Associations of teaching styles with students' mathematics dispositions in Secondary education

BRITISH SOCIETY FOR RESEARCH INTO LEARNING MATHEMATICS

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Outline

The (educational) problem

The project

The analytical/methodological framework

- brief overview of instruments
- brief overview of measure construction
- Analytical challenges

Overview of Findings

- Some descriptive results
- Models of change over time
- Qualitative

Concluding Points

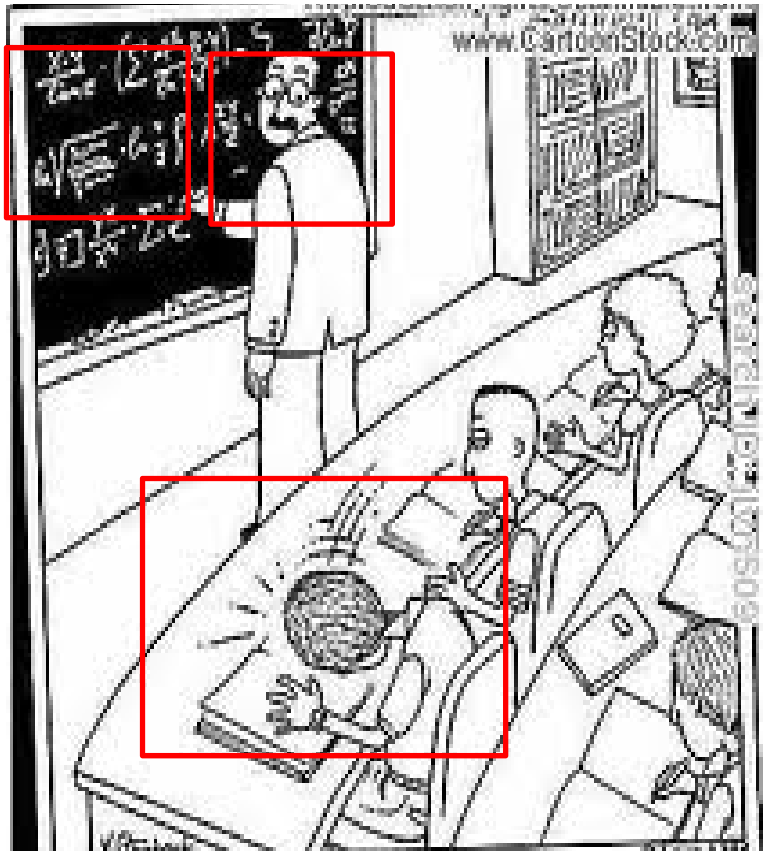
Introduction: The STEM ‘issue’

STEM: Science Technology, Engineering and Mathematics

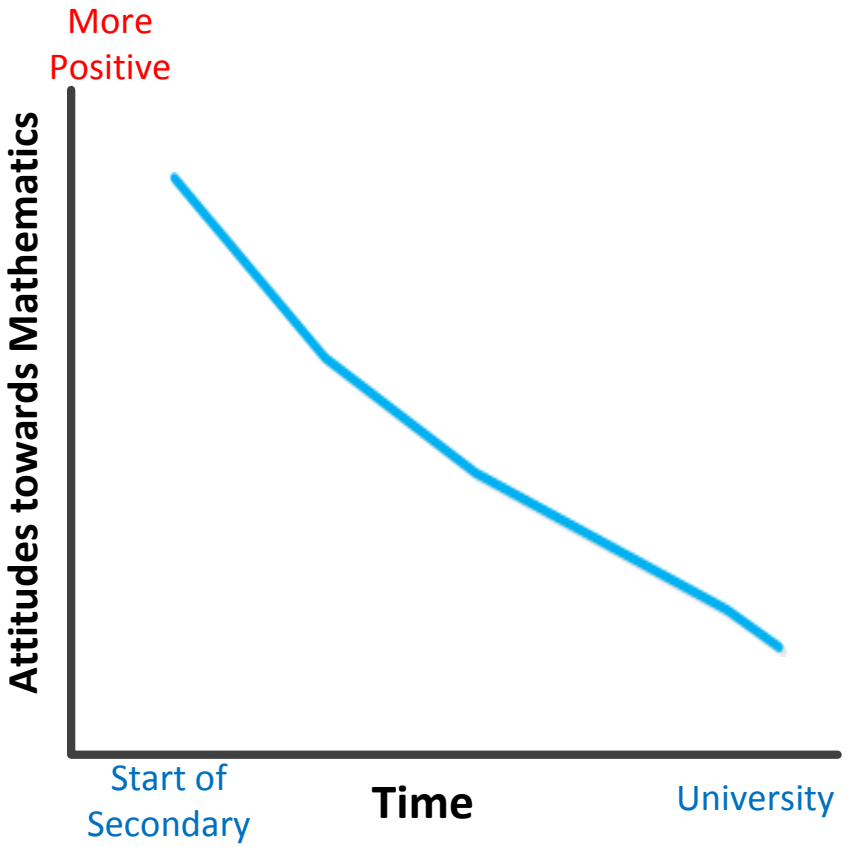
Participation remains problematic

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:

oconnecting teaching to students' mathematical understandings, and productions
o 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 Teleprism Project

TELEPRISM

Teaching and Learning Practices in Secondary Mathematics

ESRC funded study (RES-061-25-0538) in UK

(2011-2014) (www.teleprism.com)

"Mathematics teaching and learning in secondary schools: the impact of pedagogical practices on important learning outcomes"

