Measuring Teaching Practices with the Rasch Model: Part 1: Teachers and Students' perceptions of 'transmissionism'

10th Rasch UK Day

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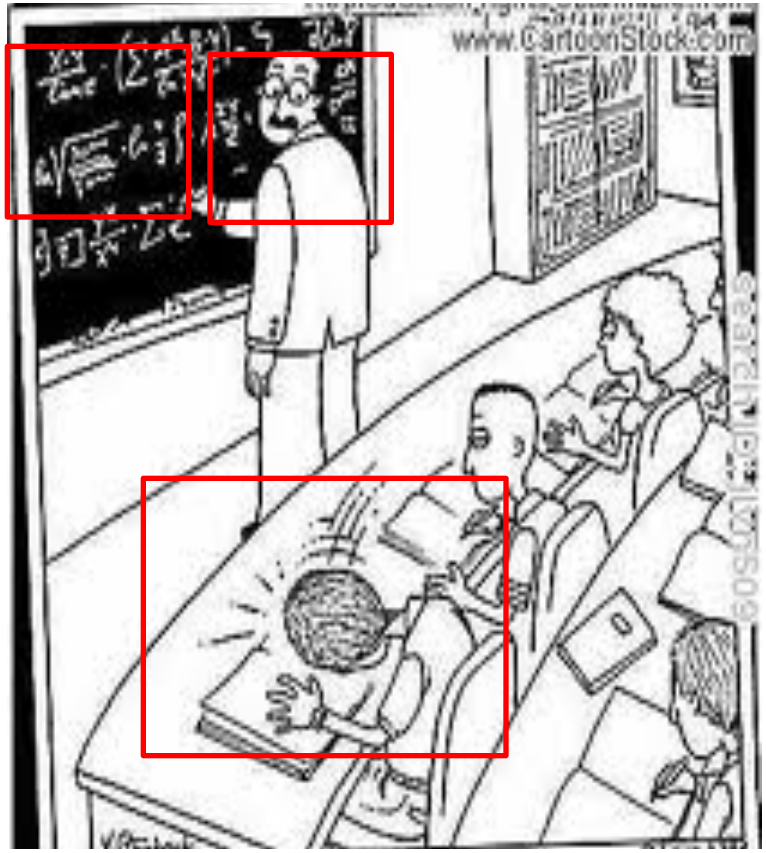
Outline

- Introduction to the need to ‘measure’ teaching practices and the projects
- The story of a ‘construct’ development
- Rasch Model Results
- Using Rasch resulted scores in further analysis
- Some conclusions and challenges

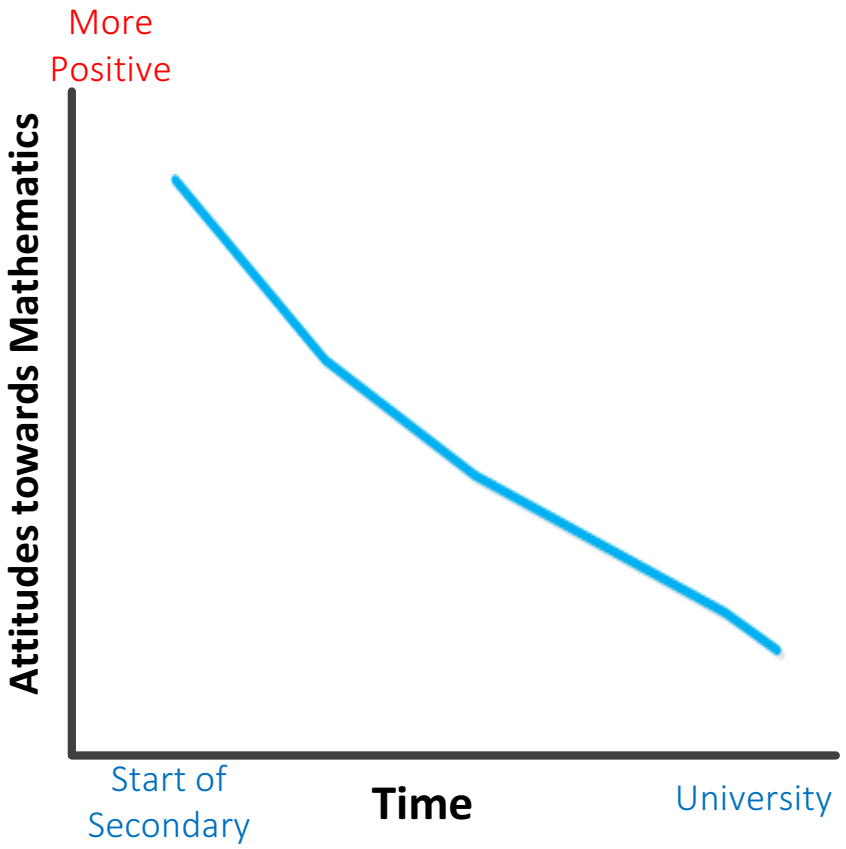
The STEM 'issue'

STEM: Science Technology, Engineering and Mathematics
Participation remains problematic
Students dispositions are declining

The main actors



Recent evidence …



Reform and Pedagogy

- The worldwide 'reform agenda' of mathematics teaching emphasizes problem-solving, creativity, and discussion

➔ to improve both understanding and dispositions towards the subject (NCTM, 2000).

- BUT, many studies (e.g. TIMSS), have shown how attitudes to mathematics and science are in decline, and that some part of this decline is associated with efforts aimed at increasing standards
- Focus on standards is closely associated with traditional teaching, and the marginalisation of reform approaches

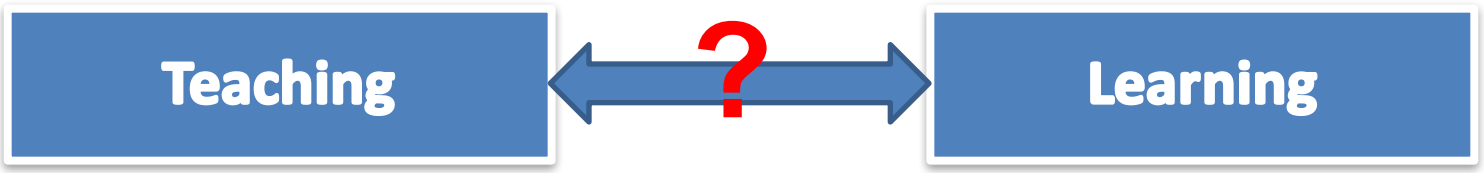
➔ the drive to raise standards can be counterproductive for dispositions, especially when it has the effect of narrowing teaching practices ➔ gap in evidence

A Research Problem / Question …

•Widely accepted that effective maths teaching should be connectionist, in two ways:

- connecting teaching to students' mathematical understandings, and productions
- connecting teaching and learning across mathematics' topics, and between mathematics and other (e.g., scientific) knowledge.

•Missing from the debate: informed analysis of teachers' pedagogy and the impact that this has on student outcomes in terms not only of attainment in, but also developing dispositions towards, mathematics and mathematically demanding subjects.



➔ Our research question:
What is the association between teaching styles/practices in mathematics with variables relevant to students' mathematical dispositions /attitudes?

