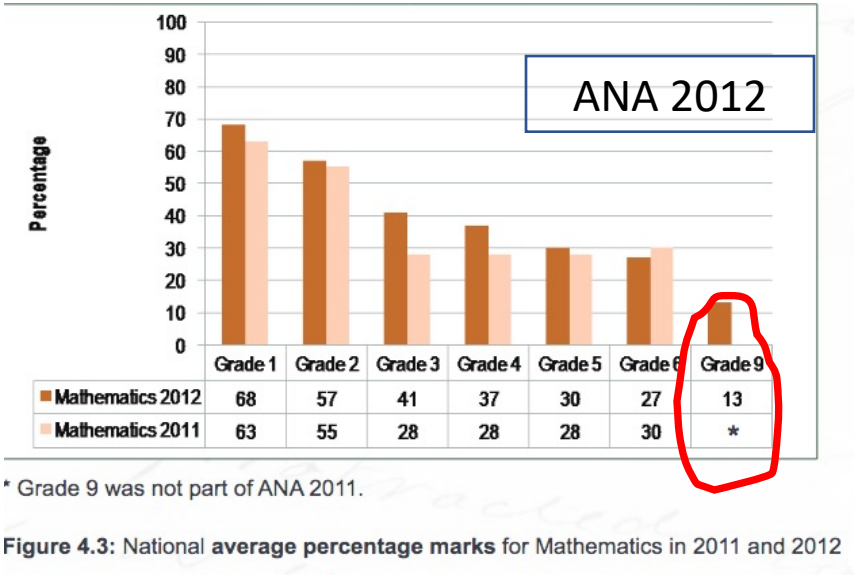
The Problem

Access for all, learning for some, Grades 8 - 9

Diagnostic assessment 2010
(low or no-fee project schools)

Basic algebra - Grs 8 and 10

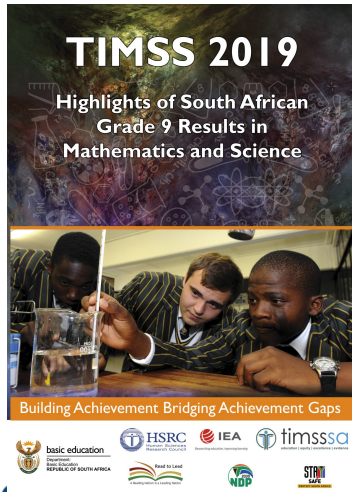
Foundations poor and/or unstable



	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 9
Mathematics 2012	68	57	41	37	30	27	13
Mathematics 2011	63	55	28	28	28	30	*

* Grade 9 was not part of ANA 2011.

Figure 4.3: National **average percentage marks** for Mathematics in 2011 and 2012



Inside systemic poor performance, a wide socio-economic achievement gap
Fee/ No-fee schools

Grade 9 ….75 points
(440 vs 365 Ave)

Mathematics education in no-fee and low fee schools

Curriculum

- Highly prescriptive and regulated
- Emphasis on coverage

Conditions of work

- Limited resources (material and human)
- Limited access to technology
- Learners not prepared for their grade

Teacher knowledge and practice

- In lower secondary – low levels of teacher knowledge of mathematics with many teaching 'out of field'
- Observation in school classrooms - incoherence – object of learning out of focus

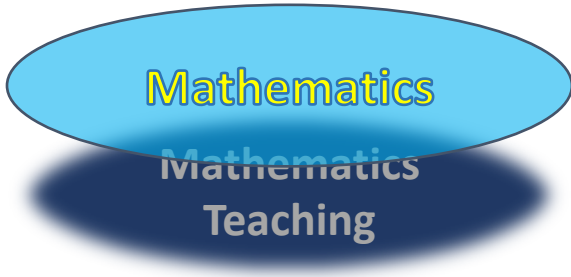
The intervention

What, why and how

Theory of change

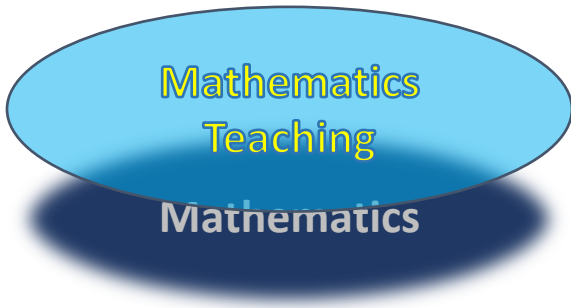
Our starting point

- Paying attention to teachers' **mathematics-for-teaching** would lead to better teaching and ultimately to student learning gains