TEAM

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

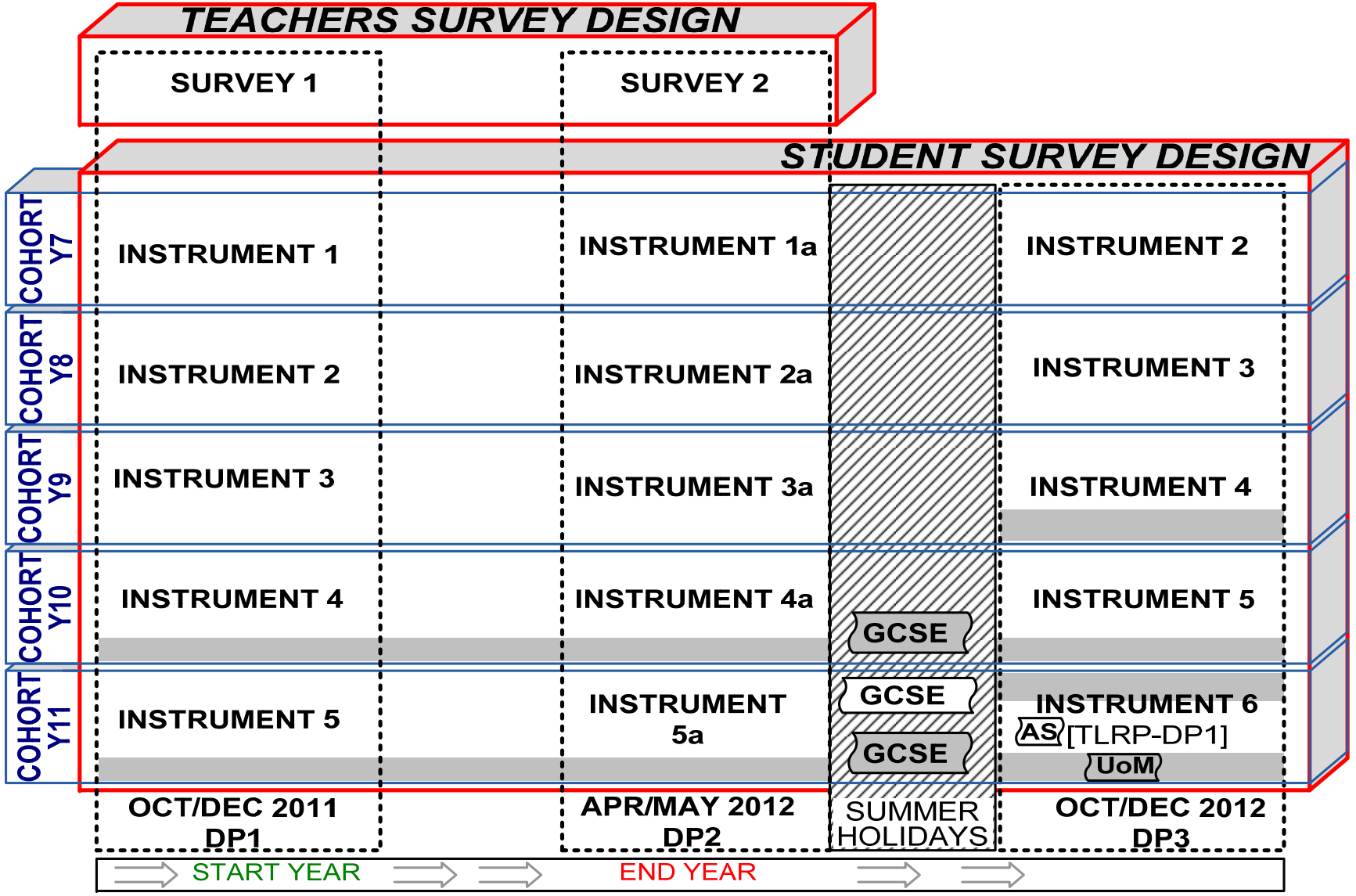
Teleprism: Aims

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

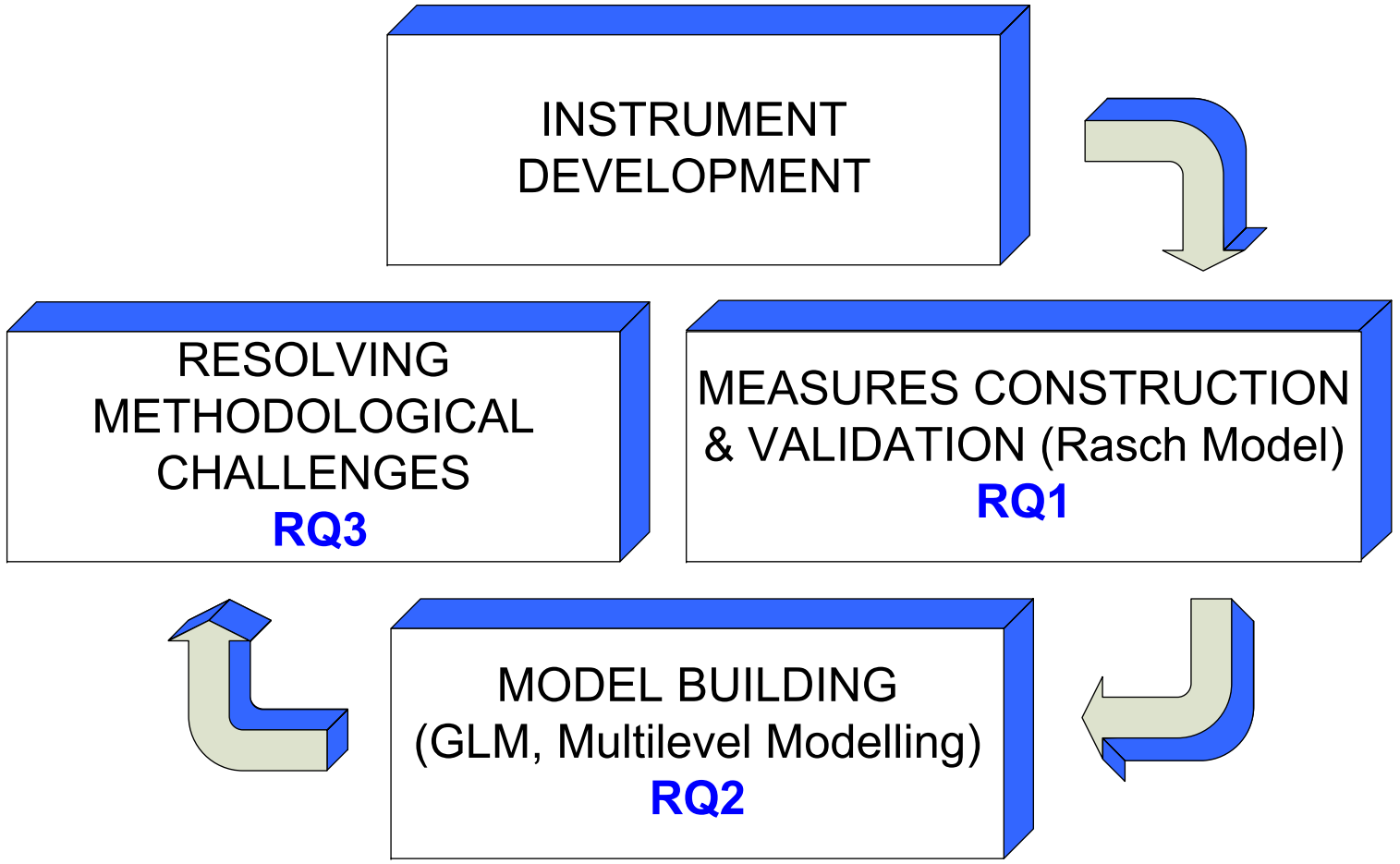
Students @Start

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

The data longitudinally (… and missing data)

Year group cohort	**Data Point 1** Start of academic year 2011-2012	**Data Point 2** End of academic year 2011-2012	**Data Point 3** Start of academic year 2012-2013
7	3974	2679	2510 (Year 8)
8	3073	2000	1667 (Year 9)
9	2733	1823	1527 (Year 10)
10	2157	1562	1355 (Year 11)
11	1837	773	144 (Year 12)
Total	**13774**	**8837**	**7203**

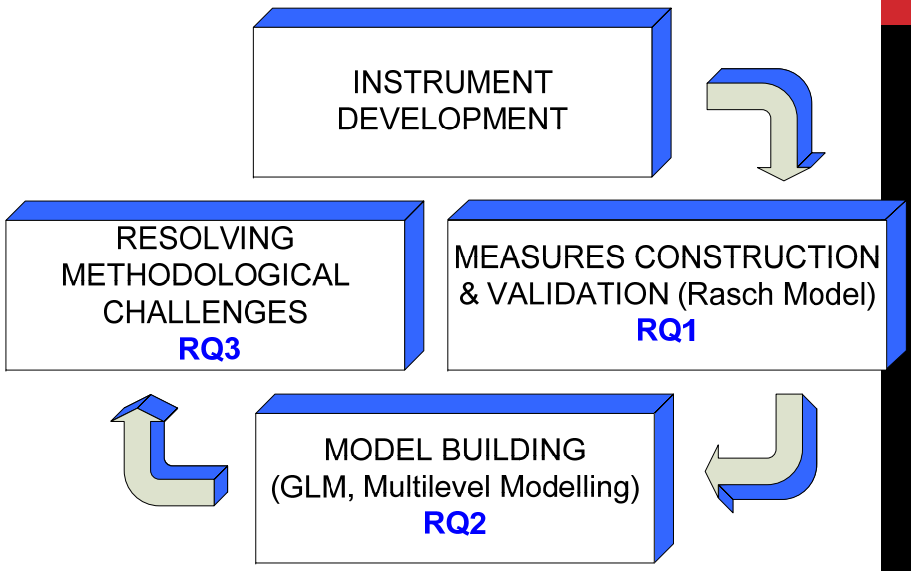
The Methodological/ Analytical Framework



The Research Questions

RQ1: How can we measure (i) teachers' (self-reported) pedagogic practices and (ii) students' dispositions (and other learning outcomes) to study and use mathematics?

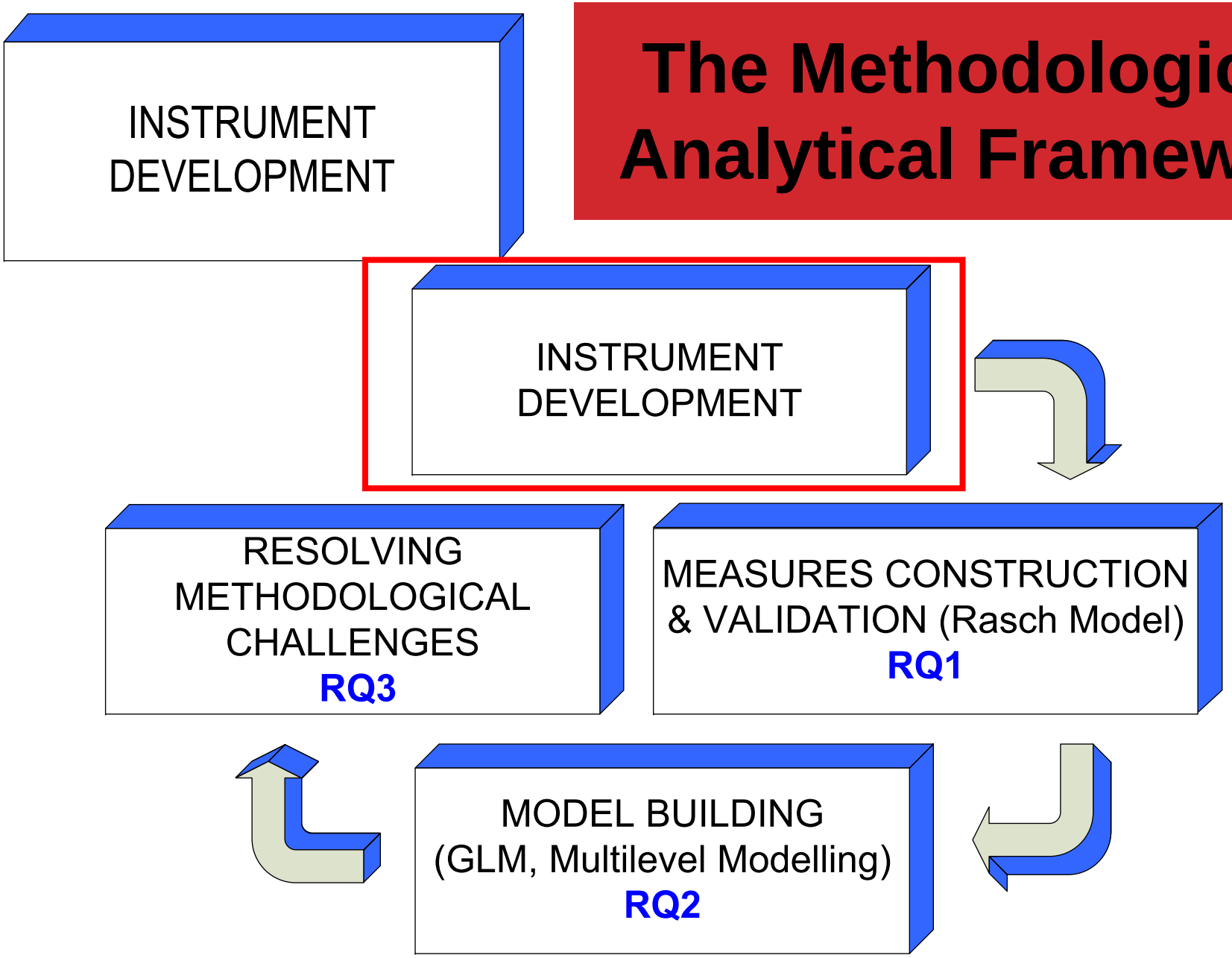
How do these measures vary across key subgroups (e.g. year groups), background variables (e.g. class, ethnicity, gender) and institutional types (schools)?



RQ2: How do background and process variables (e.g. programme type) and pedagogy predict students' learning dispositions, outcomes and decisions from Y7 to Y11?

RQ3: How can cross-sectional and longitudinal models be combined in the context of hierarchical data structures and missing data?

The Methodological/ Analytical Framework



INSTRUMENT DEVELOPMENT

The Questionnaire

MANCHESTER 1824

The University of Manchester

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

TeLePriSM

Teaching and Learning Practices in Secondary Mathematics

First Student Questionnaire

Dear pupil,

You are being invited to take part in a research study run by Dr Maria Pampaka from the University of Manchester. The questionnaire you are about to complete is about your mathematics lessons in your school.

No-one else will see your answers to this questionnaire as it is **strictly confidential.** We are only asking you to enter your unique username, which will be given by your teacher, because we hope to repeat this survey twice more and would like to be able to match your answers between surveys.

Please answer ALL questions as honestly as possible.

By completing and returning this questionnaire we take it that you are happy to take part in this research and would like to thank you very much in advance!