The ESRC Trans-Projects

- **TLRP WP Programme: "Keeping open the door to mathematically demanding F&HE programmes" (2006 – 2008)**

- **TransMaths: "Mathematics learning, identity and educational practice: the transition into Higher Education" (2008-2010)**

- TeLePriSM : Teaching and Learning Practices in Secondary Mathematics (2011-2014)

TELEPRISM TEAM

Project investigator	Maria Pampaka
Research Associates	Lawrence Wo, Afroditi Kalambouka
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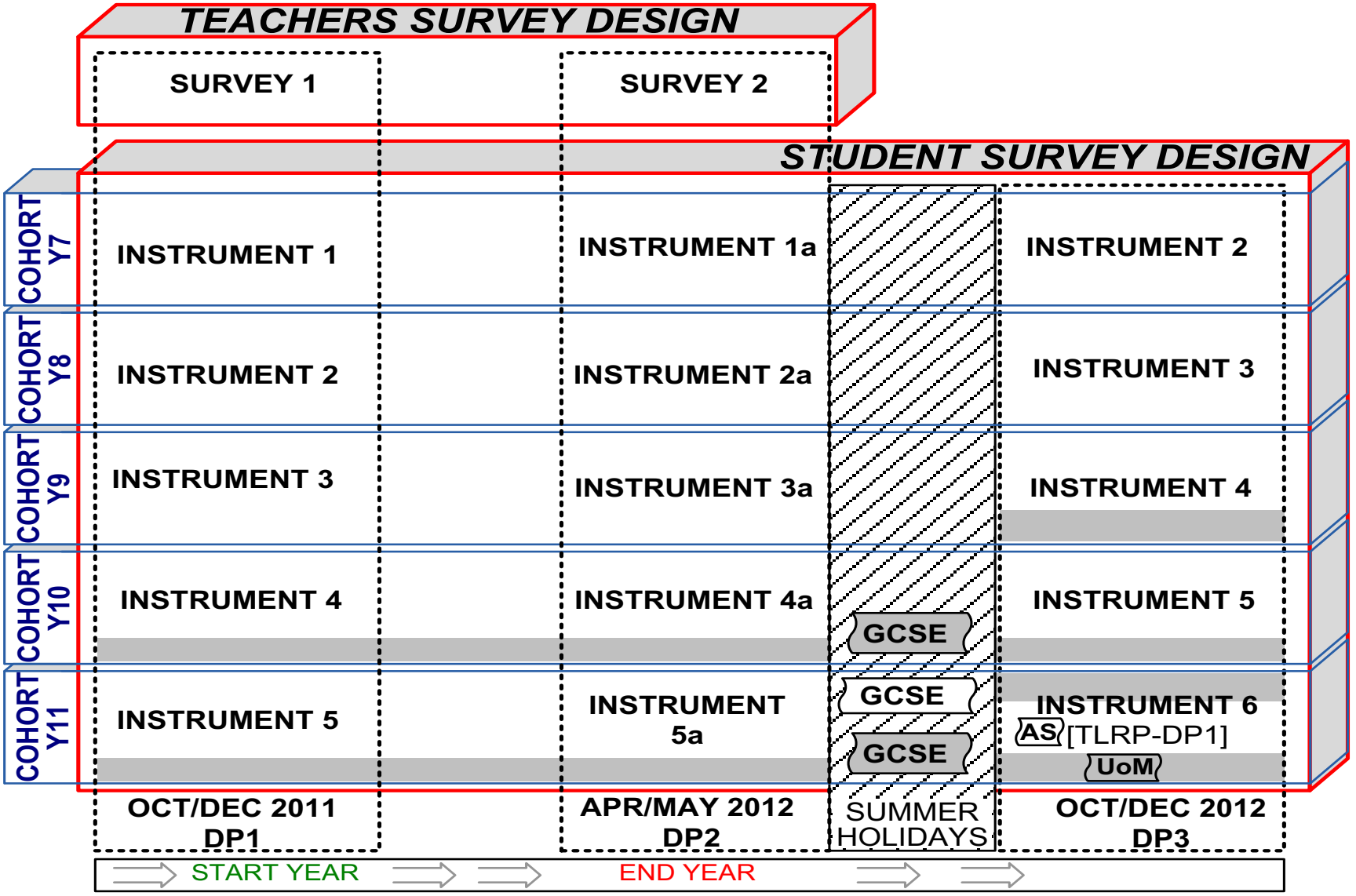
Mentors	Prof Julian Williams, Prof Ian Plewis

Teleprism: Aims

- Aim: To map secondary students' learning outcomes and choices, including dispositions and attitudes, together with the teaching they are exposed to.
- Surveys for students from Years 7 to 11 (3 times) and also for their mathematics teacher (twice).
- Case studies in a small number of schools with lesson observations and interviews with students and teachers.

The Teleprism Survey Design



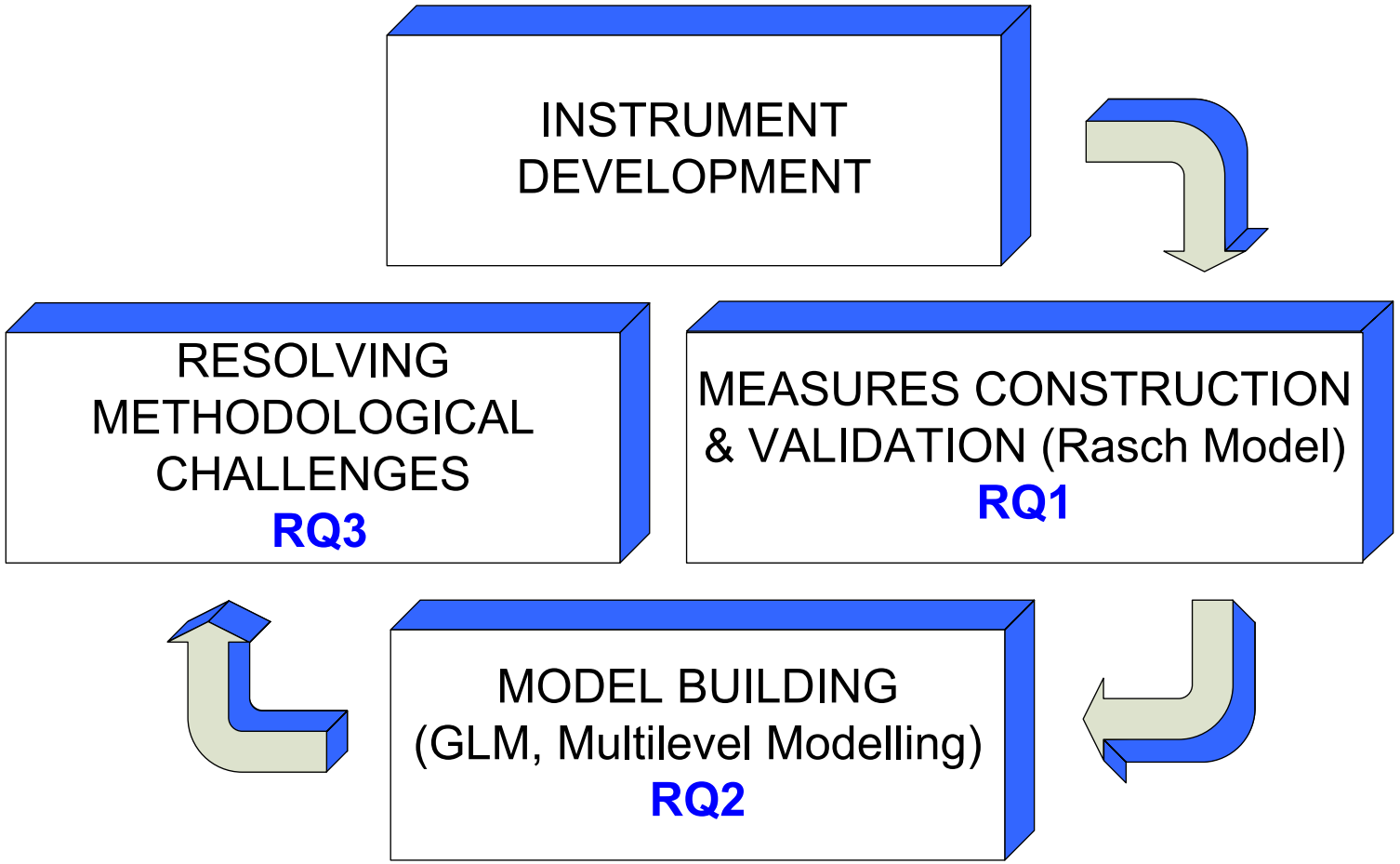
Participating Schools

Age range	Boys only	Girls only	Mixed	Total
11-16	0	2	13	15
11-18	1	5	19	25
Total	1	7	32	40