Mathematics-for-Teaching (MfT) (Adler, 2005; Adler & Davis, 2006)

- Combination of SMK and PCK (Subject and pedagogic content knowledge)
- Boundaries between knowledge types not important for us
- **BUT** we need to pay *explicit* and *separate* attention to mathematics and to mathematics teaching



Professional development focused on MfT has

- direct effect on **teacher knowledge**
- indirect effect (and delayed effect) on **teaching practices and student learning gains**

Transition Maths 1 (MfT) course

Goal

Prepare teachers to navigate the transition from Grade 8/9 maths to Grade 10 maths

In Phase 1, 2012 – 2014
10 schools, 1 district, 45 teachers

Phase 2, 2016 – 2018
70 schools 6 districts 125 teachers

Model

- 8 x 2-day units over 1 year – on campus (away from school)
- Mathematics (75%)
  - Algebra (including integers) (6 days)
  - Function (4)
  - Geometry (3)
  - Trigonometry (3)
- Teaching (25%) *(A guiding framework)*
  - Lesson goal
  - Examples, tasks, representations
  - Explanations and justifications
  - Student participation
- 7 Assignments
- 3 tests: selection test, mid-course test, final test

Model is "lean"
No coaching
No classroom-based support

(some lesson study, phase 1)

Principles, rationales – inner workings of the model

Mathematics (revisiting school maths, learning new maths)

- What? Network of connected (scientific) concepts
  - Powerful in generality and opaque in reified structures
- Why? Poor imitative practices, fragmented, incoherent

Teaching (and guiding framework)

- What? Goal directed (object of learning)
  - Mediated by resources, cultural tools;
  - A coherent mathematical story matters in lessons
- Why? Object out of focus, incoherence

Theoretically informed

Empirically grounded

PD approach

- What? Content focused; over time; community; Working with current teaching/learning practices towards the above …
- Why? Respectful of curriculum requirements, context and conditions of work

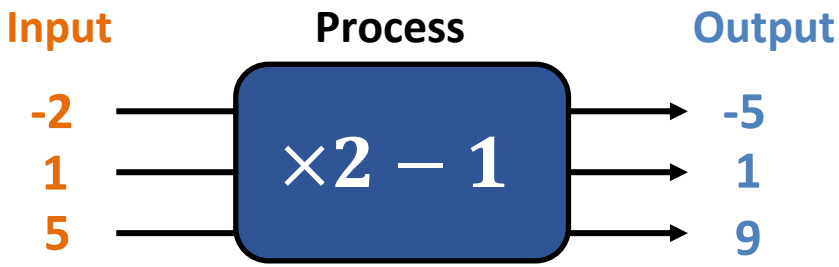
Example of **revisiting** school maths

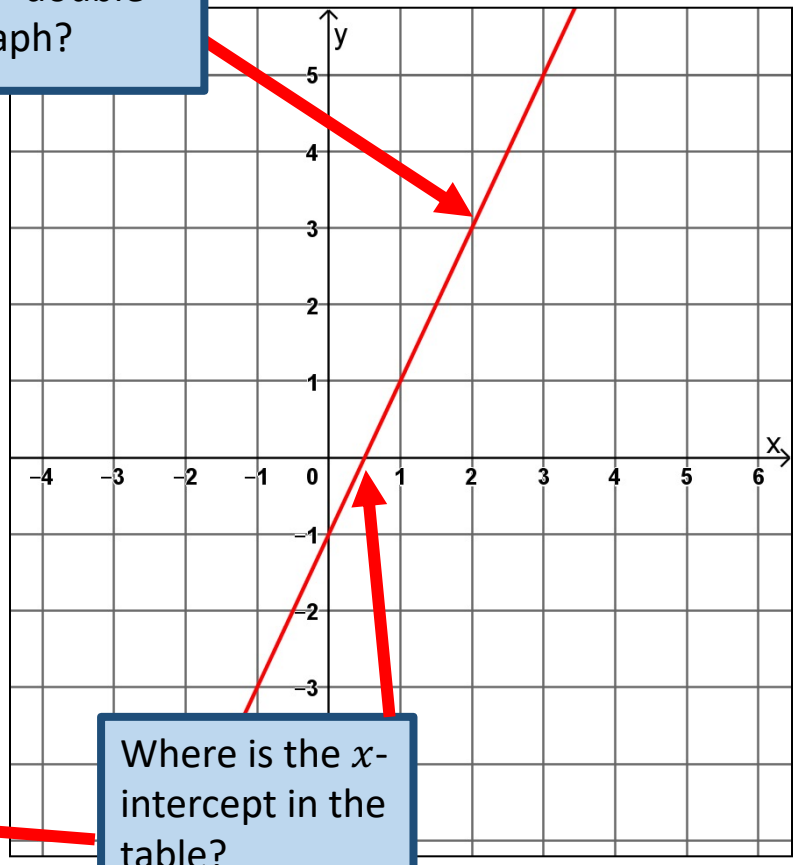
5 representations of 1 function and their connections