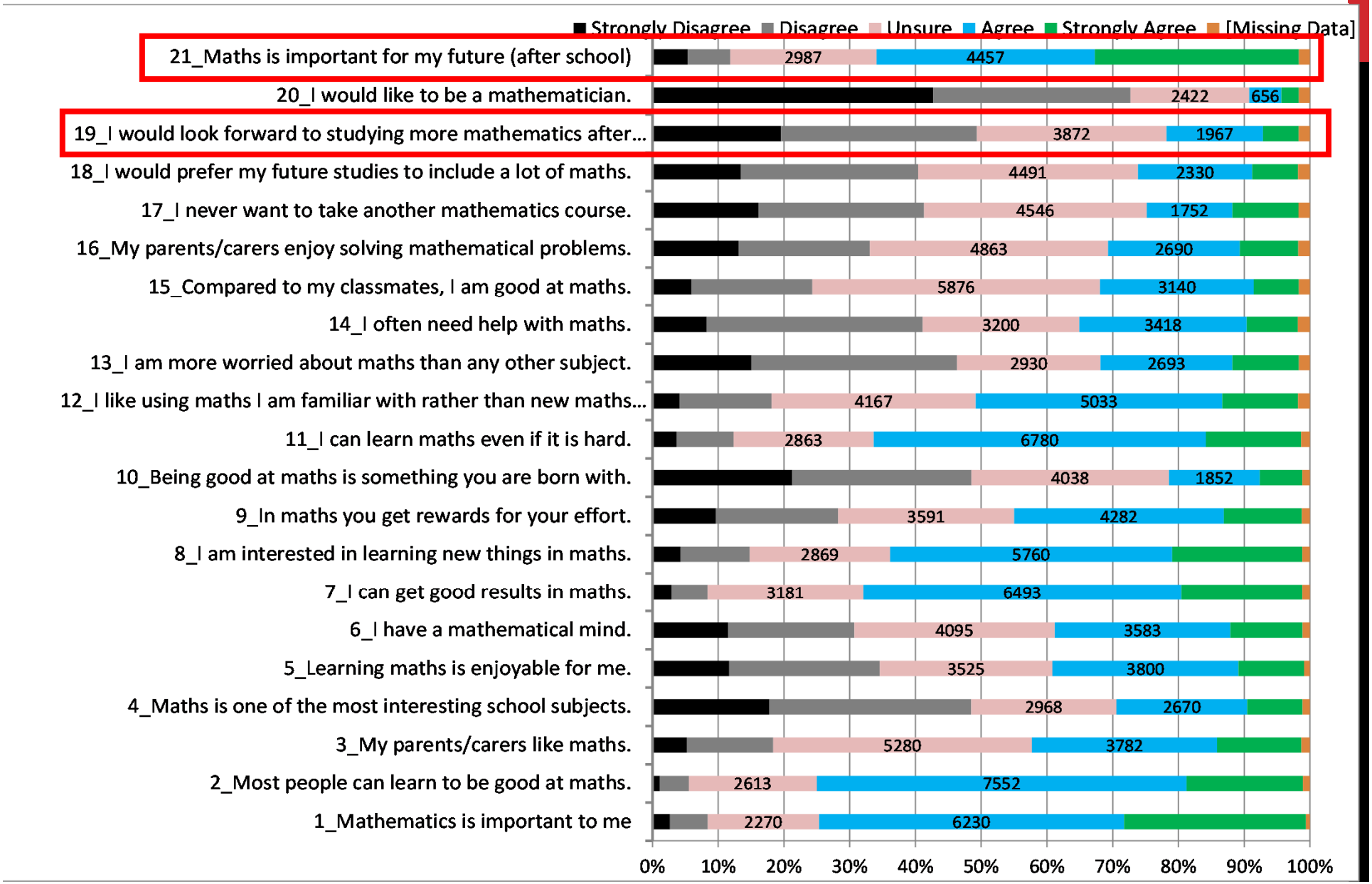
Part A – About yourself and your school

INSTRUMENT DEVELOPMENT

The Questionnaire

- 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)

Example: Maths Attitudes



Example: Maths Self-Efficacy

5. How confident are you to **calculate the range of a set of numbers** such as:

A rugby team played 7 games.

Here is the number of points they scored in each game.

3 5 8 9 12 12 16

(a) Work out the range.

.....

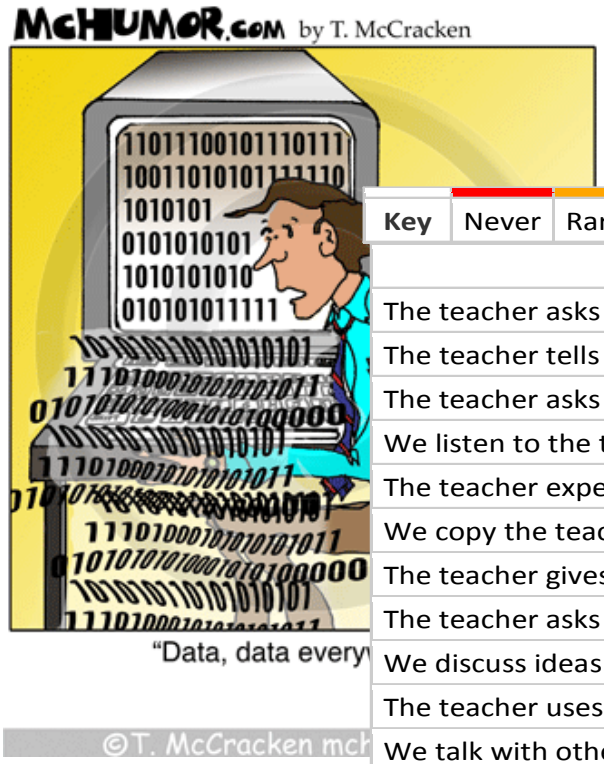
Not confident at all **Not very confident** **Fairly confident** **Very confident**

"In this section, we are asking you to say how confident you would be at using mathematics to solve different problems. We don't ask you to actually solve the problems."

We asked the students….

How maths is taught this year?

[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

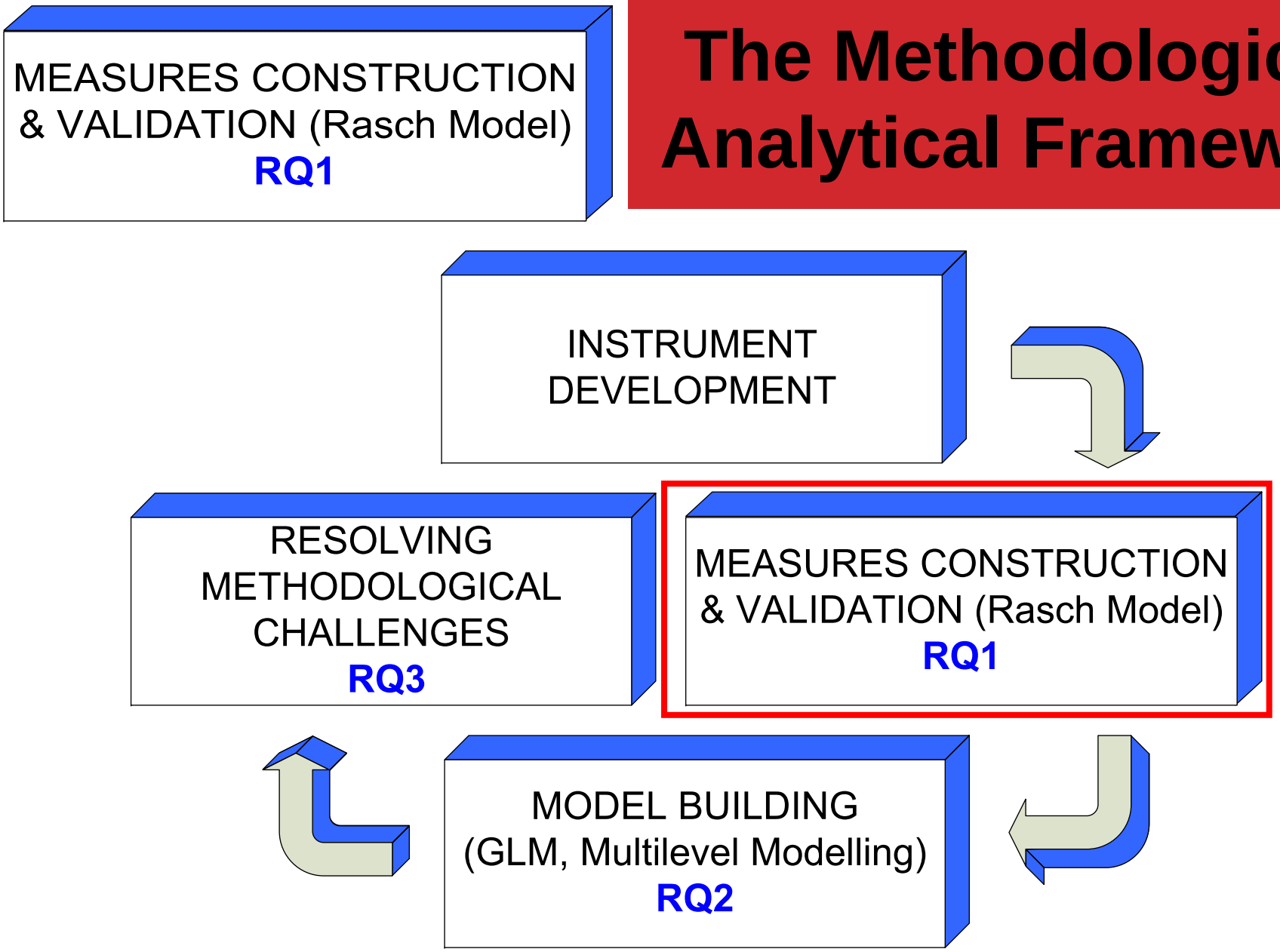


DATA ANALYSIS ...BEFORE RASCH

Key	Never	Rarely	Sometimes	Always

Item name	Frequency bars
The teacher asks us questions.	
The teacher tells us which questions/activities to do.	
The teacher asks us to explain how we get our answers.	
We listen to the teacher talk about the topic.	
The teacher expects us to remember important ideas learnt in the past.	
We copy the teacher's notes from the board.	
The teacher gives us problems to investigate.	
The teacher asks us what we already know about a lesson topic.	
We discuss ideas with the whole classroom.	
The teacher uses the computer to teach some topics.	
We talk with other students about how to solve problems.	
We work through exercises from the textbook.	
We use calculators.	
We ask other students to explain their ideas.	
We explain our work to the whole class.	
The teacher tells us to work more quickly.	
The teacher tells us what value the lesson topic has for future use.	
We work together in groups on projects.	
What we learn is related with our out-of-school life.	
We learn that mathematics is about inventing rules.	
We get assignments to research topics on our own.	
The teacher starts new topics with problems about the world.	
We use computers.	
We do projects (assignments) that include other school subjects.	
We learn how mathematics has changed over time.	
We use other things like newspapers, magazines, or video.	

The Methodological/ Analytical Framework



MEASURES CONSTRUCTION & VALIDATION (Rasch Model)
RQ1

Measurement

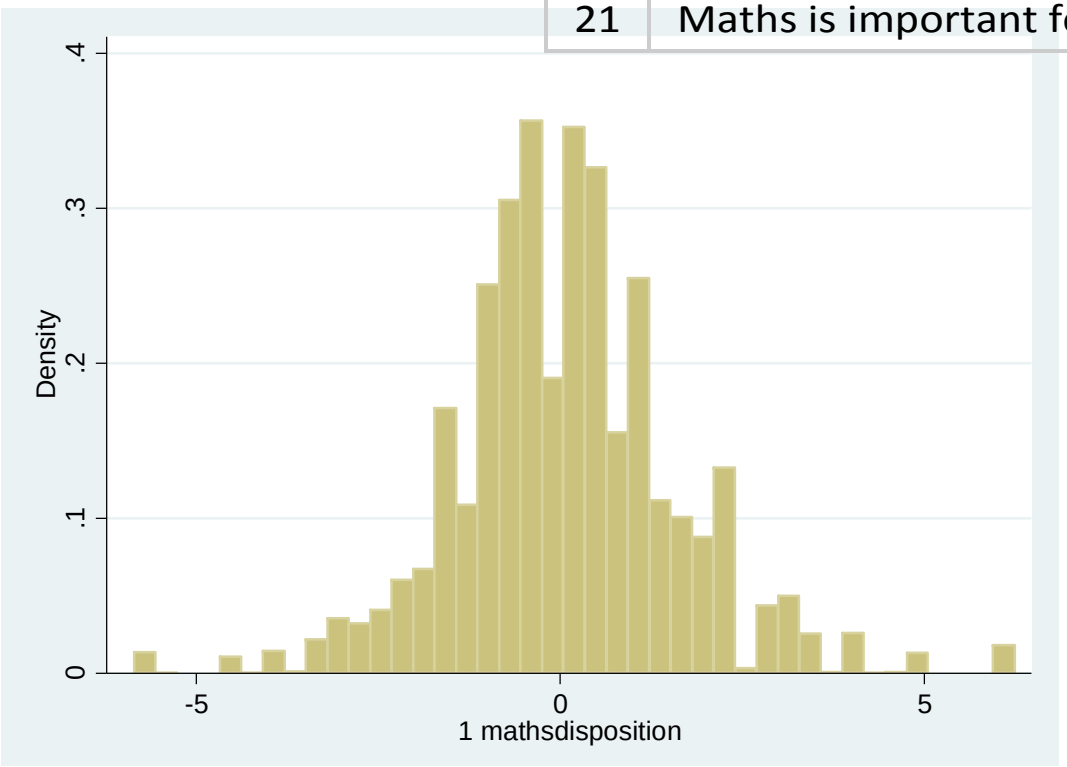
- 'Theoretically': Rasch Analysis (Item Response Theory)
  - Partial Credit Model
  - Rating Scale Model