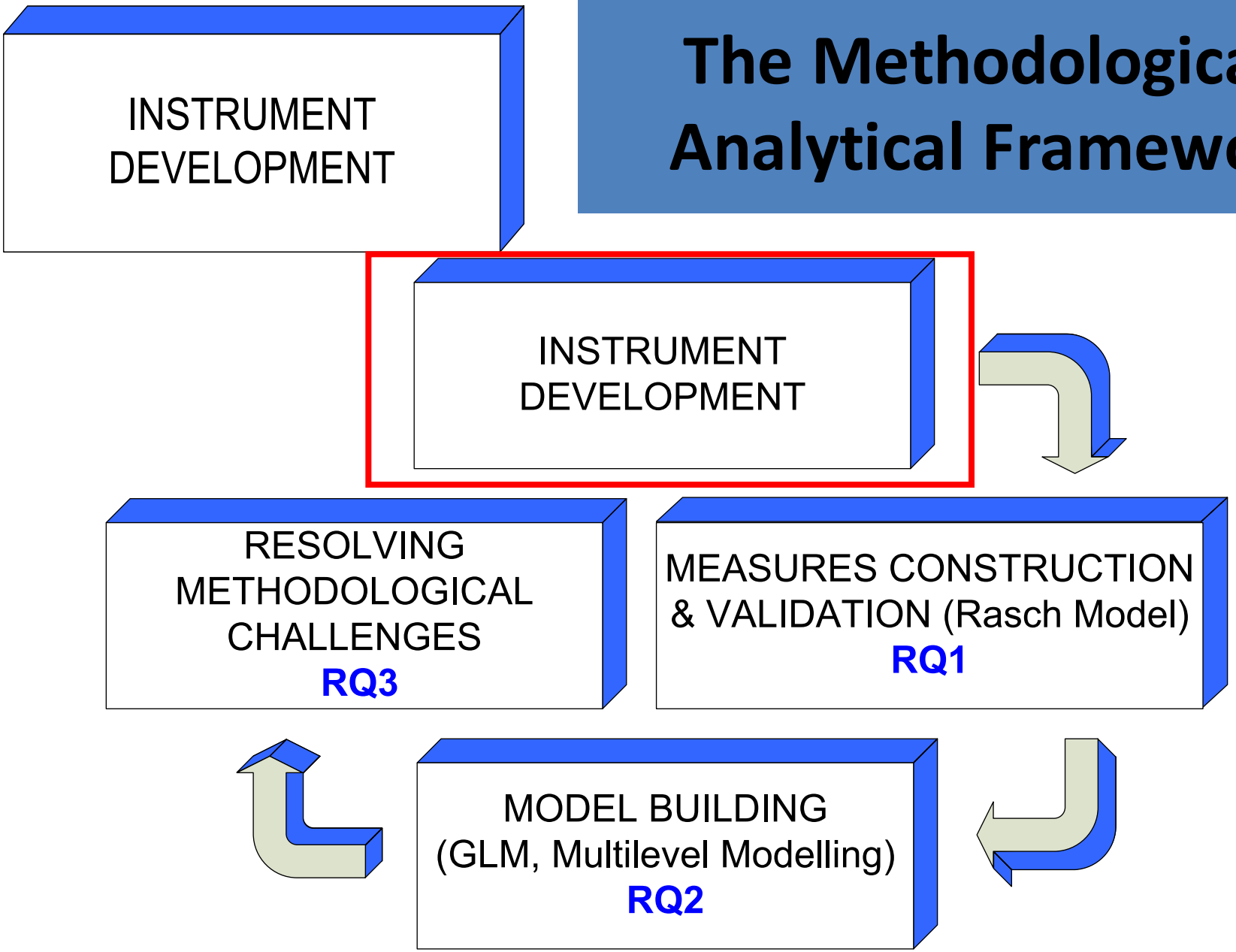
Students @Start

Year 7	3884
Year 8	3025
Year 9	2668
Year 10	2145
Year 11	1794
Total	**13516**

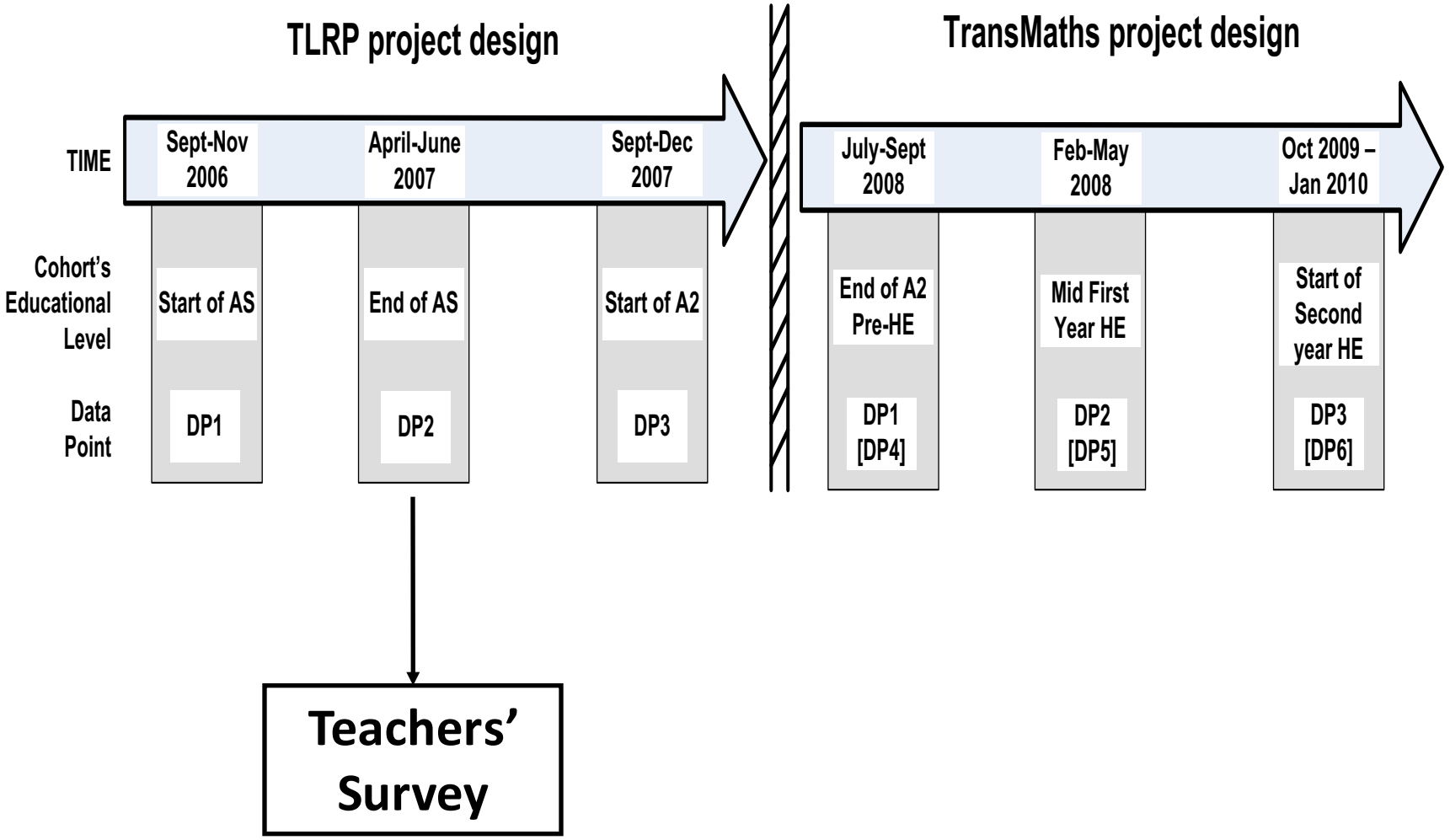
The Methodological/ Analytical Framework



