Title	Application of a proposed framework for mathematical modelling instruction
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Application of a proposed framework for Mathematical Modelling Instruction

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Introduction

- Sharing on what 2 schools have done in implementing modelling lessons
- Part 1: Professional development support for teachers
- Part 2: Teachers' implementation of modelling lessons

Professional development support

A framework for modelling instruction (Ang, in press) was proposed to guide teachers develop differentiated learning experiences in mathematical modelling

Grounding in Literature

- Appropriate students' prior knowledge for cognitively demanding modelling tasks (Galbraith, 2006; Stillman et al., 2007)
- Teachers need to be clear about mathematical understanding that students are to demonstrate in learning tasks (Doyle,1988)
- Solution space for modelling task important for facilitating modelling learning experiences (Blum and Borromeo Ferri, 2009)

Differentiated modelling experiences

- Level 1 - focus on learning of skills directly or indirectly related to modelling
- Level 2 - aimed at developing modelling competencies, applies existing or standard models to a real life problem/situation
- Level 3 – require to tackle a fairly substantial real life problem, students need to apply various modelling skills and competencies

Framework for Mathematical Modelling Instruction (Ang, to appear)

Framework Component	Explanation
1. WHICH Level of Learning Experience?	Decide which level (Level 1, 2 or 3) of mathematical modelling learning experience that we wish to focus on.
2. WHAT is the Skill/Competency?	List all the specific skills and competencies (mathematical or modelling) that we target in this learning experience; State the problem to be solved, if applicable.
3. WHERE is the Mathematics?	Write down the mathematical concepts or formulae or equations that will be needed in this learning experience.
4. HOW to Solve the problem/model?	Prepare and provide plausible solutions to the problem identified in this learning experience.
5. WHY is this experience a success?	List factors or outcomes that can explain why this experience is considered successful and look out for them during the activity.

Level 3

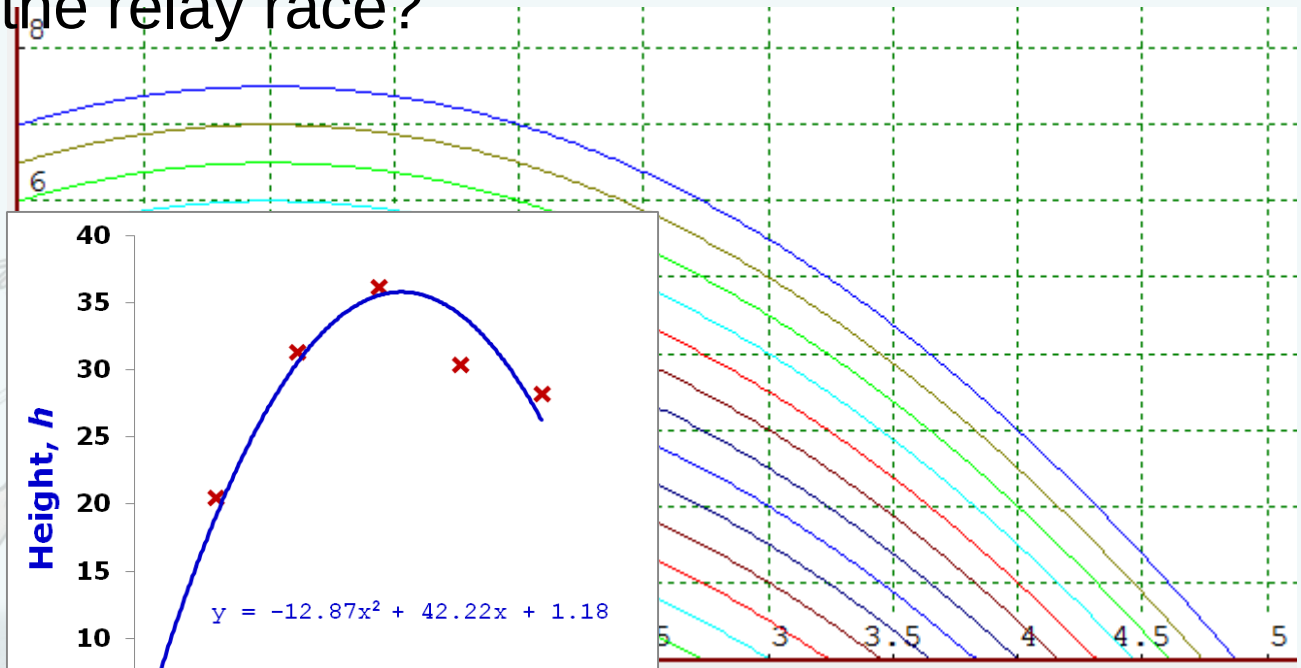
Level 2

Level 1

Baton passing problem (Osawa, 2002)

Your group needs to win the relay race.

How should your group go about running the relay race?