- '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

Example: A measure of Maths Dispositions

1	Mathematics is important to me.
4	Maths is one of the most interesting school subjects.
5	Learning maths is enjoyable for me.
8	I am interested in learning new things in maths.
17	I never want to take another mathematics course. [R]
18	I would prefer my future studies to include a lot of maths.
19	I would look forward to studying more mathematics after schoo
20	I would like to be a mathematician.
21	Maths is important for my future (after school)



Teaching Practices: Descriptive Stats @DP1

Key	Never	Rarely	Sometimes	Always

Item name	Frequency bars
The teacher asks us questions.	
The teacher tells us which questions/activities to do.	
The teacher asks us to explain how we get our answers.	
We listen to the teacher talk about the topic.	
The teacher expects us to remember important ideas learnt in the past.	
We copy the teacher's notes from the board.	
The teacher gives us problems to investigate.	
The teacher asks us what we already know about a lesson topic.	
We discuss ideas with the whole classroom.	
The teacher uses the computer to teach some topics.	
We talk with other students about how to solve problems.	
We work through exercises from the textbook.	
We use calculators.	
We ask other students to explain their ideas.	
We explain our work to the whole class.	
The teacher tells us to work more quickly.	
The teacher tells us what value the lesson topic has for future use.	
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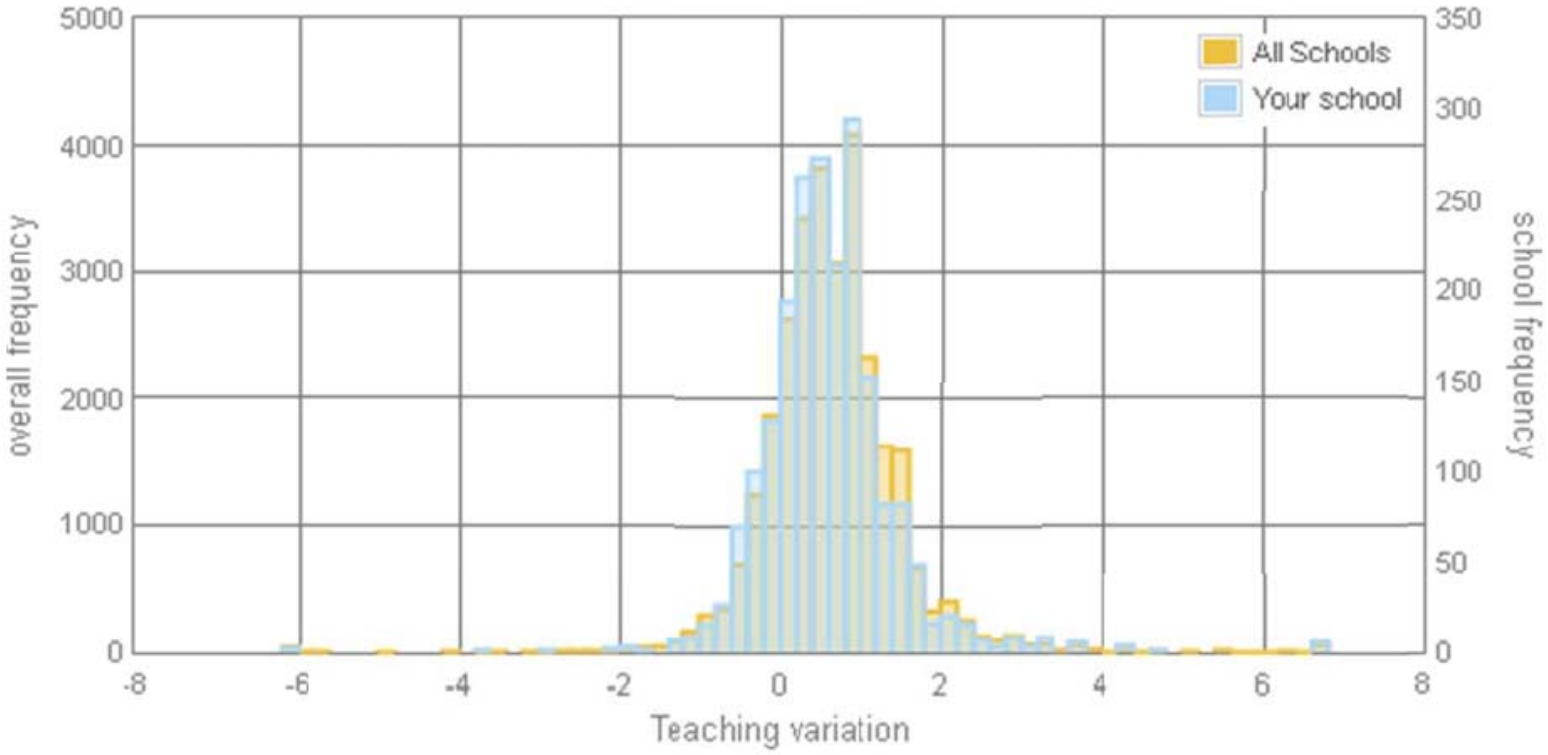
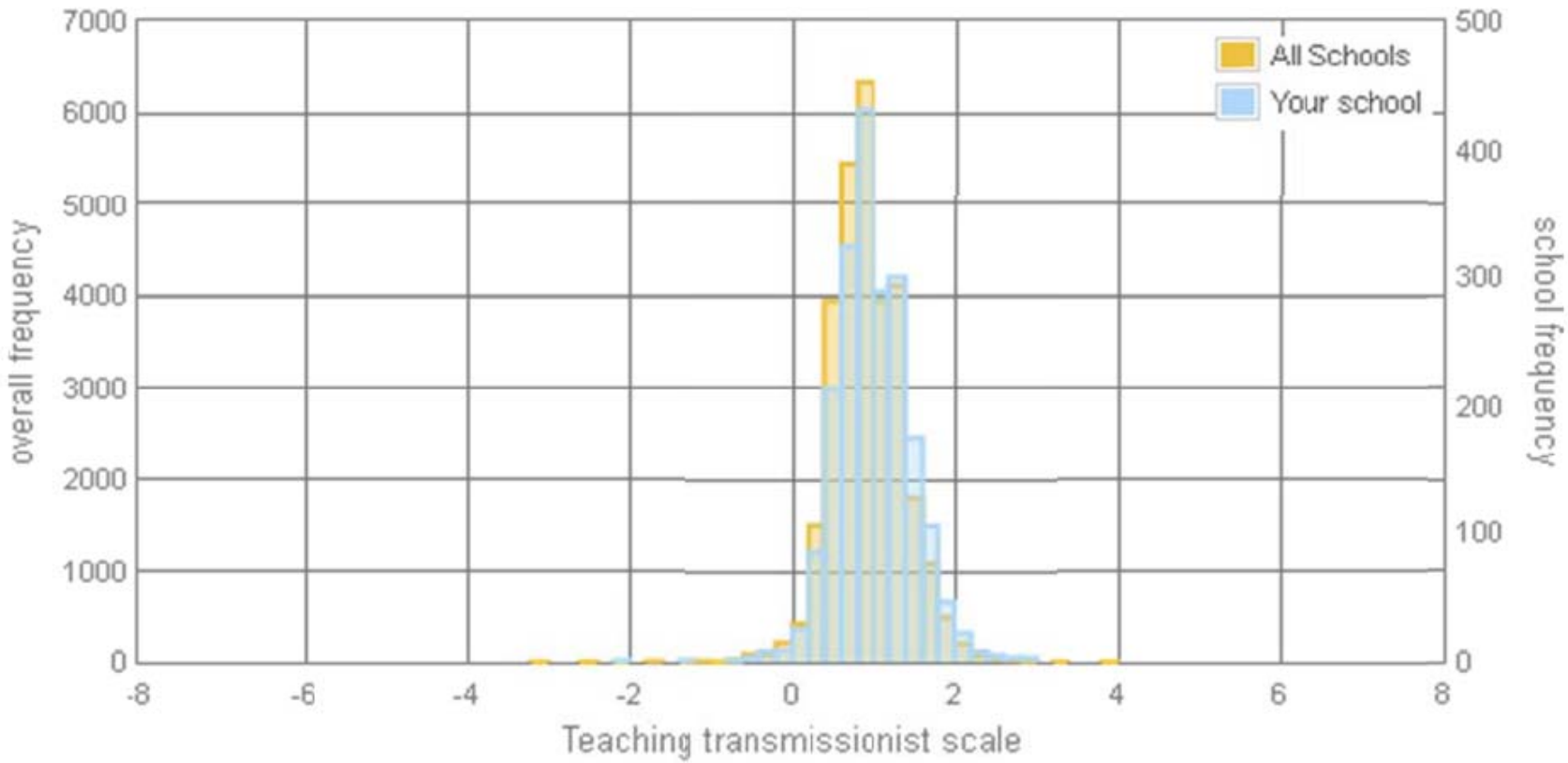
We learn that mathematics is about inventing rules.	
We get assignments to research topics on our own.	
The teacher starts new topics with problems about the world.	
We use computers.	
We do projects (assignments) that include other school subjects.	
We learn how mathematics has changed over time.	
We use other things like newspapers, magazines, or video.	

A measure of Teaching Variations



A measure of Transmissionist Teaching



Constructed and Validated Measures

- A measure of ‘perceived parental involvement/support’
- Mathematics disposition: (the higher the score the more disposed the student is towards further study or engagement with mathematics)
- Mathematics ‘identity’: (the higher the score the more positively/strongly the student relates or identifies with mathematics)
- Mathematics Self-efficacy
- Perceptions of teaching:
  - Teaching Variation: the higher the score on this measure the more diverse the maths lessons are (from students' perspective).
  - Transmissionist teaching: the higher the score the more 'traditional' or teacher-centred the practices as reported by the students.