To get the output you double the input and decrease by 1

$$y = 2x - 1$$

Where is "double" in the graph?





x	-2	-1	0	2	3	10
y	-5	-3	-1	3	5	19

Where is the x-intercept in the table?

Revisiting inequalities

Is the statement ***always true***, ***sometimes true*** or ***never true***?

7 $x^2 > 0$	8 $-x < 0$
9 $(m-4)^2 > 0$	10 $(p+2)^2 > 2$

Attention to reasoning and communicating mathematically

Modelling principles of variation

Example of new mathematics

Square root function

Sketch the graphs

Determine the domain and range of each function

a) $y = \sqrt{x - 2}$

b) $y = \sqrt{x} - 2$

c) $y = \sqrt{2 - x}$

d) $y = 2 - \sqrt{x}$

Example of new mathematics

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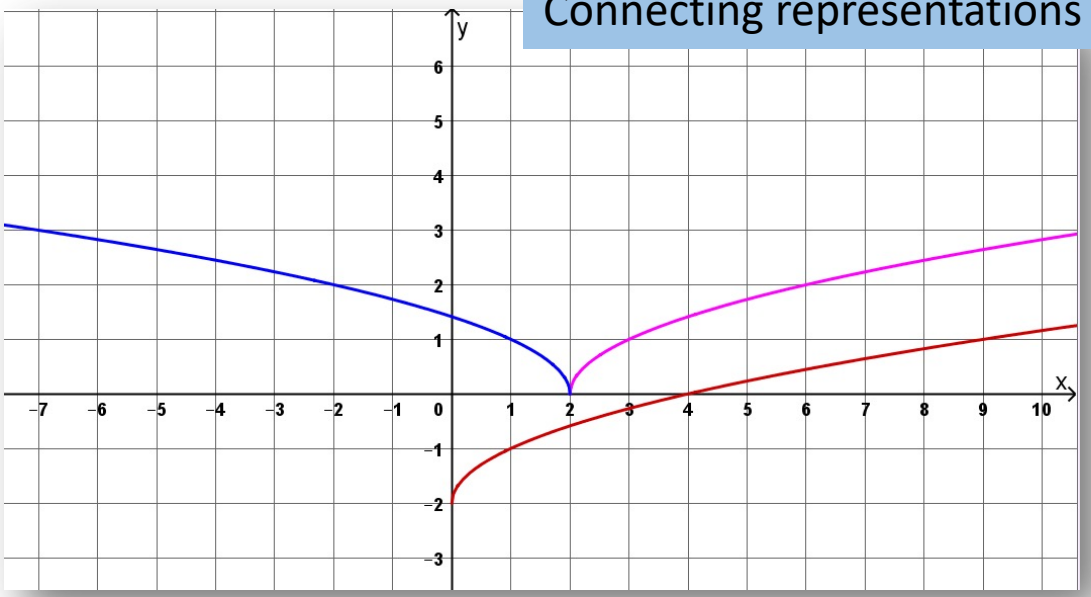
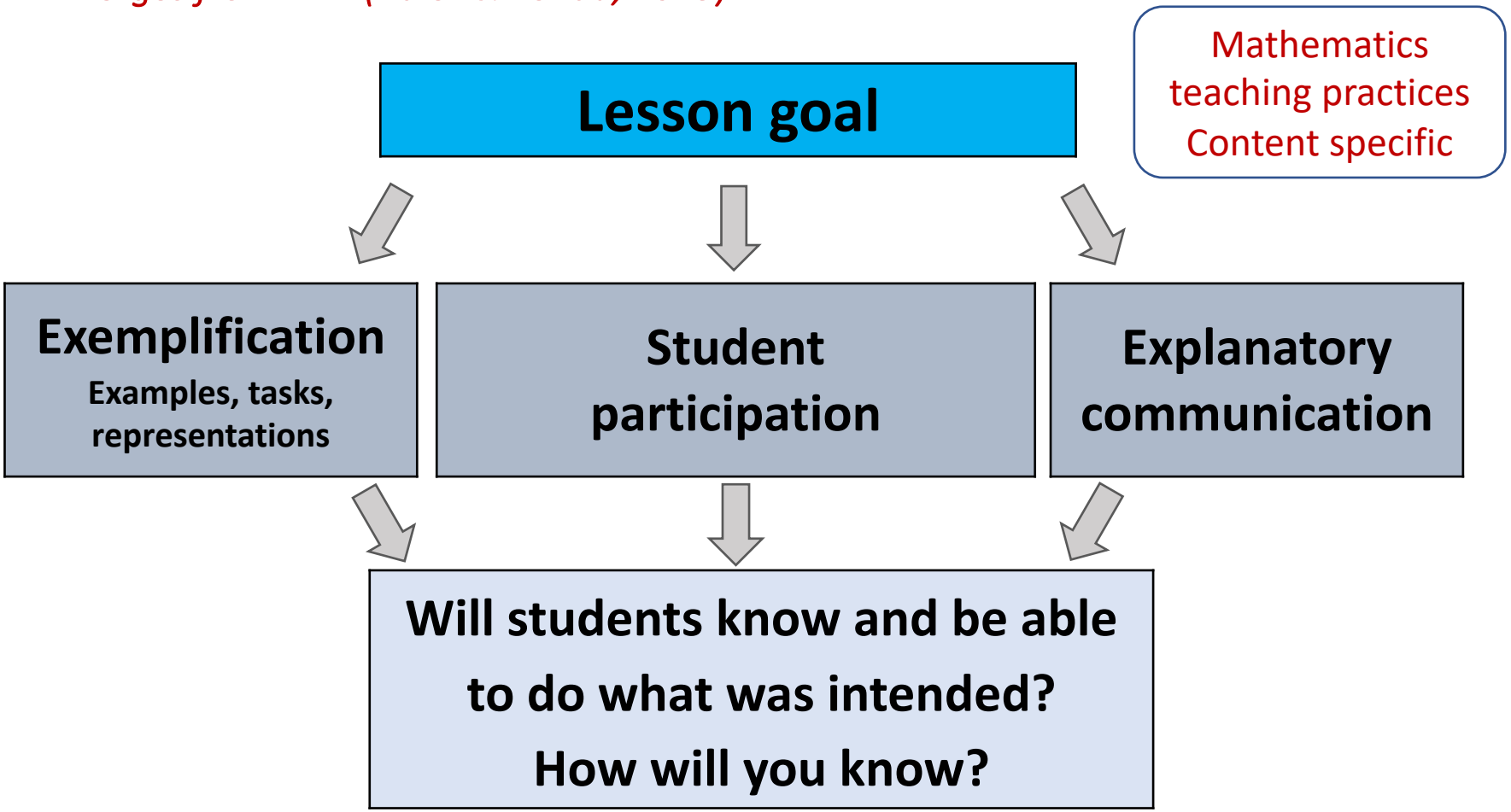
Modelling principles of variation
Connecting representations



Maths Teaching Framework

Emerges from MDI (Adler & Ronda, 2015)



Example of

Exemplification with variation

Lesson goal: Learners must be able to simplify expressions with brackets that appear in different positions

Simplify each of the following:

1) $x + 3(x + 5) =$
2) $(x + 3)x + 5 =$

3) $x + 3(x + 5) =$
4) $x - 3(x + 5) =$

5) $x + 3(x + 5) =$
6) $(x + 3)(x + 5) =$

7) $(x + 3)(x + 5) =$
8) $(x + 3) - (x + 5) =$

- What's different (varies)?
- What's the same (invariant)?
- What can come into focus?
- How does this help learners to focus on the lesson goal?

- Task – computation with connection and relating
- Generality and structure

Principles of variation. (Marton et al)

Sequencing and pairing

Contrast, similarity, juxtaposition

Example of explanatory communication

Producing an explanation (word use, justifying)

Your Grade 9 learners say they know that $5p$ and $4q$ are unlike terms.

They say "we can add like terms, we cannot add unlike terms".