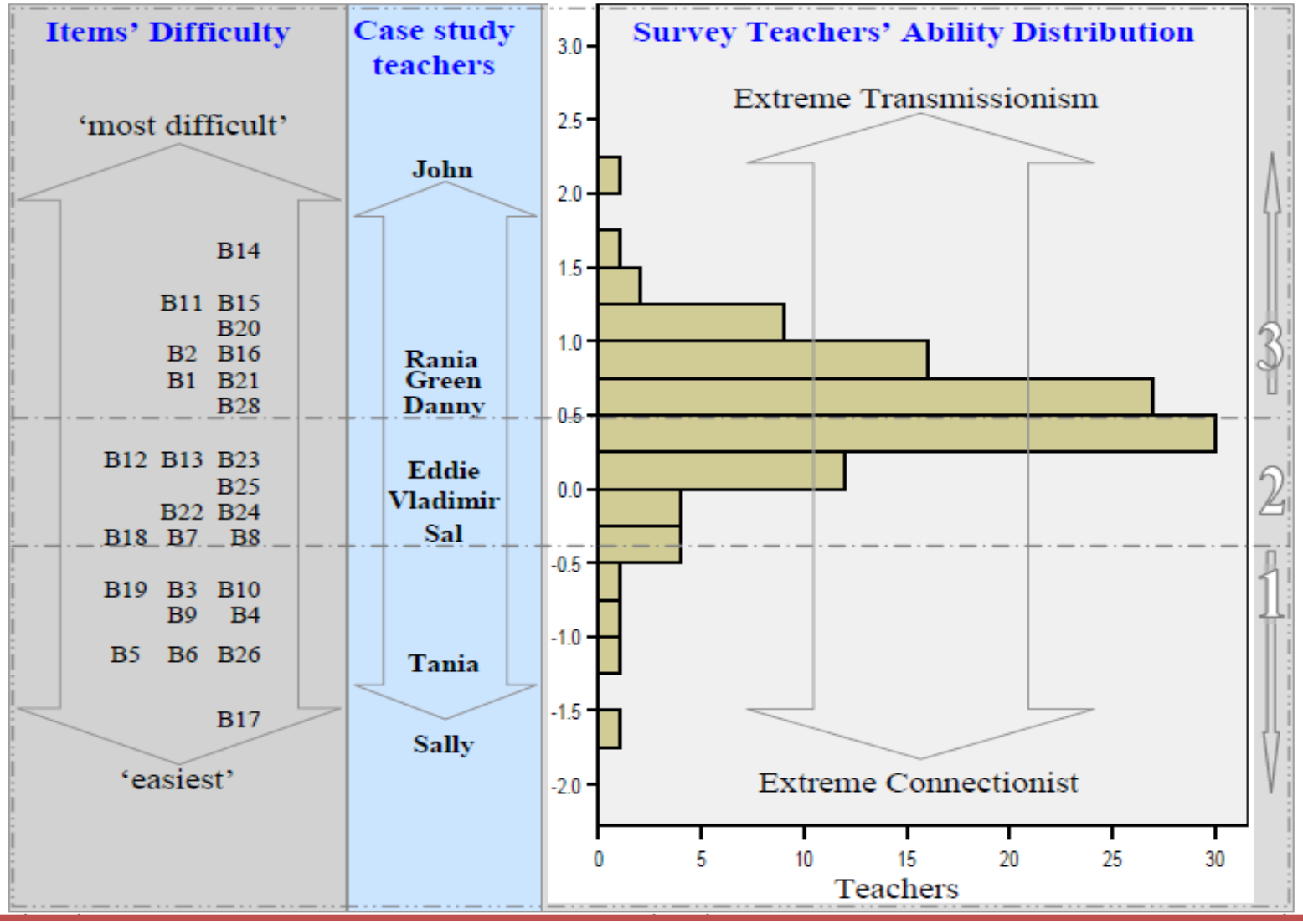
The Methodological/ Analytical Framework



Building on Previous work: Transmaths



A measure of teachers perception of 'Transmissionism'– pre-University



For Secondary School Practices…

- Adopted the ideas of the above instrument…
- But …
- changes to address different practices (for students)
- And additionally…
- Students' understanding of statements (from Year 7 to 11)

The Secondary Maths Teacher Instrument

- 30 items

teaching_15	Students work on extended mathematics investigations or projects (a week or more in duration)
teaching_16	Students start with easy questions and work up to harder questions
teaching_17	Students read from a mathematics textbook in class
teaching_18	Students use mathematical concepts to interpret and solve applied problems
teaching_19	Students play mathematics games
teaching_20	Students work through exercises from textbooks or worksheets
teaching_21	Students work on their own, consulting a neighbour from time to time
teaching_22	Students choose which questions to tackle
teaching_23	I choose examples that appeal to students
teaching_24	I try to indicate the value of each lesson topic for future use
teaching_25	When a student asks a question, I give a clue (or scaffold) instead of the correct answer
teaching_26	During instruction I ask a lot of short questions to check whether students understand the content matter
teaching_27	I assign mathematics homework
teaching_28	I ask students to explain their reasoning when giving an answer
teaching_29	I encourage students to explore alternative methods for solutions
teaching_30	I allow students to work at their own pace

Student Instrument

How is maths taught this year?

26 items

Part D – How maths is taught and learnt

In this section we want to find out how maths is taught this year.
Please tell us, how often does the following happen in your maths lessons?

[Please circle the appropriate number in each line]		Never	Rarely	Sometimes	Always
1	The teacher asks us questions.	1	2	3	4
2	The teacher asks us to explain how we get our answers.	1	2	3	4
3	The teacher starts new topics with problems about the world.	1	2	3	4
4	The teacher tells us to work more quickly.	1	2	3	4
5	The teacher uses the computer to teach some topics.	1	2	3	4
6	The teacher gives us problems to investigate.	1	2	3	4
7	The teacher expects us to remember important ideas we learned in the past.	1	2	3	4
8	The teacher tells us which questions/activities to do.	1	2	3	4
9	The teacher asks us what we already know about a lesson topic.	1	2	3	4
10	The teacher tells us what value the lesson topic has for future use.	1	2	3	4
11	We work together in groups on projects.	1	2	3	4
12	We listen to the teacher talk about the topic.	1	2	3	4
13	We copy the teacher's notes from the board.	1	2	3	4
14	We talk with other students about how to solve problems.	1	2	3	4
15	We ask other students to explain their ideas.	1	2	3	4
16	We do projects (assignments) that include other school subjects.	1	2	3	4
17	We work through exercises from the textbook.	1	2	3	4
18	We learn how mathematics has changed over time.	1	2	3	4
19	What we learn is related to our out-of-school life.	1	2	3	4
20	We learn that mathematics is about inventing rules.	1	2	3	4
21	We get assignments to research topics on our own.	1	2	3	4
22	We use calculators.	1	2	3	4
23	We use computers.	1	2	3	4
24	We use other things like newspapers, magazines, or video.	1	2	3	4
25	We discuss ideas with the whole classroom.	1	2	3	4
26	We explain our work to the whole class.	1	2	3	4

The Questionnaire (list of 'constructs')

- About yourself and your school
  - Background information
  - Class and Teacher identifiers
  - Parental support/involvement
- Your feelings about mathematics (Maths Attitudes)
- Aspirations and intentions for after High School
- How maths is taught (Perceptions of teaching)
- Confidence in maths tasks (Maths Self-efficacy)

Data for this Analysis (Teachers, Students, Matched)

	Dataset 1 (teaching Cases)		Dataset 2 (all students)		Dataset 3 (student matched)	
Year Group	**DP1**	**DP2**	**DP1**	**DP2**	**DP1**	**DP2**
Year 7	68	25	3926	2632	1523	425
Year 8	69	19	3039	1964	1338	387
Year 9	47	14	2716	1804	944	262
Year 10	39	25	2127	1532	715	454
Year 11	36	13	1835	767	603	216
Total teaching cases/Students	**263***	**97**	**13643**	**8699**	5123	1744
In Classes			**666**	**465**	**230**	**84**
With Teachers			**249**	**185**	**119**	**39**

DP1: Oct to December 2011 (for teachers a few cases extended to January 2012) - DP2: June/July 2012

*Some teachers responses had missing classes – these responses were useful for some analyses (validation)