Some Findings…

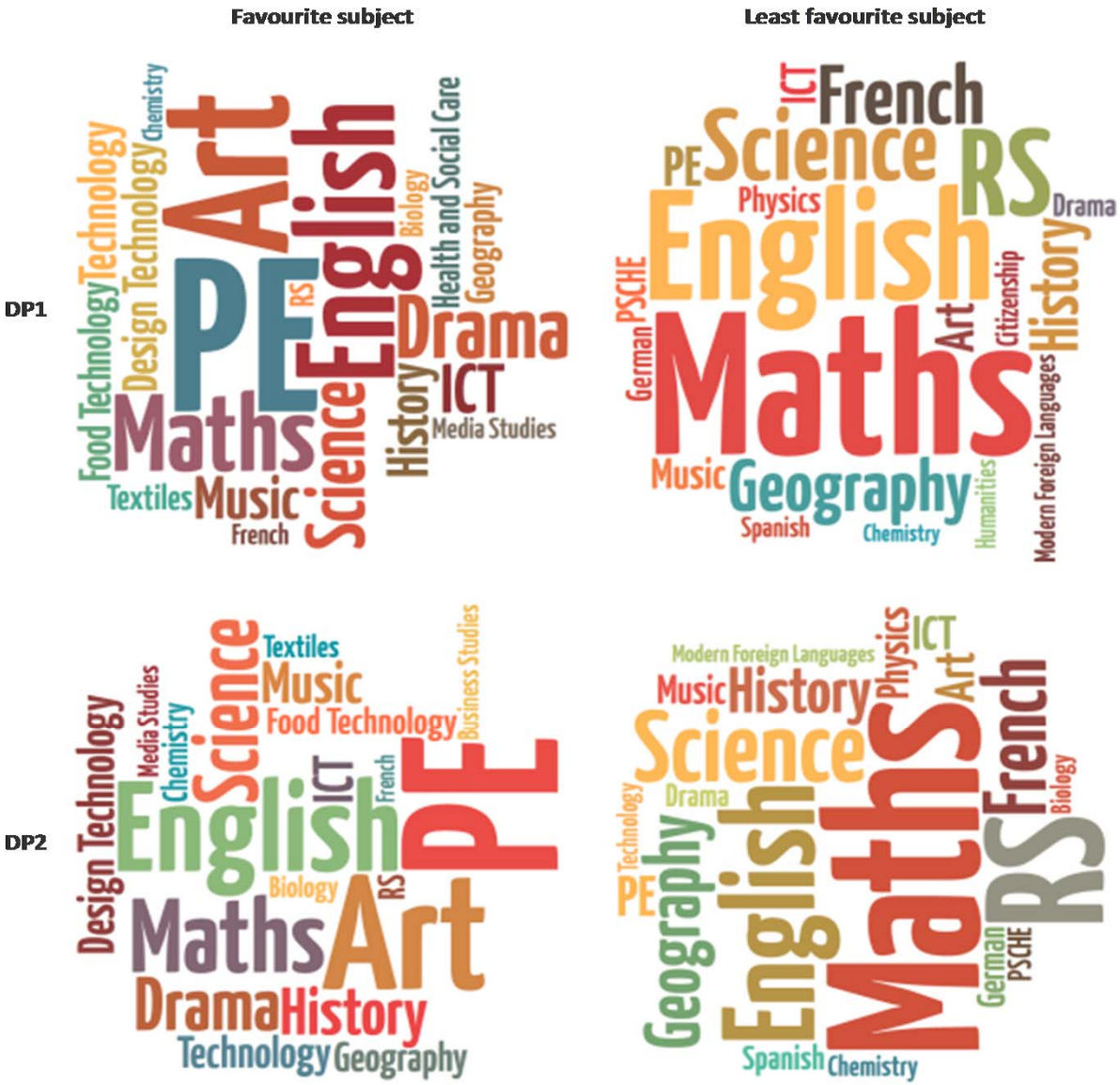
An overview of results with a combination of:

- Descriptive Results

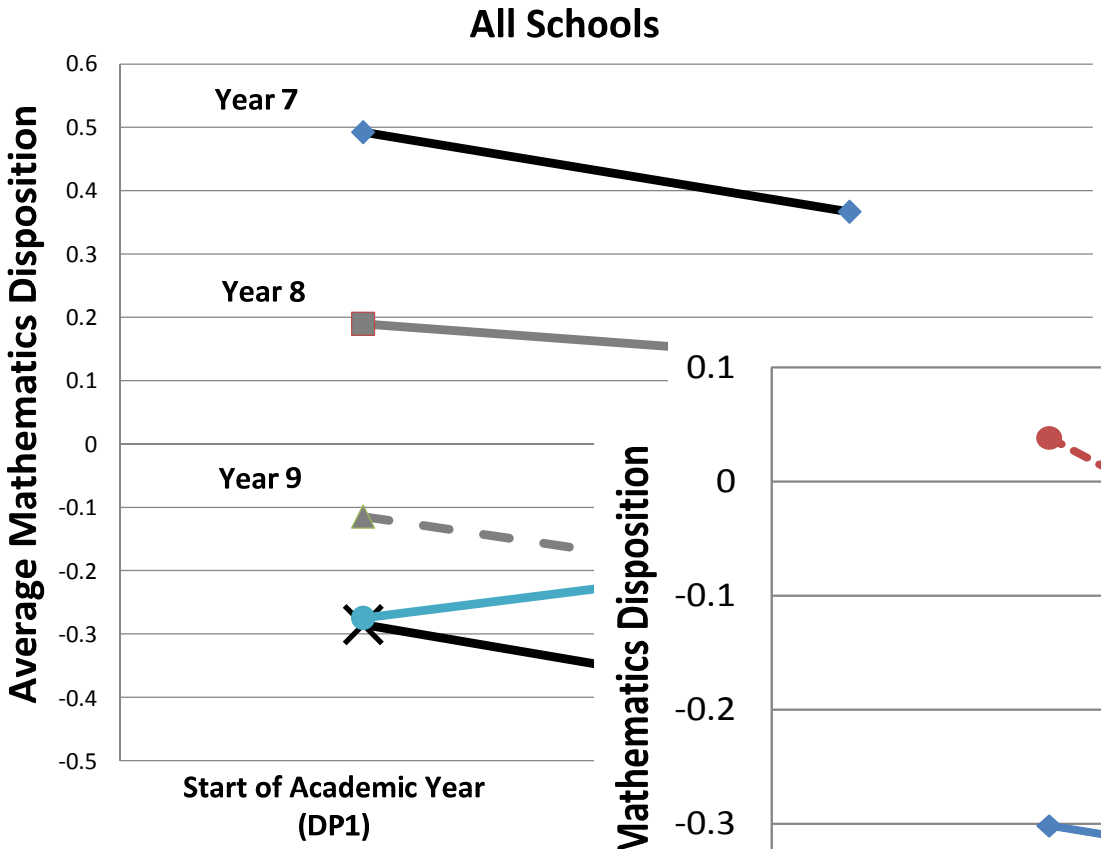
- Multilevel Modelling
- Growth Curve Modelling