But in a test they write $5p + 4 = 9p$

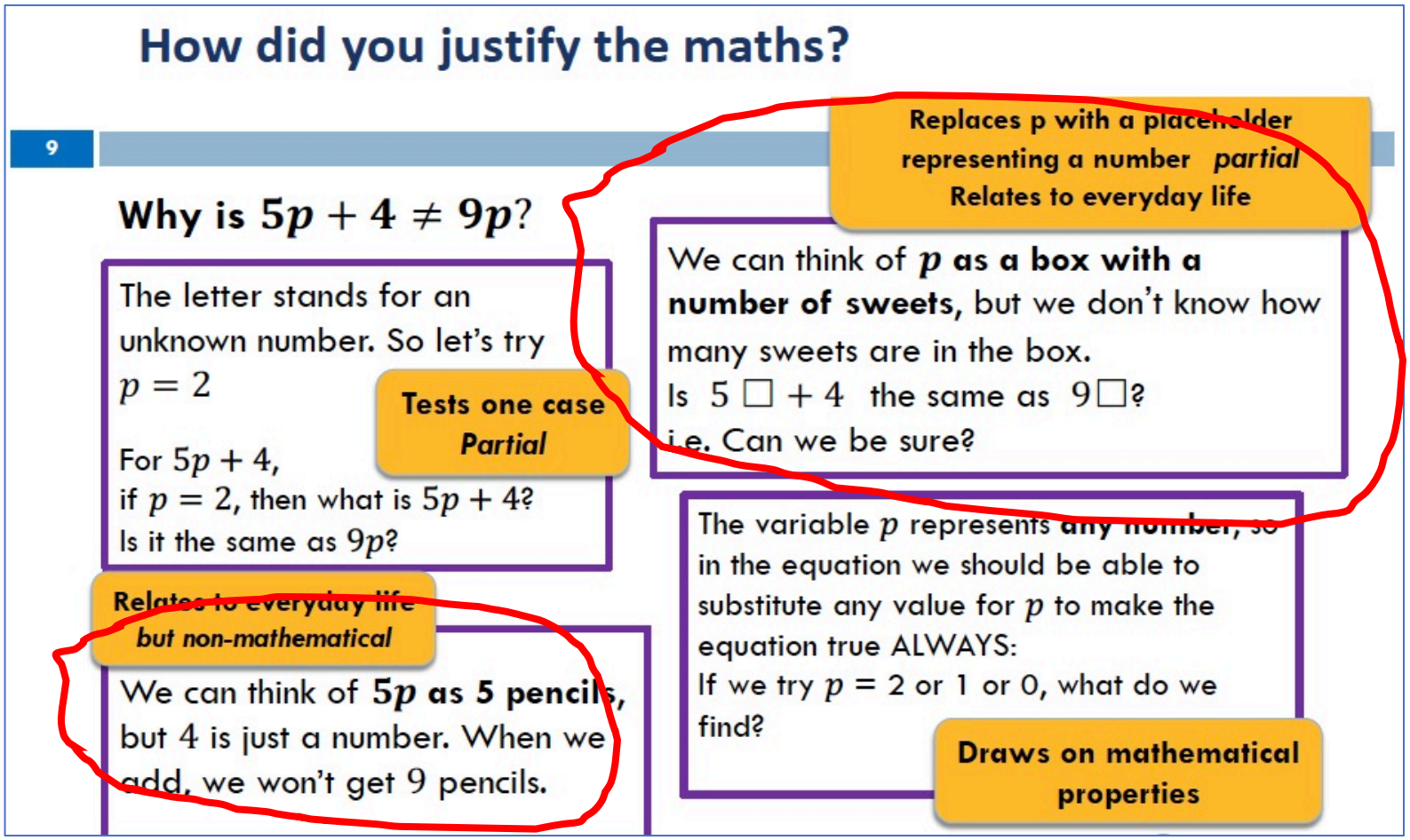
Teacher task
Well known error
Early algebra

- **On your own**
  - How will you convince a learner who writes $5p + 4 = 9p$ that s/he is wrong?
  - Write down at least two different ways

- **In your group**
  - Collect the different ways of explaining from your group members
  - Decide which way of explaining is the most convincing for Grade 9 learners
    - Write it up in poster form

Establish criteria for valued knowledge

Establishing criteria for valid justifications - attending explanatory communication