Professional development support

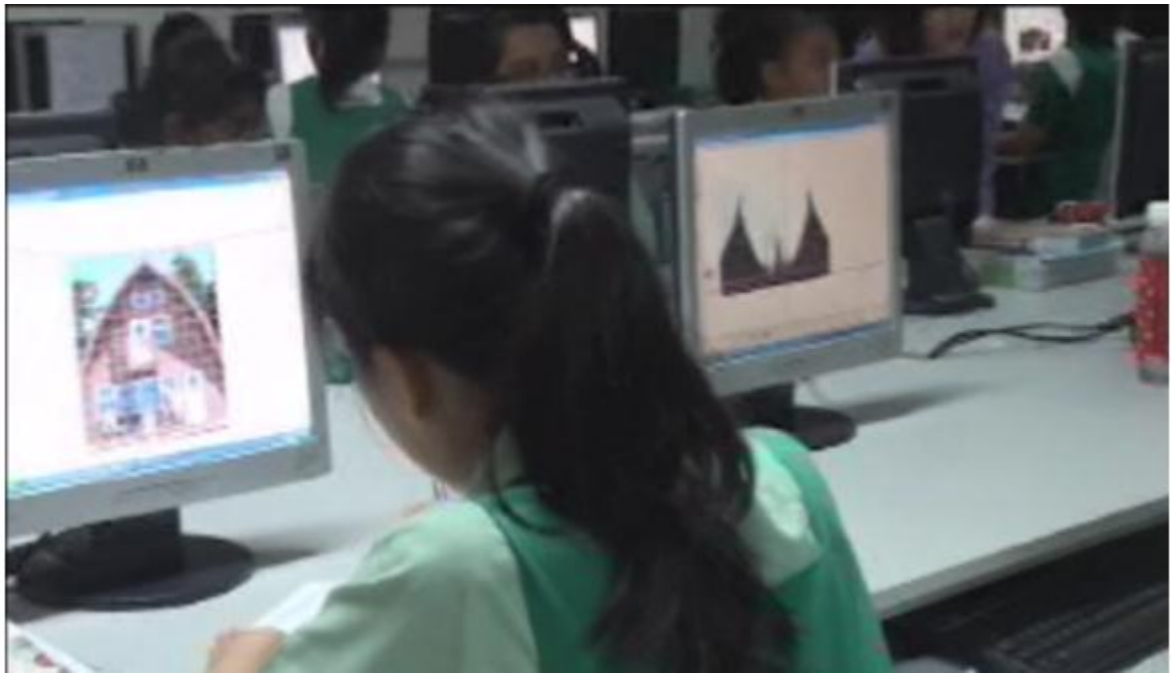
- 2 case study schools: 4 teachers
- One meeting with teachers on the use of framework
- Teachers used framework to plan and design modelling lessons
- One meeting to discuss planned lessons
- Ongoing feedback and discussion