MEASURES CONSTRUCTION & VALIDATION (Rasch Model)
RQ1

Measurement

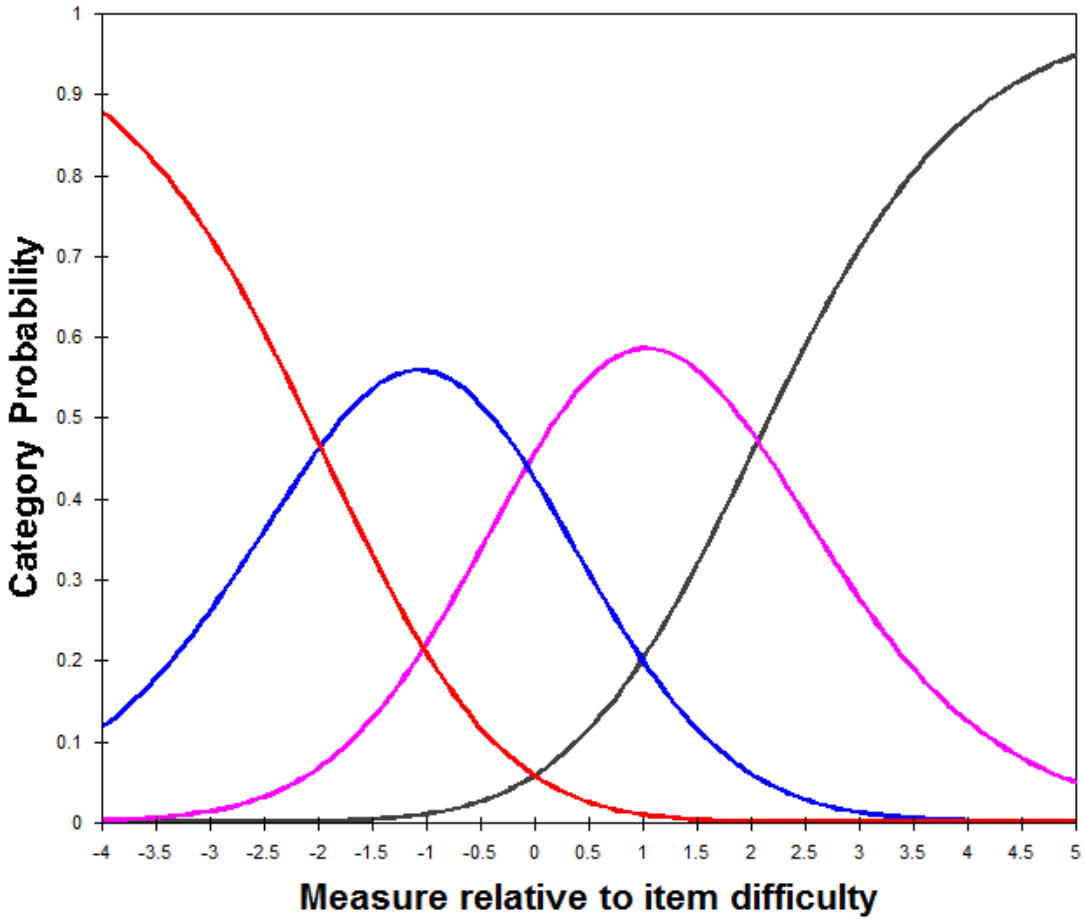
- 'Theoretically': Rasch Analysis (Item Response Theory)
  - Rating Scale Model
- 'In practice' – the tools: Winsteps software
- Interpreting Results:
  - Item Fit Statistics (to ensure unidimensional measures)
  - Differential Item Functioning for 'subject' groups
  - Person-Item maps for hierarchy
  - Qualitative checks

Teachers' Perceptions – Fit Statistics

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	ITEM
1	675	360	1.58	.08	.99	-.2	.99	-.1	.41	.35	53.1	53.5	teaching_1
2	1232	359	-1.95	.09	.96	-.5	.99	-.2	.10	.32	51.8	55.7	teaching_2
3	1103	359	-1.01	.08	.97	-.4	.96	-.6	.26	.35	60.4	55.5	teaching_4
4	966	359	-.16	.08	1.24	3.1	1.23	3.0	.30	.37	45.7	53.1	teaching_5
5	860	358	.44	.08	.68	-5.2	.68	-5.2	.56	.37	59.5	50.8	teaching_6
6	1082	360	-.86	.08	.99	.0	1.00	.0	.61	.36	50.6	55.7	teaching_7
7	938	360	.02	.08	1.13	1.7	1.12	1.7	.44	.37	49.4	51.9	teaching_8
8	645	360	1.77	.08	1.00	.1	.98	-.3	.48	.34	53.9	53.2	teaching_9
9	560	359	2.37	.09	1.41	5.3	1.62	7.4	.12	.32	47.9	54.8	teaching_10
10	1203	357	-1.77	.09	1.11	1.6	1.08	1.2	.47	.33	52.7	53.8	teaching_11
11	1013	356	-.50	.08	1.52	6.3	1.53	6.5	.23	.36	41.9	55.0	teaching_12
12	1025	357	-.56	.08	.82	-2.6	.82	-2.7	.40	.36	63.6	55.2	teaching_13
13	1238	358	-2.03	.09	1.26	3.5	1.23	3.1	.39	.32	55.6	55.7	teaching_14
14	1259	356	-2.27	.10	1.24	3.1	1.17	2.2	.44	.31	62.6	59.5	teaching_15
15	1126	357	-1.21	.08	.88	-1.7	.86	-2.1	.29	.35	62.2	55.1	teaching_16
16	836	358	.58	.08	.72	-4.4	.73	-4.3	.34	.37	59.2	51.0	teaching_18
17	980	356	-.30	.08	.87	-1.9	.87	-1.9	.46	.36	55.6	54.1	teaching_19
18	960	358	-.15	.08	.87	-1.8	.87	-1.9	.32	.36	62.8	53.0	teaching_20
19	946	357	-.08	.08	.87	-1.9	.86	-2.0	.21	.36	59.7	52.5	teaching_21
20	1026	355	-.61	.08	1.20	2.6	1.19	2.6	.35	.36	51.0	55.4	teaching_22
21	780	357	.90	.08	.82	-2.7	.82	-2.7	.40	.36	54.1	52.4	teaching_23
22	744	356	1.11	.08	.86	-2.2	.86	-2.1	.40	.36	58.7	53.2	teaching_24
23	565	357	2.31	.09	1.00	.0	1.00	.1	.24	.32	54.6	54.7	teaching_25
24	1166	357	-1.49	.09	1.18	2.5	1.22	3.1	-.02	.34	50.4	54.0	teaching_26
25	566	357	2.30	.09	.79	-3.2	.80	-3.0	.42	.32	59.4	54.6	teaching_28
26	781	357	.89	.08	.75	-4.0	.75	-3.9	.53	.36	58.0	52.4	teaching_29
27	814	357	.70	.08	.93	-1.1	.94	-.9	.22	.37	52.9	51.4	teaching_30
MEAN	929.2	357.7	.00	.08	1.00	-.2	1.01	-.1			55.1	54.0	
S.D.	210.9	1.4	1.34	.01	.21	2.9	.22	3.0			5.4	1.8	

- Items 10 and 12 showed slight misfit (with infit values above 1.4) but due to their face value and location on scale it was decided to keep them. Item 10 ("I tend to follow the textbook closely"), for example was also the most difficult item to endorse and such items do tend to produce misfit values.

Teachers' Perception – Category Statistics



el="R"

IFIT OUTFIT MNSQ	MNSQ	STRUCTURE CALIBRATN	CATEGORY MEASURE	
1.02	1.03	NONE	(-3.18)	4
.97	.99	-1.98	-1.07	3
.97	.98	-.08	1.04	2
1.00	1.03	2.06	(3.24)	1

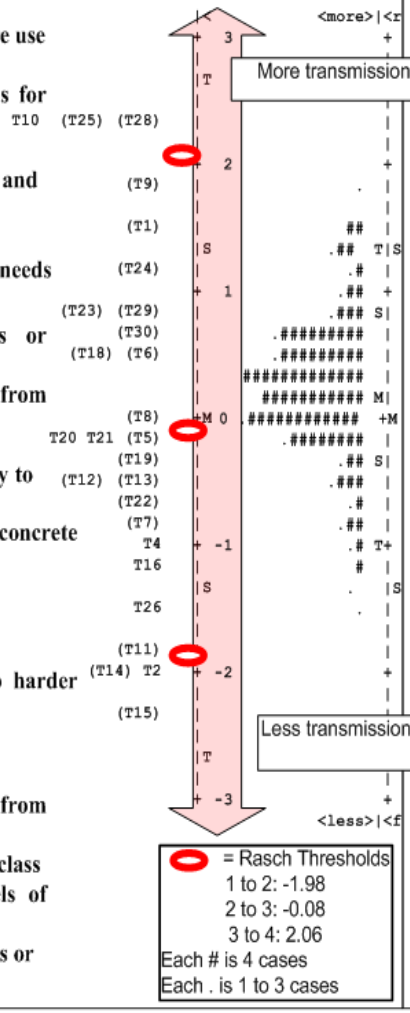
s in category. It is not a parameter estimate.