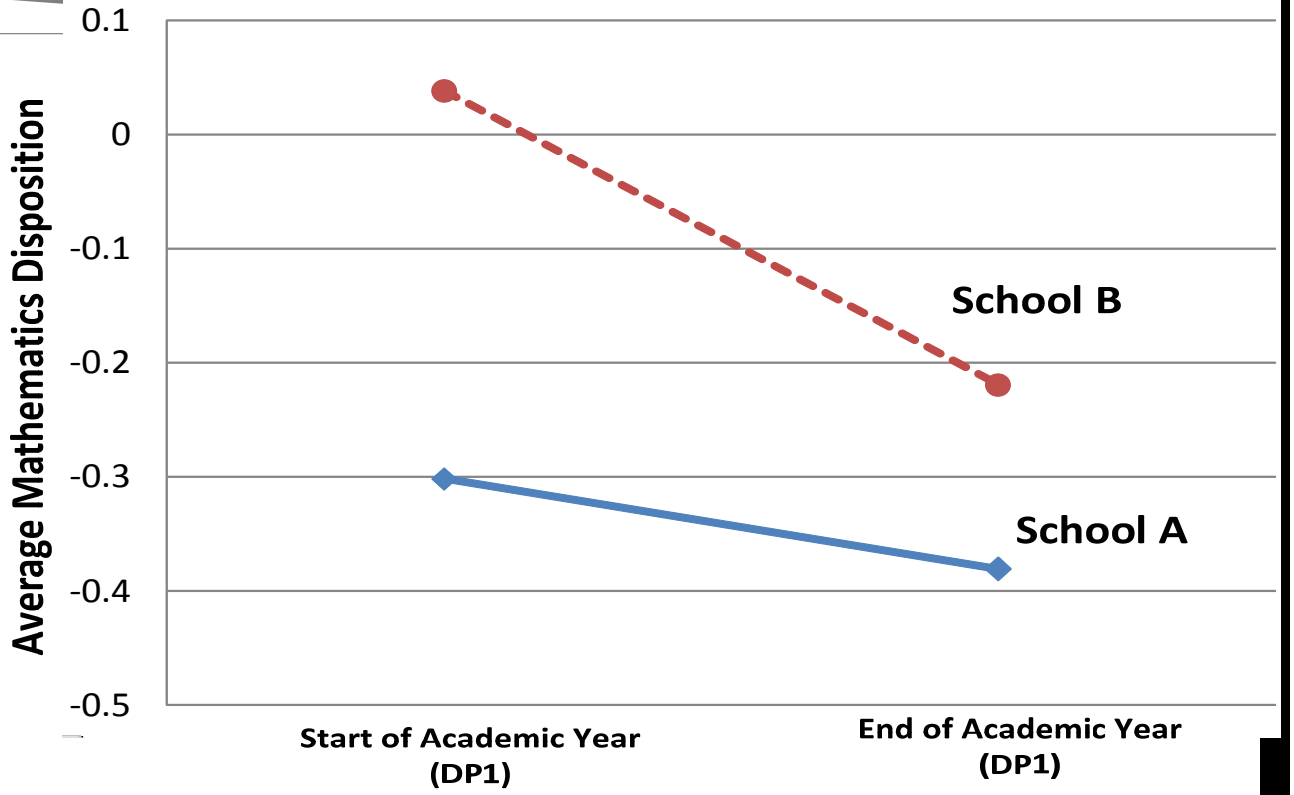
- Qualitative Evidence

Students' Favourite Topics

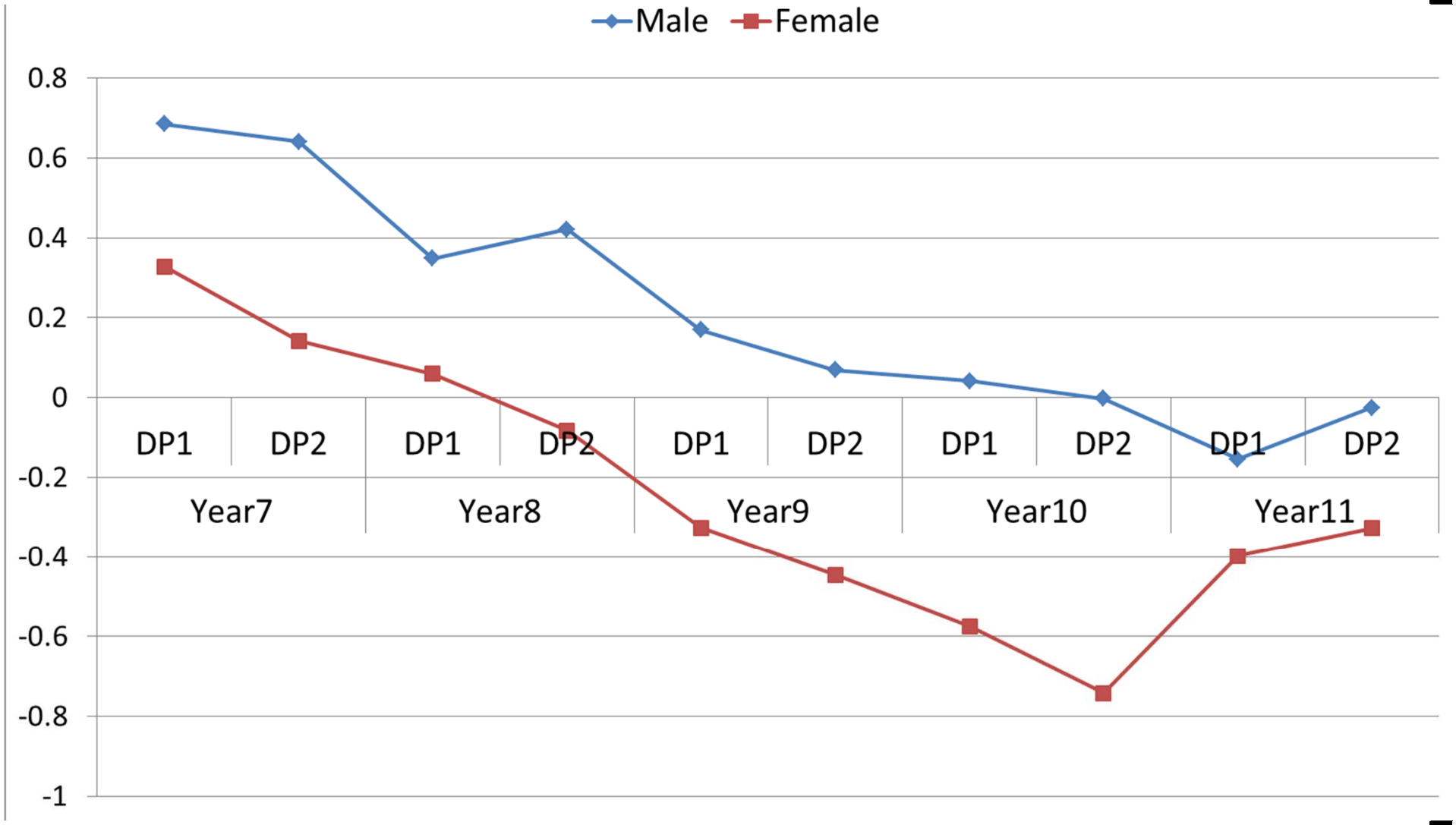


Mathematics Dispositions

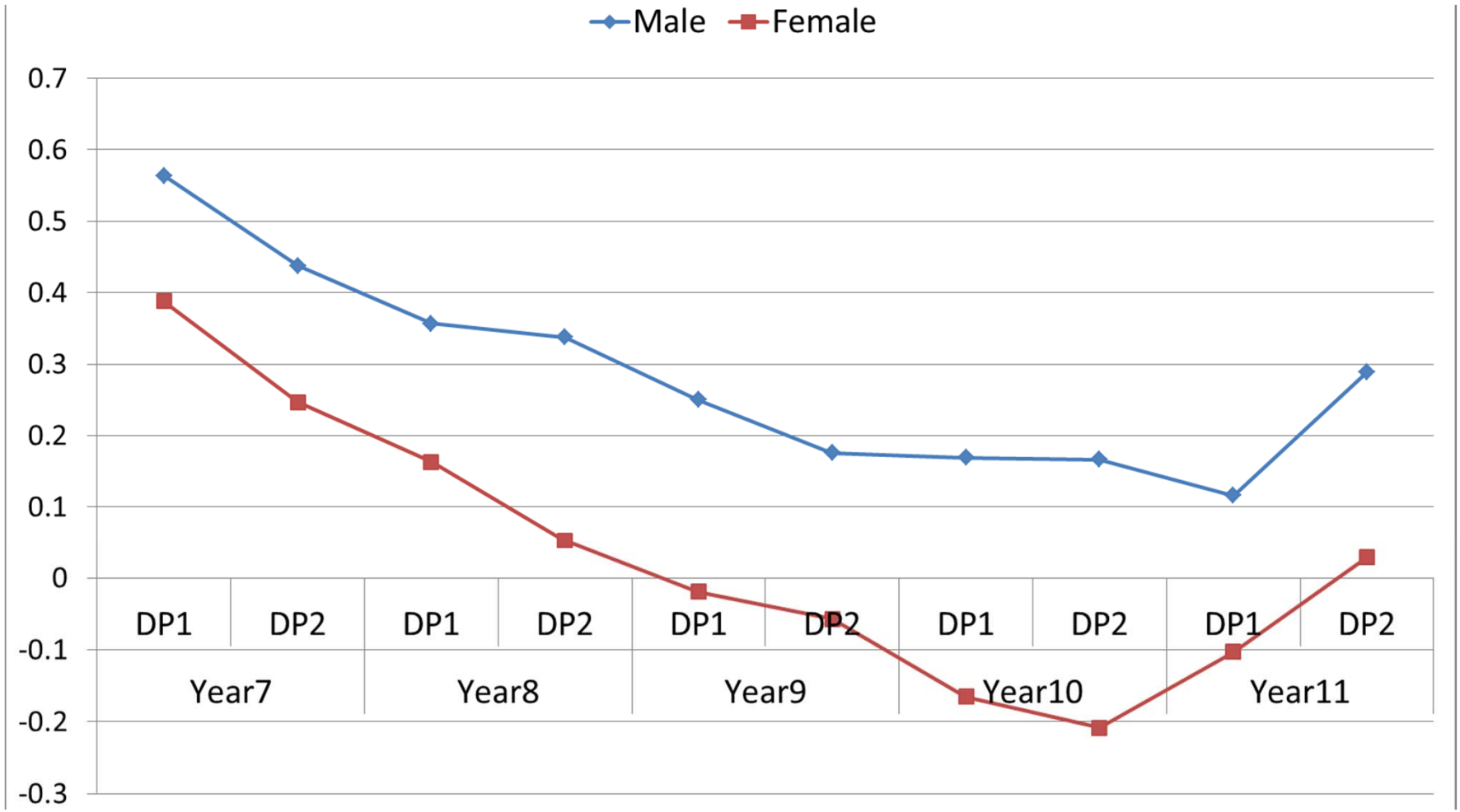




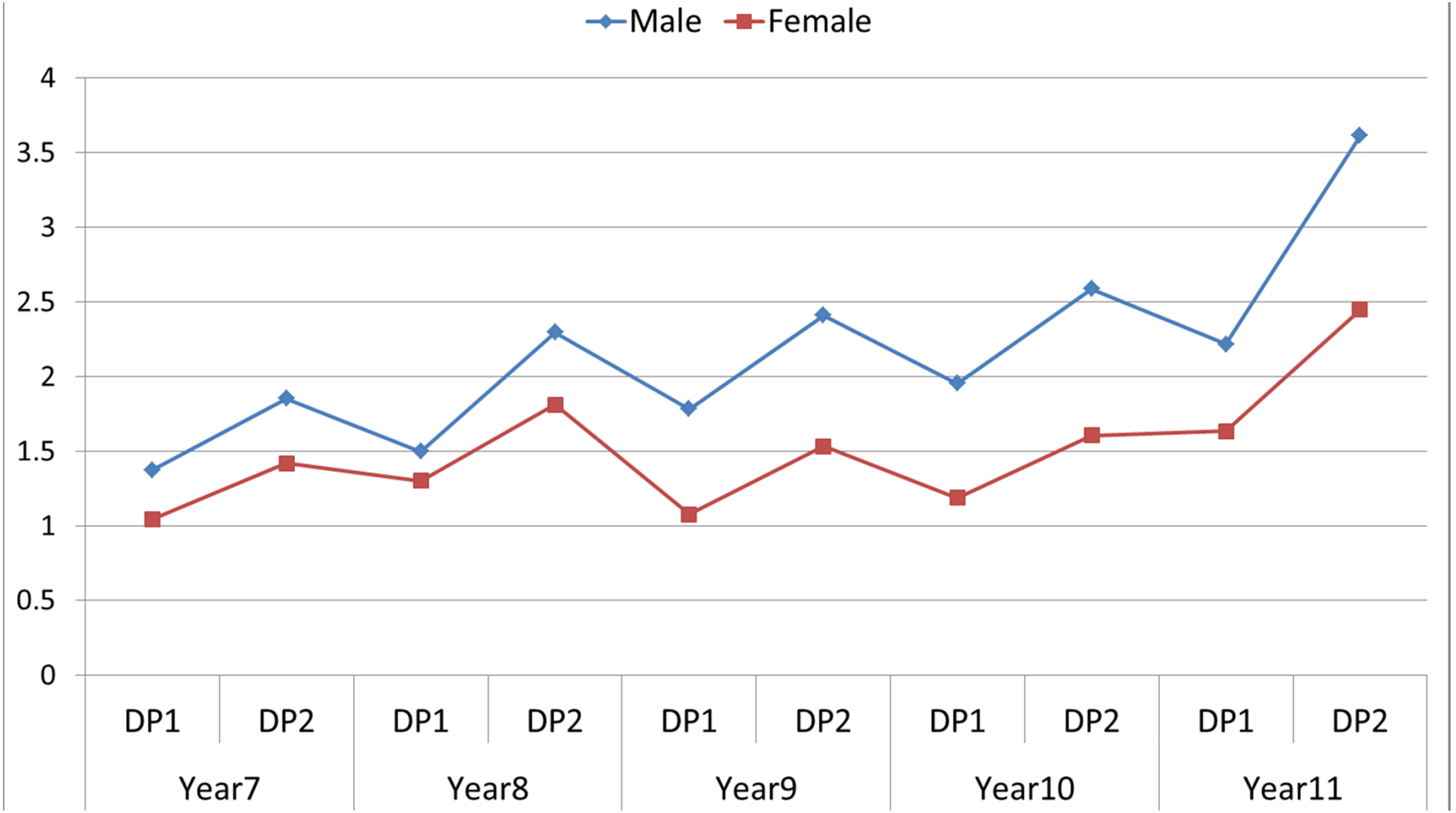
Average Maths Dispositions (Gender)



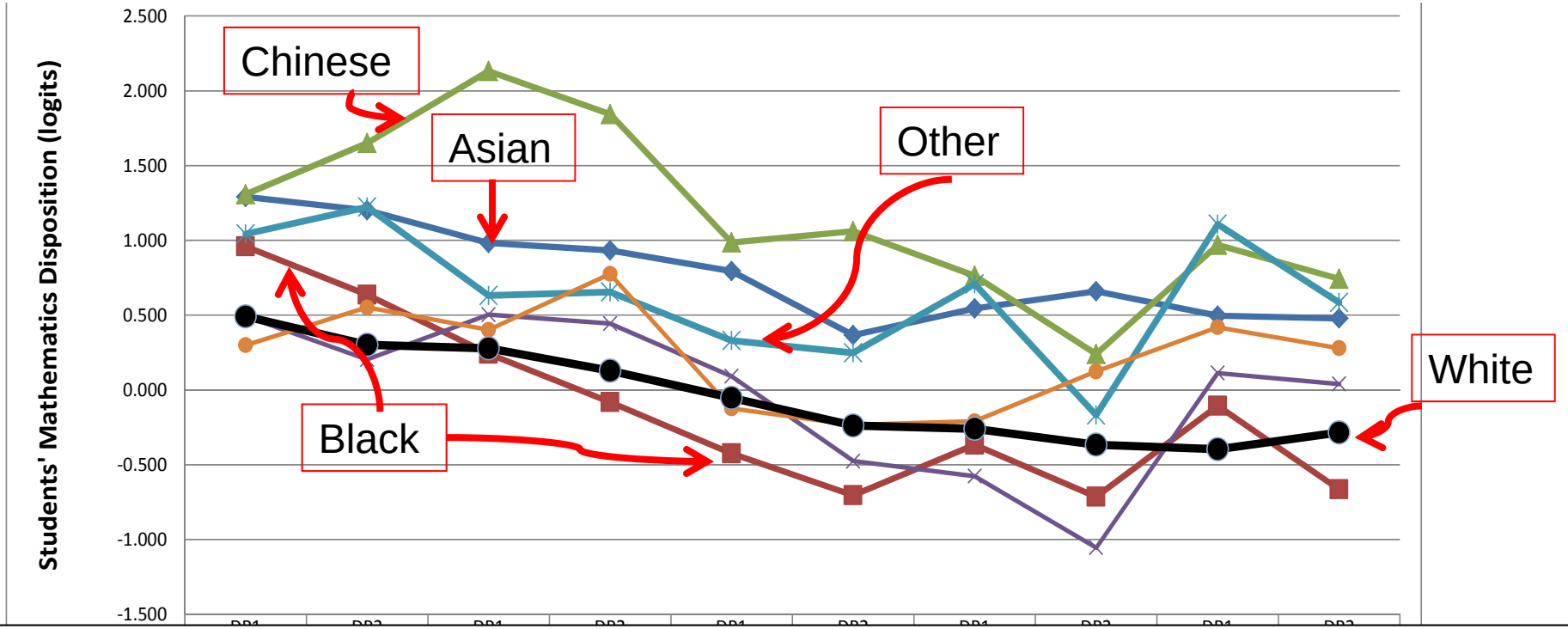
Average Maths Identity (Gender)