Impact studies

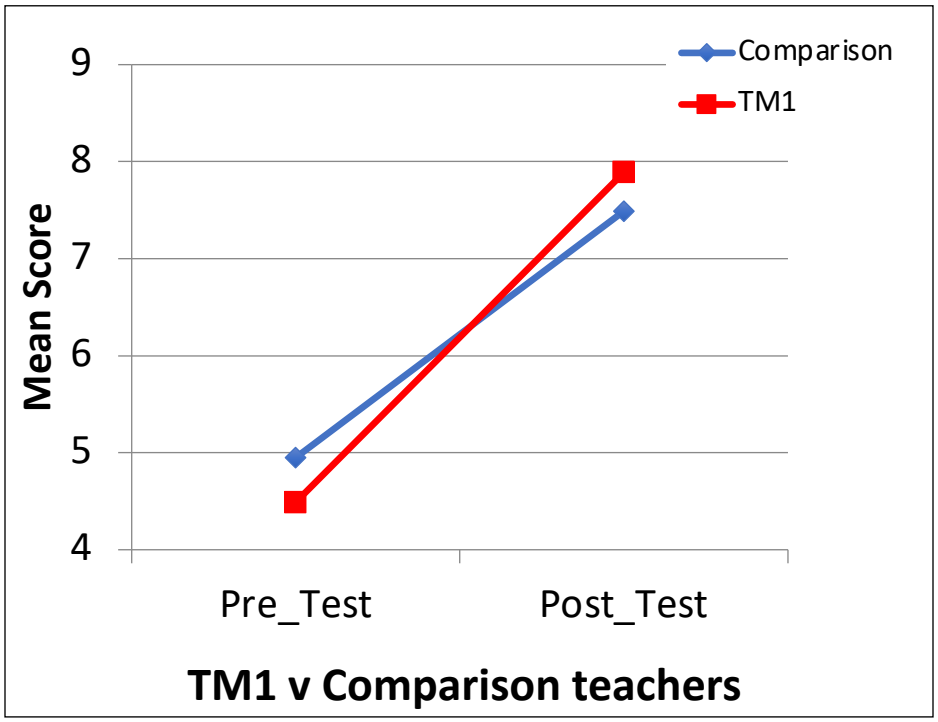
“The learning gains study”

Teacher knowledge (MfT)?
Learner attainment?

Our (linked) research

Learning Gains Study Pilot (2013)

(Pournara et al, 2015)



Learners taught by teachers who had done the TM1 course out-performed learners in the same schools taught by teachers who had not done the TM1 course.

Evidence of promise for TM1 as a PD intervention

- Small sample, low scores, small gains
- Effect size: $d = 0.21$

Impact of TM1 on teachers' mathematical knowledge

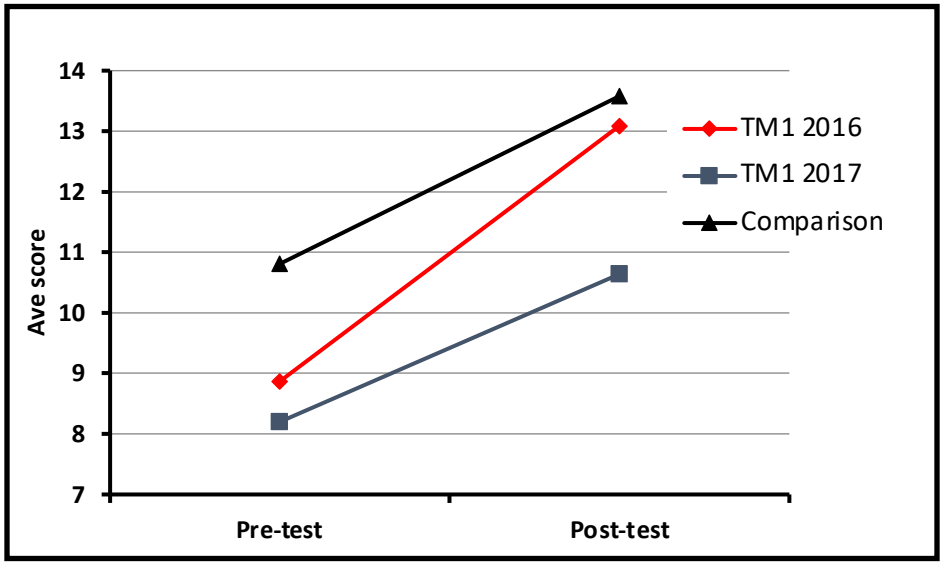
TM1 course		Teachers completing TM1 course				
		N	Ave mk	SD	t-test	
2016	Selection test	40	61.58	15.79	t = 8.73 df = 39 $p < 0.001$	14.3 pp
	Final test		**75.91**	**18.25**		
2017	Selection test	39	65.39	17.77	t = 5.20 df = 38 $p < 0.001$	11.4 pp
	Final test		**76.83**	**19.85**		
2018	Selection test	46	70.73	15.82	t = 4.36 df = 45 $p < 0.001$	7.9 pp
	Final test		**78.63**	**17.21**		