D-MEASURE ----ZONE----	50% CUM. PROBABLTY	COHERENCE M->C	C->M	RMSR	ESTIM DISCR	
-INF	-2.27		65%	26%	.9107		4
2	-1.98	.04	-1.07	-2.27	-.03	-2.11	52%	61%	.5712	1.00	3
3	-.08	.03	1.04	-.03	2.31	-.05	54%	72%	.4904	1.01	2
4	2.06	.03	(3.24)	2.31	+INF	2.16	66%	28%	.8381	1.01	1

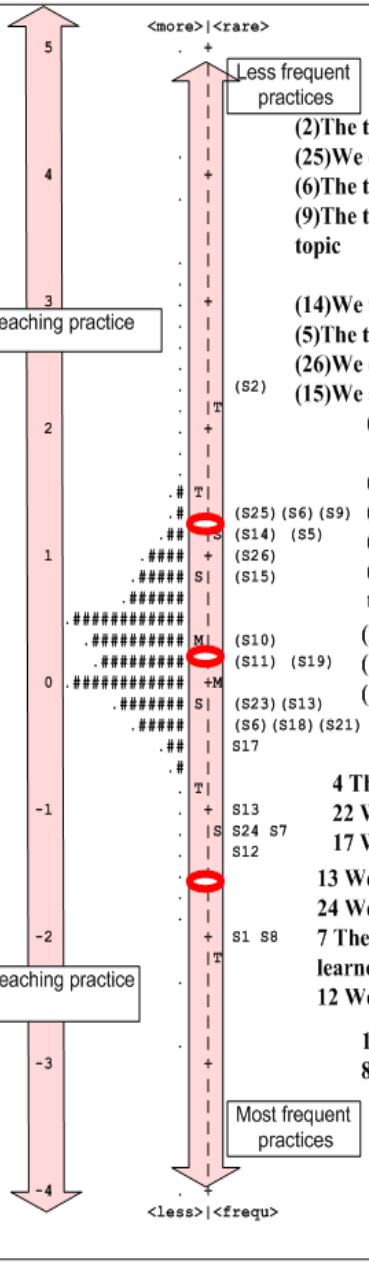
Measures of teachers and students' perception of TP

Teachers' Perception of 'Transmissionist' Teaching Practice

10. I tend to follow the textbook closely
(25) When a student asks a question, I give a clue (or scaffold) instead of the correct answer
(28)I ask students to explain their reasoning when giving an answer
(9)I encourage students to discuss the mistakes they make
(1) I introduce a new topic by first determining what the students already know about it
(24)I try to indicate the value of each lesson topic for future use
(23)I choose examples that appeal to students
(29) I encourage students to explore alternative methods for solutions
(30) I allow students to work at their own pace
(18) Students use mathematical concepts to interpret and solve applied problems
(6) I have my students work collaboratively in pairs
(8)I teach each student differently according to individual needs
(5) I jump between topics as the need arises
20. Students work through exercises from textbooks or worksheets
21. Students work on their own, consulting a neighbour from time to time
(19) Students play mathematics games
(12) Students decide for themselves whether it is necessary to cooperate with other students
(13) Students engage in mathematical activities using concrete materials
(22) Students choose which questions to tackle
(7) I have my students work collaboratively in groups
4. I teach the whole class at once
16. Students start with easy questions and work up to harder questions
26. During instruction I ask a lot of short questions to check whether students understand the content matter
(11) Students work on projects in which subject material from various subjects is integrated
(14) Students make formal presentations to the rest of the class
2. I offer content matter in gradually increasing levels of complexity
(15) Students work on extended mathematics investigations or projects (a week or more in duration)



Students' Perception of 'Transmissionist' Teaching Practice



(2)The teacher asks us to explain how we get our answers
(25)We discuss ideas with the whole classroom
(6)The teacher gives us problems to investigate
(9)The teacher asks us what we already know about a lesson topic

(14)We talk with other students about how to solve problems
(5)The teacher uses the computer to teach some topics
(26)We explain our work to the whole class
(15)We ask other students to explain their ideas
(10)The teacher tells us what value the lesson topic has for future use
(11)We work together in groups on projects
(19)What we learn is related to our out-of-school life
(23)We use computers
(3)The teacher starts new topics with problems about the world
(21)We get assignments to research topics on our own
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(18)We learn how mathematics has changed over time

4 The teacher tells us to work more quickly
22 We use calculators
17 We work through exercises from the textbook
13 We copy the teacher's notes from the board
24 We use other things like newspapers, magazines, or video
7 The teacher expects us to remember important ideas we learned in the past
12 We listen to the teacher talk about the topic

1 The teacher asks us questions
8 The teacher tells us which questions/activities to do

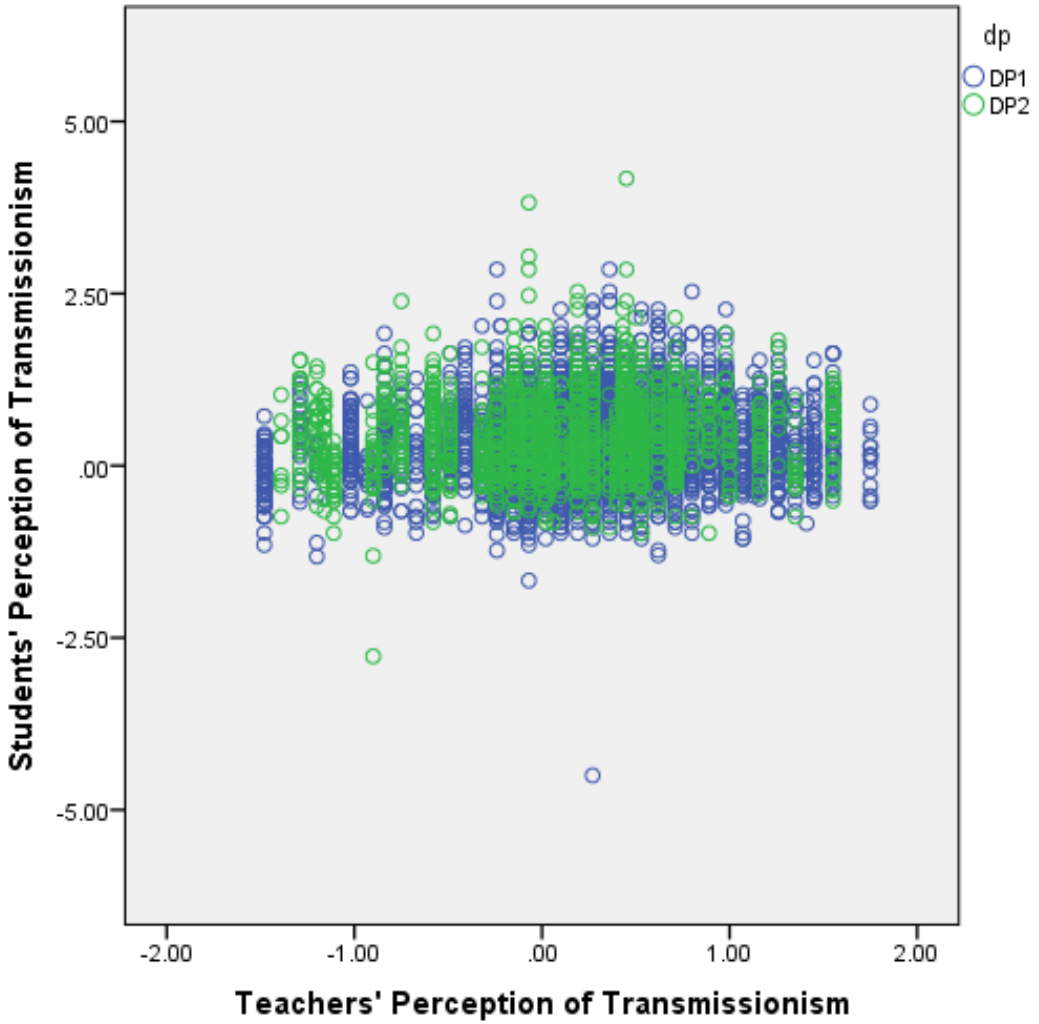
Further Analysis with these measures

- Correlation between the two perceptions (with matched data: students and teachers of the same class)
- Regression Model for Maths Disposition as response variable