Average Maths Self-Efficacy



MATHEMATICS DISPOSITION

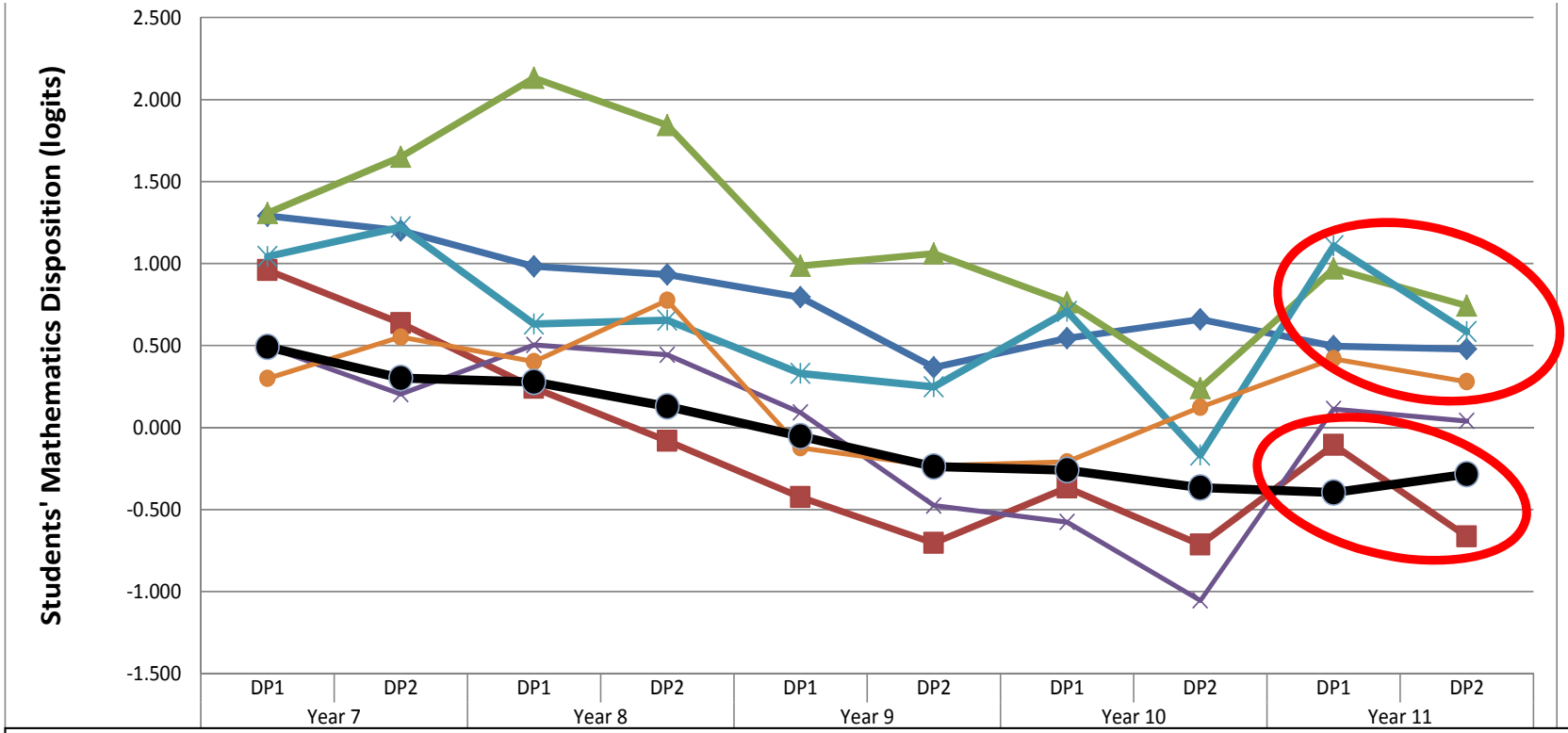


From Year 7 to 10: Overall decline

- Asian, Chinese and Other consistently higher than White
- Black significantly lower than Asian

More intense decline (Year 7 higher than White, then reverse)

MATHEMATICS DISPOSITION



Change during Year 11:

- Asian, Other and Other white more disposed compare to White
- Black less disposed compared to Asian

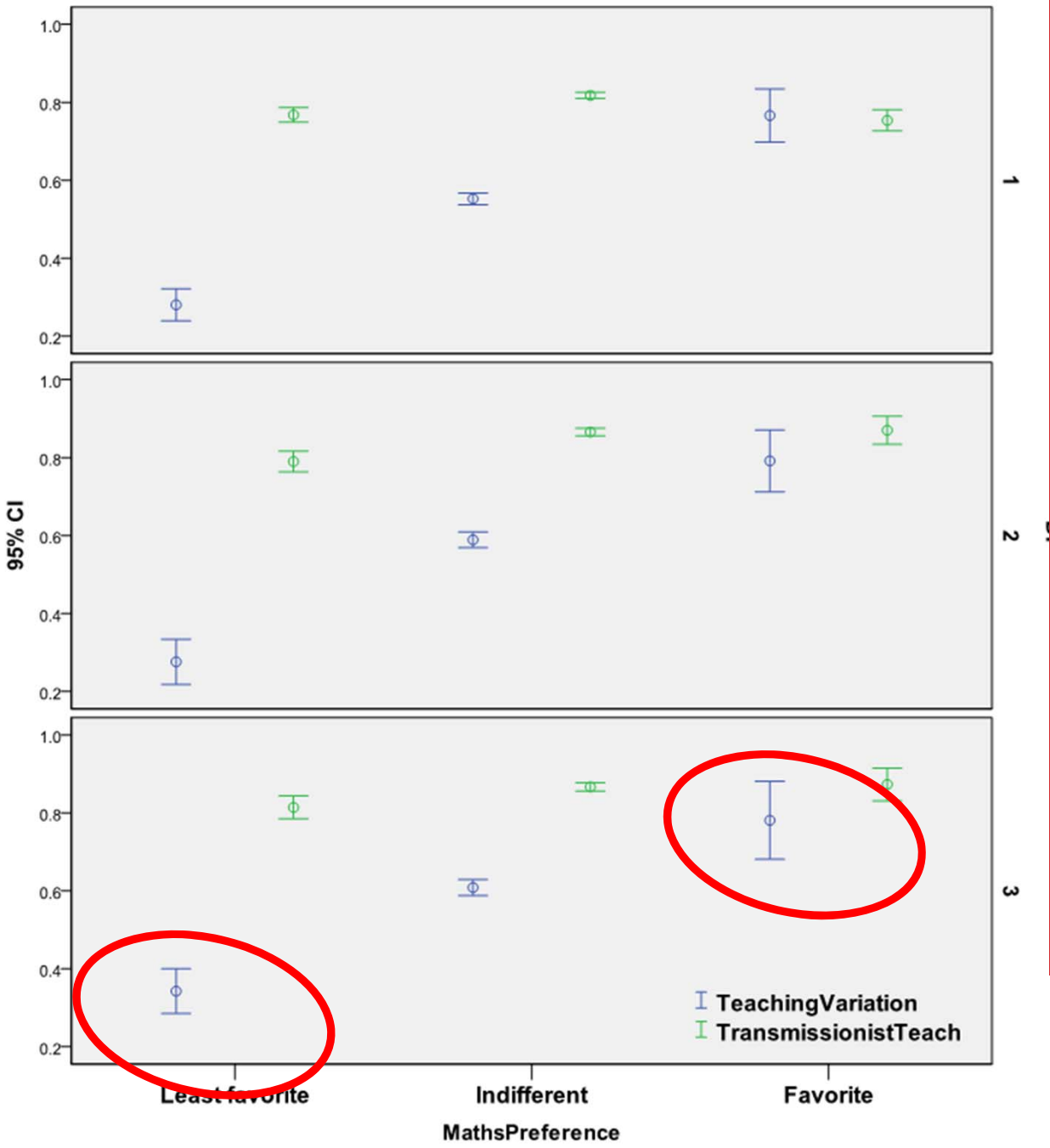
Why we measure all these?

Employing technology
to keep students' attention.

Question:
Are some practices more engaging?

Research Question:

What is the association of the measure of teaching style with variables relevant to students' mathematics dispositions /attitudes