TM1 had a (statistically) significant impact on teachers' MfT

Final test is more difficult and covers more content than selection test. So gains may be under reported

Learning Gains Study (2018)

2018 study



The TM1 2016 teachers had a greater impact on learners than the TM1 2017 teachers and the comparison teachers

Gains of TM1 2016 group are significantly different to gains of TM1 2017 group

		Pre-test		Post-test		
Cohort	**N**	**Ave score**	**SD**	**Ave score**	**SD**	**Change in Ave score**
TM1 2016	815	8.87	6.90	13.09	8.76	**4.22**
TM1 2017	772	8.20	6.03	10.64	7.89	2.44
Comparison group	1531	10.81	8.02	13.58	9.27	2.78

Practical implications of Learning Gains 2018

Effect sizes

Teacher group	Grade 9	Grade 10
TM1 2016	d = 0.68	d = 0.50

Equivalent to 8 months additional progress

Equivalent to 6 months additional progress

There is a delayed impact on learners of teachers' participation in PD

Higgins et al (2012)
Teaching and Learning Toolkit
Education Endowment Trust

What about teaching?

(some) PhD and post-doctoral studies

Qualitative studies

Some early studies – 2011 - 2012

Dr Moneoang Leshota

Teachers' use of textbooks

African Journal of Research in Mathematics, Science and Technology Education, 2
https://doi.org/10.1080/18117295.2020.1847833
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Teacher–Textbook Relationships in Mathem in Contexts of Limited Resources

Moneoang Leshota

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This paper examines how seven teachers working in contexts of limited resources used the prescribed textbook for teaching, and the kinds of teacher–textbook relationships forged in the interactions. The study employs a sociocultural perspective to explore the processes by which teachers mobilise the affordances of the textbook to the teacher's practice, thereby advancing a particular way for studying and understanding better the teacher–textbook relationships in particular contexts. A methodological approach aggregating results for all teachers and looking for patterns of mobilisation across teachers allowed for the analysis of patterns of mobilisation regardless of the teacher. Findings point to generally tacit use of the textbook and a need for intervention on textbook use by teachers. The study makes recommendations for the production of educative guides as well as further research on the perceived role of the textbook in the teacher's practice.

Keywords: Teacher–text relationships; textbooks; affordances; pedagogical design capacity; omissions; injections; offloading; improvising

Dr Vasen Pillay

Teachers working with variation and example sets in context of a learning study

The current issue and full text archive of this journal is available on Emerald Insight at:
www.emeraldinsight.com/2046-8253.htm

IJLLS
4,3

Evaluation as key to describing the enacted object of learning

Vasen Pillay and Jill Adler
School of Education, University of the Witwatersrand, Johannesburg, South Africa

tract

ose – The purpose of this paper is to illustrate the methodology used by the authors to describe nacted object of learning, a methodology where data production and analysis is rooted in orisation of pedagogy. The authors share how the authors used this methodological approach to de a comprehensive des
ke a methodological co
portance of "evaluatio

Dr Ntsiki Luxomo

What is a (mathematical) explanation? In teaching?

Some later studies – 2015 - 2016

ZDM (2019) 51:419–432
https://doi.org/10.1007/s11858-019-01025-z

ORIGINAL ARTICLE

Identity resources and mathematics teaching identity: an exploratory study

Forster D. Ntow[1,2] · Jill Adler[1]

Accepted: 8 January 2019 / Published online: 21 January 2019
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Abstract
Previous studies have reported the influence of professional development (PD) on participating teachers' identities. However, *what* goes on in PDs, *how* and *why* they shape particular identities require further investigation. This study contributes in this direction by drawing on the notions of *practice-linked identities* and *identity resources* to examine how two teachers' mathematics teaching identities developed following their interactions with the resources offered in a particular PD. We argue that their developing mathematics teaching identities appeared to be linked to their backgrounds and initial motivations for joining the PD, which in turn influenced their selective interaction with resources. Implications for research and PD are discussed.