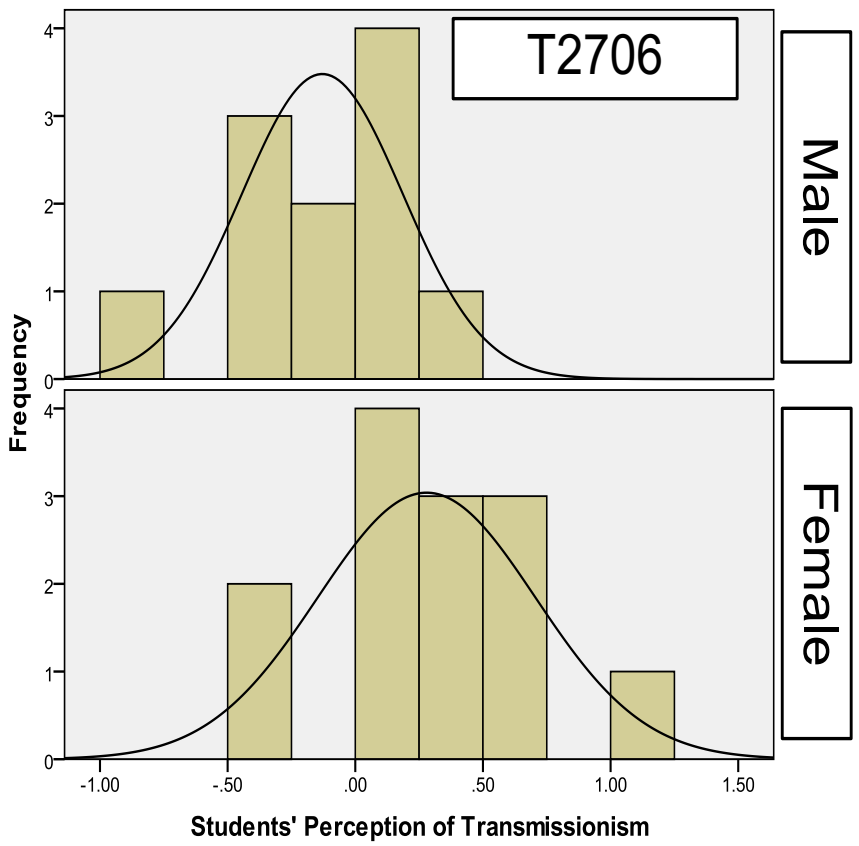
Associations between the two perceptions?

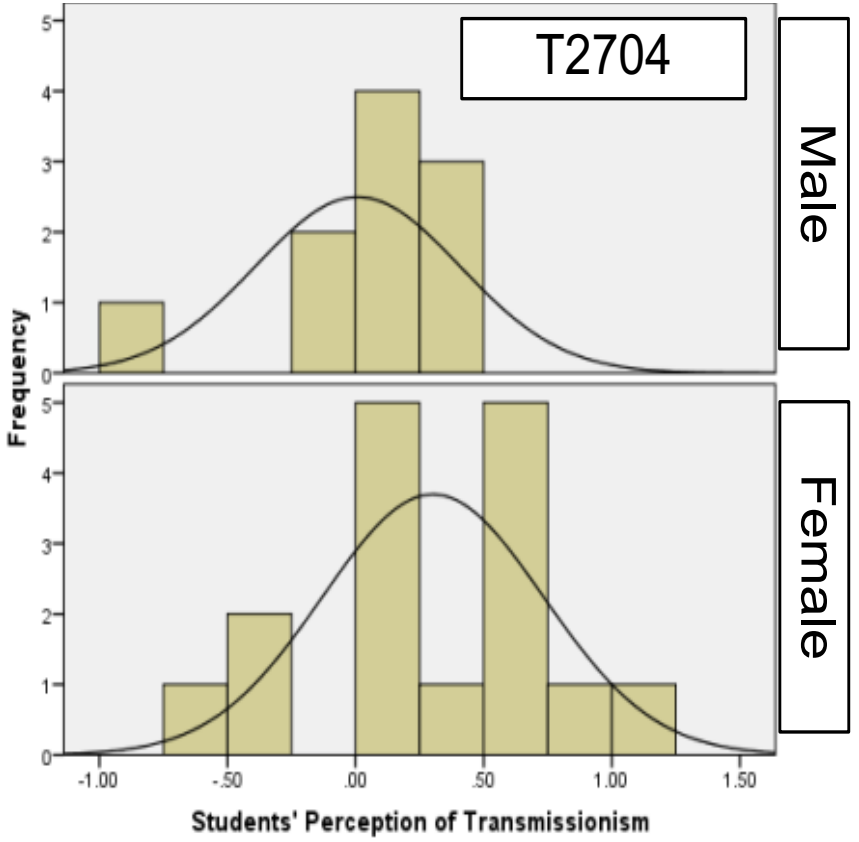
- Pearson correlations at student level
- DP1 (N= 5123): 0.119 (p<0.001),
- DP2 (N=1734) 0.088 (p<0.001).

- Correlations at class level (i.e. between teachers' score and the average of students' scores for each class)
- DP1 (N=230) 0.228 (p<0.001),
- DP2 (N=84) 0.154 (p=0.162).