Association between Maths preference and teaching style

Modelling of Change of Dispositions

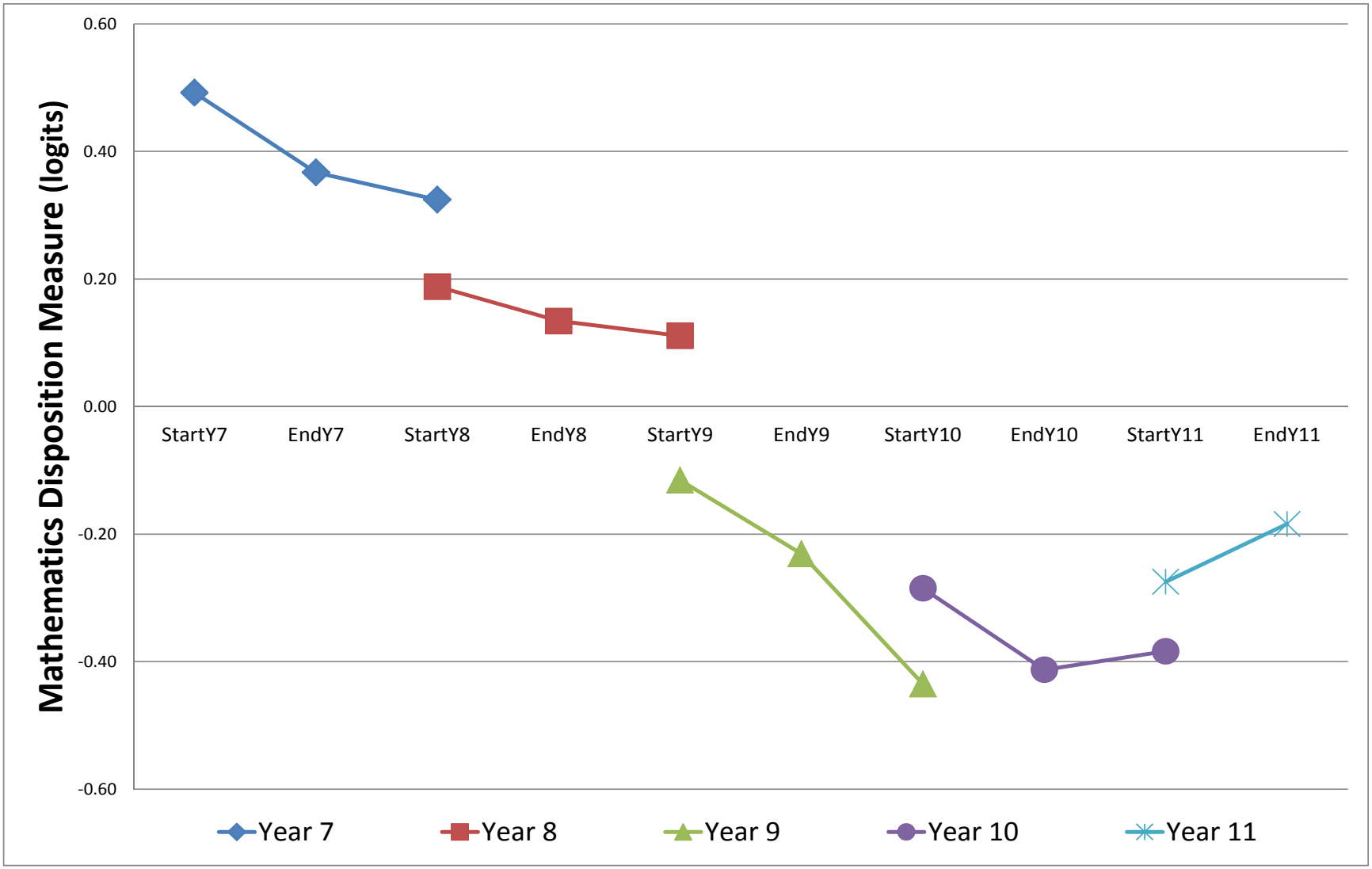
- Model Disposition at DP2 based on Disposition at DP1 and other explanatory variables

- A multilevel (3 levels) regression model
  with cross-level interactions (technical details skipped here)
- Focusing on the effect of pupil-level variables

Levels	Size
Pupils	6212
Classrooms	433
Schools	30

Fixed effects	Coef.	se	z	P>z
cons	-1.020	0.155	-6.570	0.000
Prior dispositions	0.425	0.010	41.240	0.000
Gender (Ref: Male)				
Female	-0.141	0.032	-4.370	0.000
Year Group (Ref: Year 7)				
Year 8	-0.047	0.048	-0.970	0.331
Year 9	-0.162	0.051	-3.180	0.001
Year 10	-0.131	0.052	-2.510	0.012
Year 11	-0.217	0.068	-3.180	0.001
Maths Preference (Ref: Maths Least Favour)				
Indifferent	0.640	0.042	15.380	0.000
Maths favourite	1.637	0.073	22.310	0.000
Perceived Math Ability (Ref: Poor)				
Average maths ability	0.206	0.070	2.930	0.003
Good maths ability	0.606	0.072	8.440	0.000
Excellent maths ability	1.098	0.079	13.960	0.000
Perceived Lesson Difficulty (Ref: Easy)				
Lesson difficulty about right	-0.241	0.052	-4.670	0.000
Lesson difficulty too hard	-0.741	0.067	-11.12	0.000
Parental support	0.106	0.014	7.740	0.000
Teaching variation	0.351	0.055	6.440	0.000
Teaching transmissionism	-0.101	0.035	-2.870	0.004

Mean Maths Disposition, by Cohort



The Ideal Maths Teacher
Students said…

- *Has a sense of humour*
- *Is approachable, friendly & understanding*
- *Is strict and able to 'control' a class*
- *Always provides help*
- *'Explains it well'*
- *Provides explanations repeatedly*
- *Can provide additional one-to-one when required*
- *Monitors students' involvement and 'pushes' them to achieve their best*

The Ideal Maths Lesson
Students said…

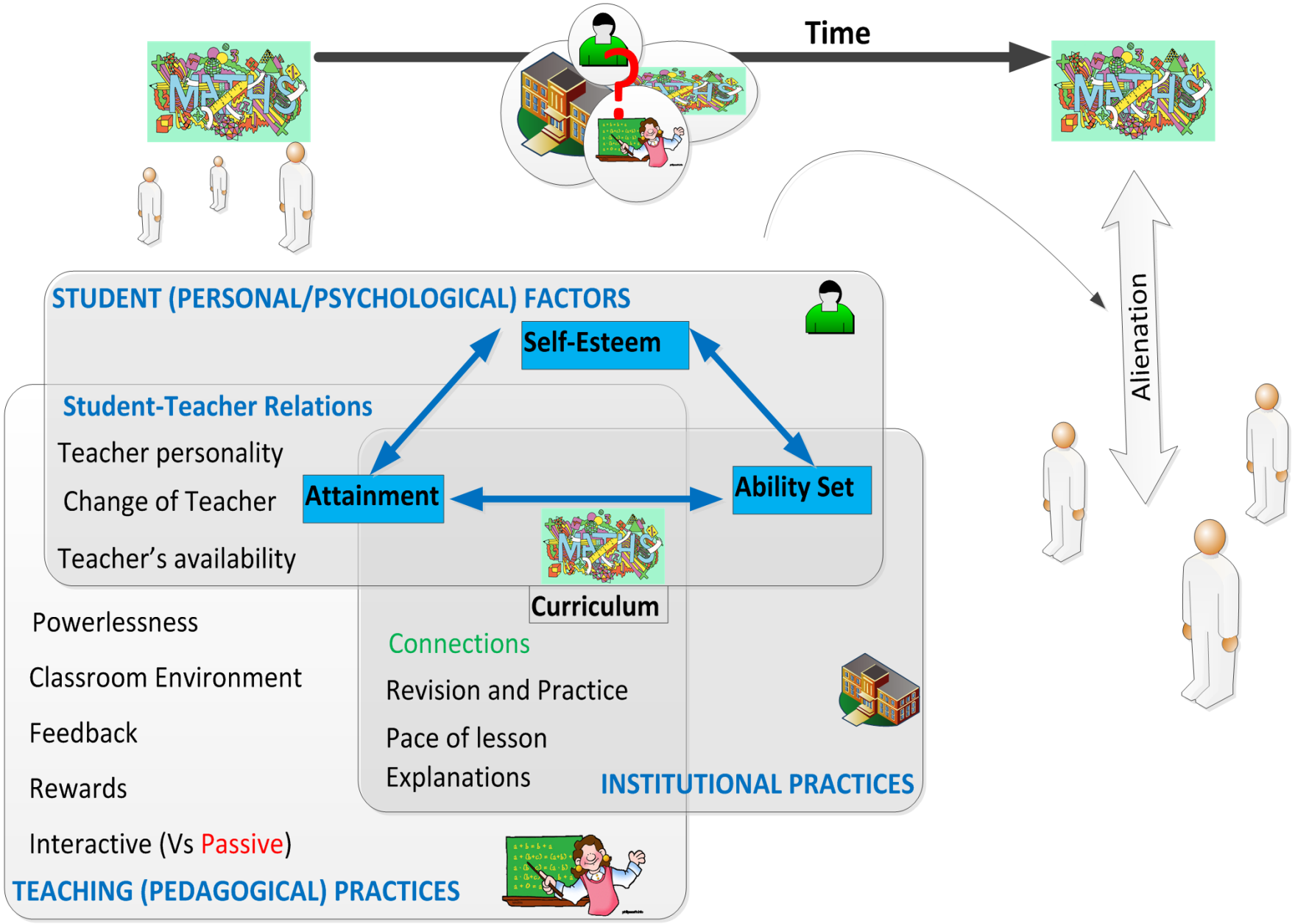
Real life connections & 'Practical'

- *"we had to build a bridge, (which one could hold the most weight), so me and student X, we won it last year, but we didn't win it this year."* (Male, Year 9)
- *"… it would be something I understand something that's quite practical"* (Male, Year 10)
- *"Group work obviously and…it would be something that's useful in life"* (Male, Year 11)

Games, fun and use of technology (mainly reported by boys)

- *"A bit more maths games"* (Male, Year 7)
- *"They should make Maths more fun because people would want to like come and enjoy it a bit more and be more involved in it, at the moment people are a bit bored […] like more computers and other like techniques and learning not just writing all the time"* (Female, Year 8)
- *"Yes, like on computers. …. Go on maths games, it is better like that"* (Male, Year 8)
- *"Probably work on iPads instead of writing* (Males, Year 11)
- *"Probably a mixture of computer and written work. Maybe some like new and different ways of learning like I said like funny videos but things that are related to teenagers as well"* (Female, Year 11)

Opportunities to be more active


Time
STUDENT (PERSONAL/PSYCHOLOGICAL) FACTORS
Self-Esteem
Student-Teacher Relations
Teacher personality
Change of Teacher
Teacher's availability
Attainment
Ability Set
Curriculum
Powerlessness
Classroom Environment
Feedback
Rewards
Interactive (Vs Passive)
TEACHING (PEDAGOGICAL) PRACTICES
Connections
Revision and Practice
Pace of lesson
Explanations
INSTITUTIONAL PRACTICES
Alienation

Concluding Thoughts

'Transmission' teaching may turn pupils off maths

A new university study has revealed that 'transmission' teaching, where the teacher stands at the front and dictates to the class, could be a key factor in explaining why a fifth of secondary children rate it as their least favourite subject.

The 'Teaching and learning practices in secondary mathematics: measuring teaching from teachers' and students perspectives' report by researchers at the University of Manchester reveals that transmission-style teaching is still the main approach in today's classrooms.

Of the more than 13,000 pupils surveyed, activities such as copying the secondary teacher's notes from the board and being asked questions by the teacher were cited as common practice, ahead of learning alternative approaches detailing how maths has changed over time or using media like magazines and videos in class.

For 22 per cent of pupils, maths is their least favourite subject, while for 7.8 per cent it is their most enjoyable lesson.

On the basis of the evidence gathered, the report's authors tentatively concluded that "students engage more with maths in less transmissionist learning environments".

However, they were also quick to absolve those in teachings jobs of blame in this situation.

"Most [teachers] say 'we would prefer to do more of the non-transmission activities, but because of the pressure of preparing pupils for exams, because of the pressure of time, we cannot'," explained Dr Maria Pampaka, who worked on the study.

Some references…

Pampaka, M., & Troncoso, P. (2014). Modelling students' progression in secondary education with the combination of separate cohorts of repeated measurements. *Paper presented at the VI European Congress of Methodology*. Utrecht, July 2014.

Pampaka, M., & Wo, L. (2014). Revisiting Mathematical Attitudes of students in Secondary Education. In Liljedahl, P., Oesterle, S., Nicol, C., & Allan, D. (Eds.) Proceedings of the Joint Meeting of PME 38 and PME-NA 36, Vol. 4, pp. 385-392.

And more on www.teleprism.com

THANK YOU!

QUESTIONS?