Dr Forster Ntow - Ghana
Learning as Identity
Postdoc 2016

A Case of Lesson Study in South Africa

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© Springer Nature Switzerland AG 2019
R. Huang et al. (eds.), *Theory and Practice of Lesson Study in Mathematics*,
Advances in Mathematics Education, https://doi.org/10.1007/978-3-030-04031-4_16

317

Dr Jehad Alshwaikh- Palestine - USA
Lesson Study
Post doc 2015 – 2016

The Maths Discourse in Instruction (MDI)Framework - Teachers' MfT and their practice

Routledge
Taylor & Francis Group

African Journal of Research in Mathematics, Science and Technology Education

ISSN: 1028-8457 (Print) 1811-7295 (Online) Journal homepage: http://www.tandfonline.com/loi/rmse20

A Framework for Describing Mathematics Discourse in Instruction and Interpreting Differences in Teaching

Jill Adler & Erlina Ronda

Dr Erlina Ronda - Philippines
(post doc, visiting researcher – 2014 …)

Mathematics Discourse in Instruction (MDI): A Discursive Resource as Boundary Object Across Practices

Jill Adler

J. Adler (✉)
University of the Witwatersrand, Johannesburg, South Africa
e-mail: jill.adler@wits.ac.za

Abstract Linked research and development forms the central pillar of the Wits Maths Connect Secondary (WMCS), a project working with secondary mathematics teachers in one province in South Africa. A key outcome is a sociocultural analytic framework—a discursive resource that has been developed and refined through our work in and across three inter-linked practices. Named Mathematics Discourse in Instruction (MDI), we have used the framework as a planning and reflection tool in professional development and we have operationalised it as an

© The Author(s) 2017
G. Kaiser (ed.), *Proceedings of the 13th International Congress on Mathematical Education*, ICME-13 Monographs, DOI 10.1007/978-3-319-62597-3_9

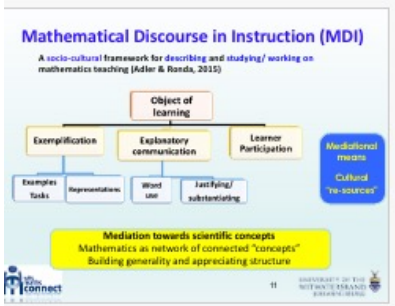
SUBJECT MATTER KNOWLEDGE AND THE QUALITY OF MATHEMATICS MADE AVAILABLE TO LEARN: SOME HYPOTHESES

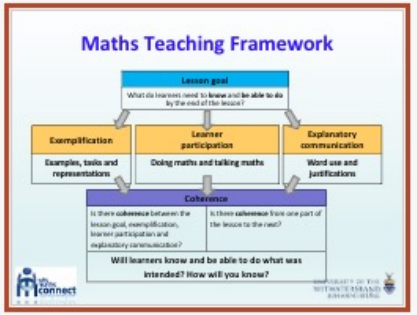
Erlina Ronda[1], Jill Adler[2]

[1]University of the Philippines, [2]University of the Witwatersrand

We offer here some hypotheses about how teachers' subject-matter knowledge is implicated in instruction through the lens of mathematical discourse in instruction (MDI) framework (Adler & Ronda, 2015).

2019. In M. Graven, H. Venkat, A. Essien & P. Vale (Eds.). Proceedings of the 43rd Conference of the InternationalGroup for the Psychology of Mathematics Education (Vol. 3, pp 257-264). Pretoria, South Africa: PME.





The (under reported) pre-post video study

9 (from 21) teachers – pre 2012 TM1 and post TM1 in 2013 video data of teaching

Significant challenges in doing the study

- unstable context of teaching
- Single lessons

Analysis of differences in teaching using MDI analytic framework

Overall results and uneven, messy, yet interesting varied suggestive patters:

- expanded example sets, attention to varying features
- substantiations … only by teachers with stronger mathematics

In conclusion and some reflections

Qualitative studies and Learning Gains study “add up” (ZDM, 2021)

Reinforcing our starting assumption of working on MfT – our theory of change

”Vision and action … in context”

Expanding exemplification as a mathematics teaching practice more easily “taken-up”

Explanatory communication – language responsive teaching

Explanatory communication (Word use

- Justifying
  - Explicit connecting what and why; how and why

More recent publications and ongoing work (references)

WMCS Colleagues (past & present)

Publications

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