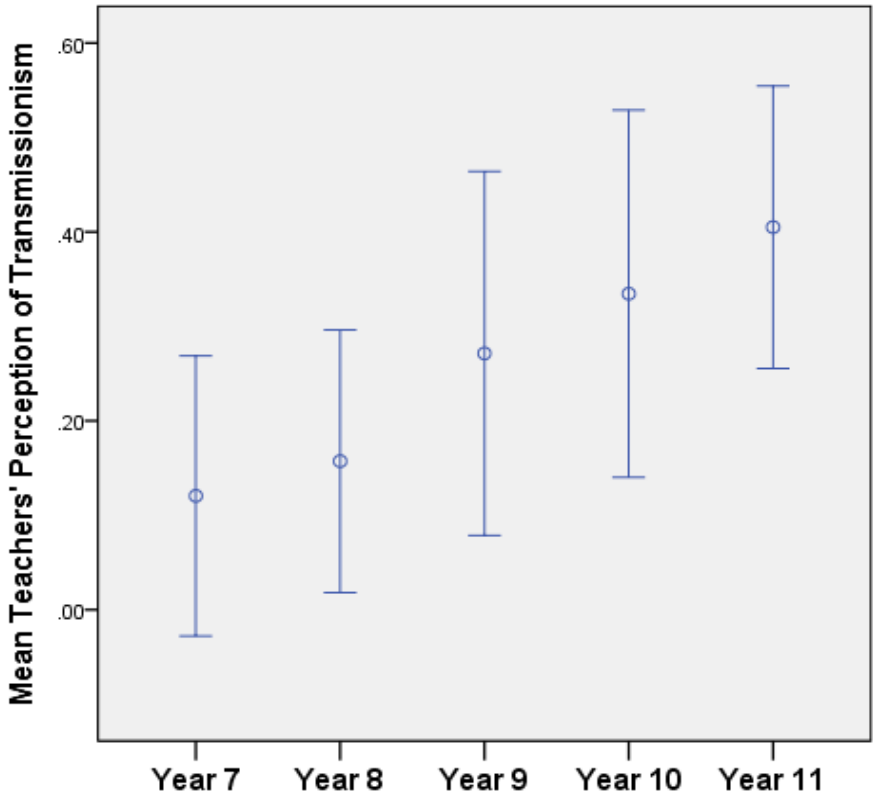


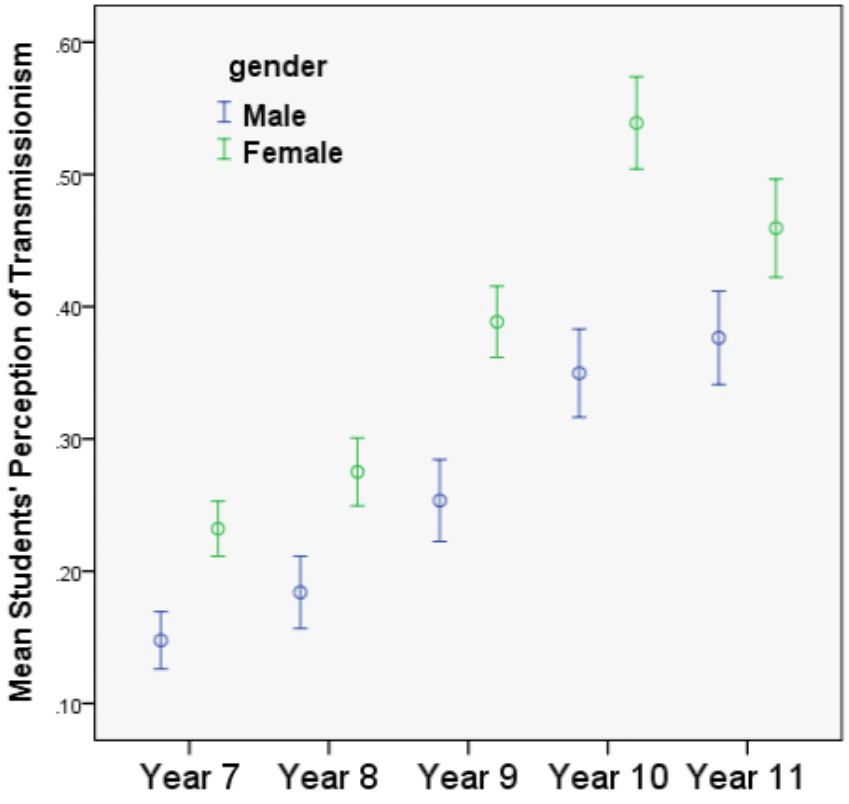
Perceptions for the same classes…



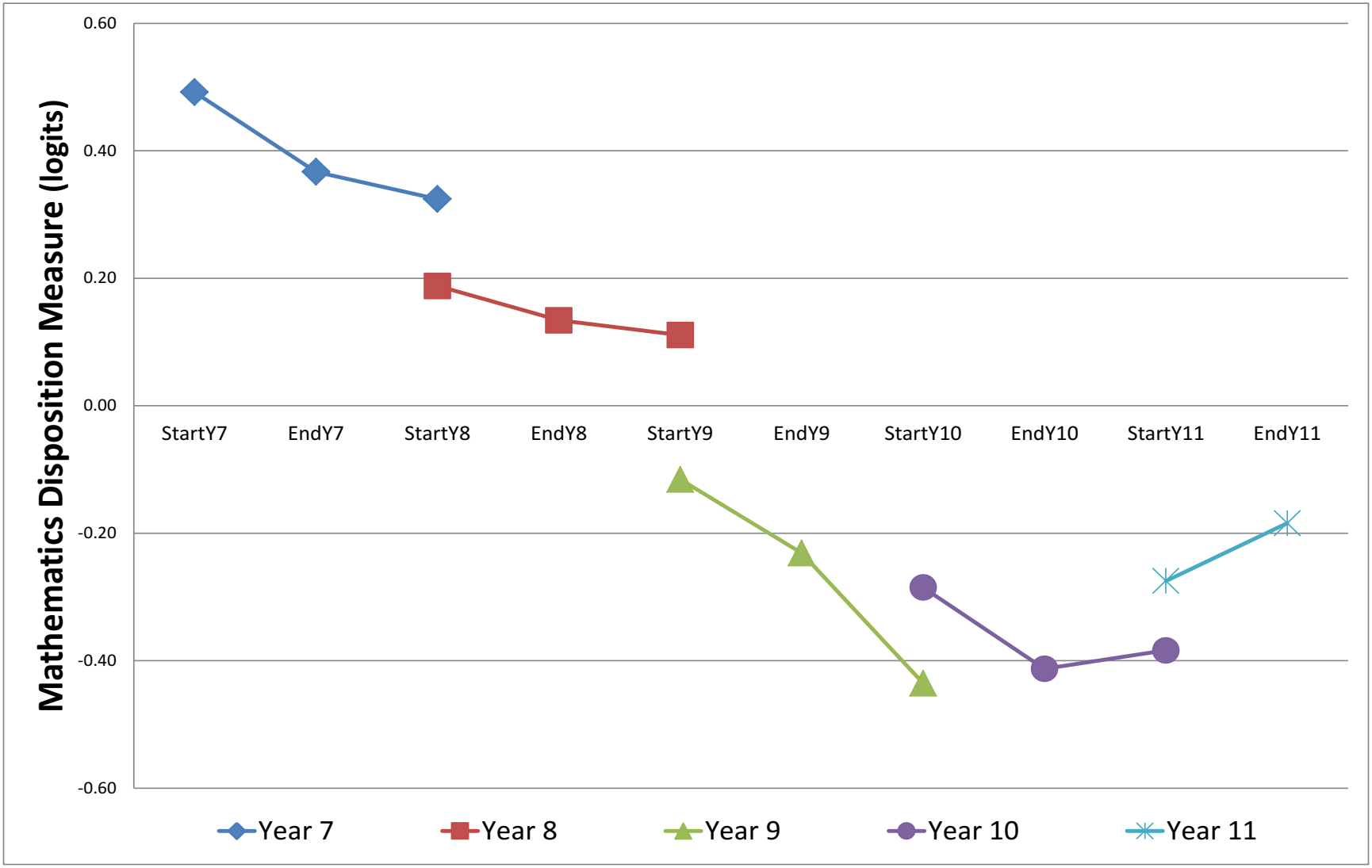


Differences in students' perceptions





Declining Mean Maths disposition



Association of Teaching perceptions and dispositions

Table 1: Regression Models for Mathematics Disposition as an outcome variable

Explanatory Variables:	**Model 1**	**Model 2**	**Model 3**
Constant	0.25 (0.02)**	0.47 (0.03) **	0.99 (0.04)**
DP (Ref: DP1)	-0.08 (0.05)	0.03 (0.04)	0.04 (0.04)
Teacher's TP	**-0.14 (0.03) ** **	-0.06 (0.03)	-0.05 (0.03)
Students' TP		**-0.77 (0.04)****	**-0.65 (0.04)****
Gender (Ref: Male)			-0.41(0.04) **
Year group (Ref: Year 7)			
Year 8			-0.25 (0.05) **
Year 9			-0.59 (0.06) **
Year 10			-0.49 (0.06) **
Year 11			-0.67 (0.04) **

Model 1: $F(2, 6856)=9.31$ ($p<0.001$), $R^2=0.0027$ (Adjusted $R^2=0.0024$)
Model 2: $F(3, 6859)=163.76$ ($p<0.001$), $R^2=0.0669$ (Adjusted $R^2=0.0665$)
Model 3: $F(8, 6743)=99.66$ ($p<0.001$), $R^2=0.1057$ (Adjusted $R^2=0.1047$)

Implications for Policy and Practice

- to keep students positively disposed and interested in mathematics, with potential implications for their future engagement with mathematically demanding courses at higher education, teaching should be less transmissionist throughout secondary mathematics,
- it is also (perhaps more importantly) crucial to monitor and respond to students' perceptions of the classroom practice, and engage teaching with students views.

Some Methodological/Measurement issues

- 'Theoretical'/Conceptual matching of two different instruments with different groups (who in theory share the same practice)…
- Equivalent measures?

- Could we possibly 'link' with only a few (5-6) same items? (same issue in next presentation)
- Multilevel Rasch (from class-level data)?

For More Information

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Thank you!