Case study school 1

Walkways get wet & slippery on rainy days

Design a rain shelter cover to address this situation

Level 1 modelling task

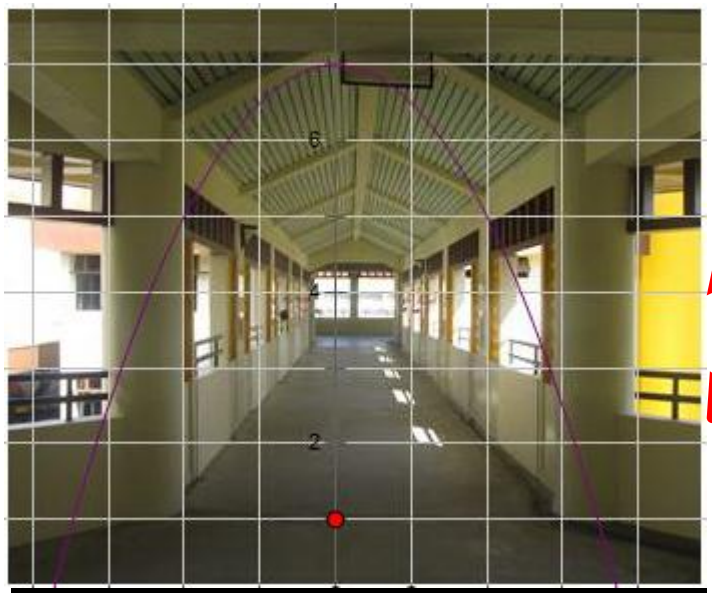


Level 2 modelling task

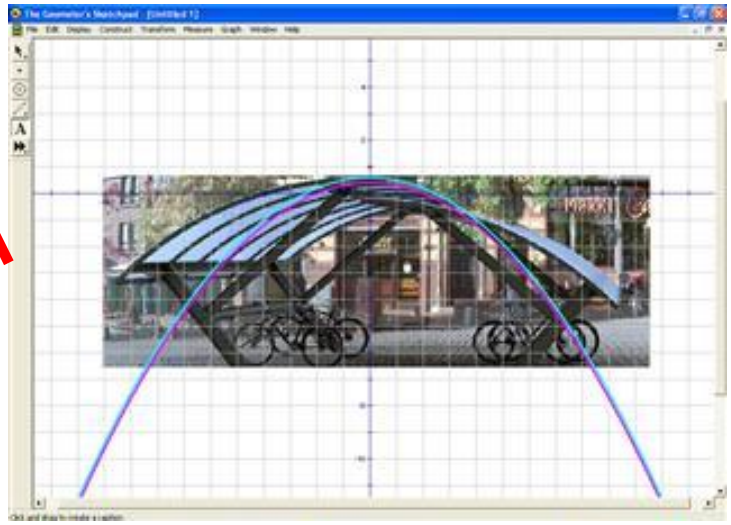
Factor No.	Factor	Rank Factor
1		
2		
3		
4		
5		

Shelter No.	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Total*
Rank Factor						

Level 2 modelling task

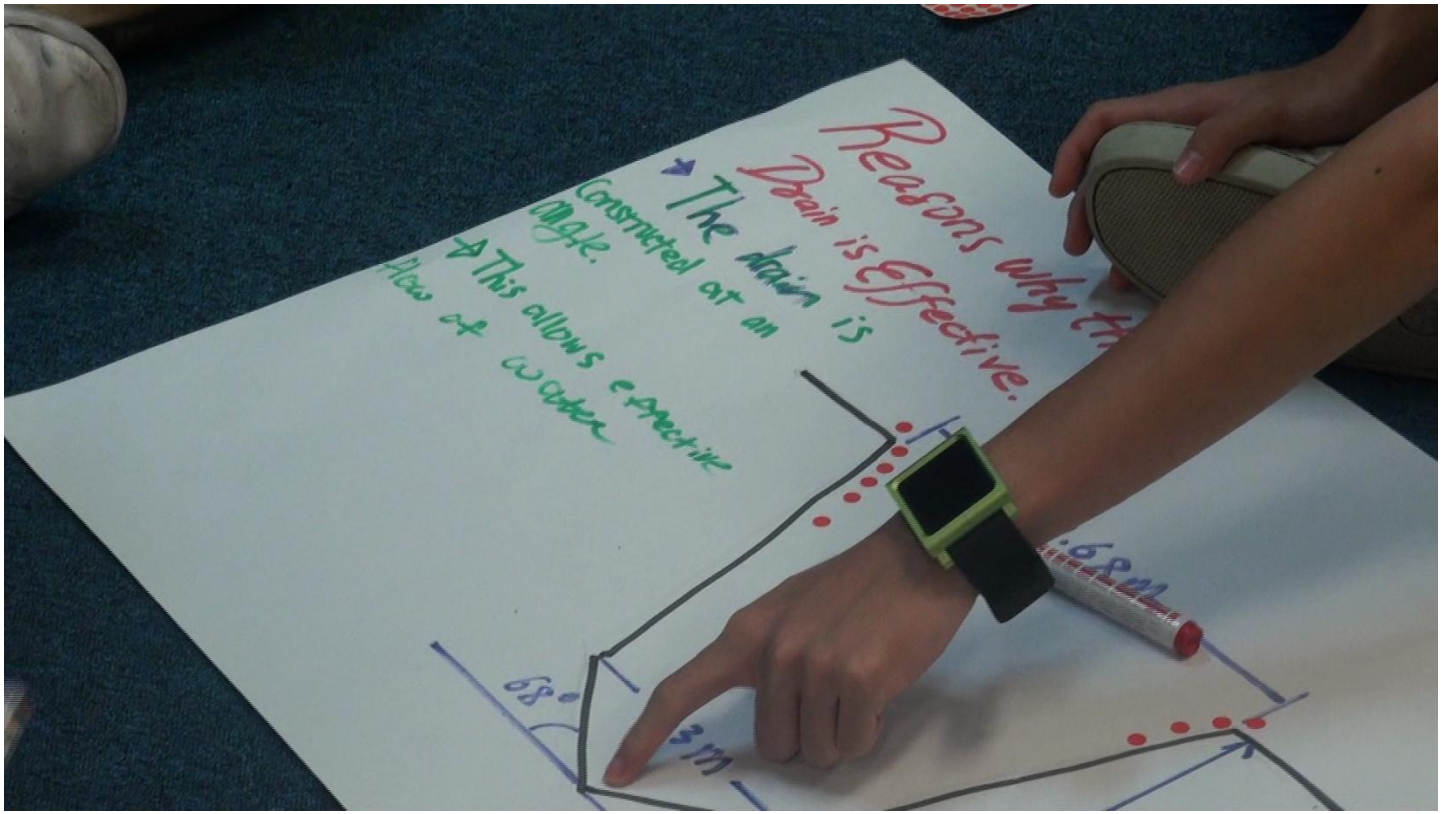


Walkways get wet & slippery on rainy days



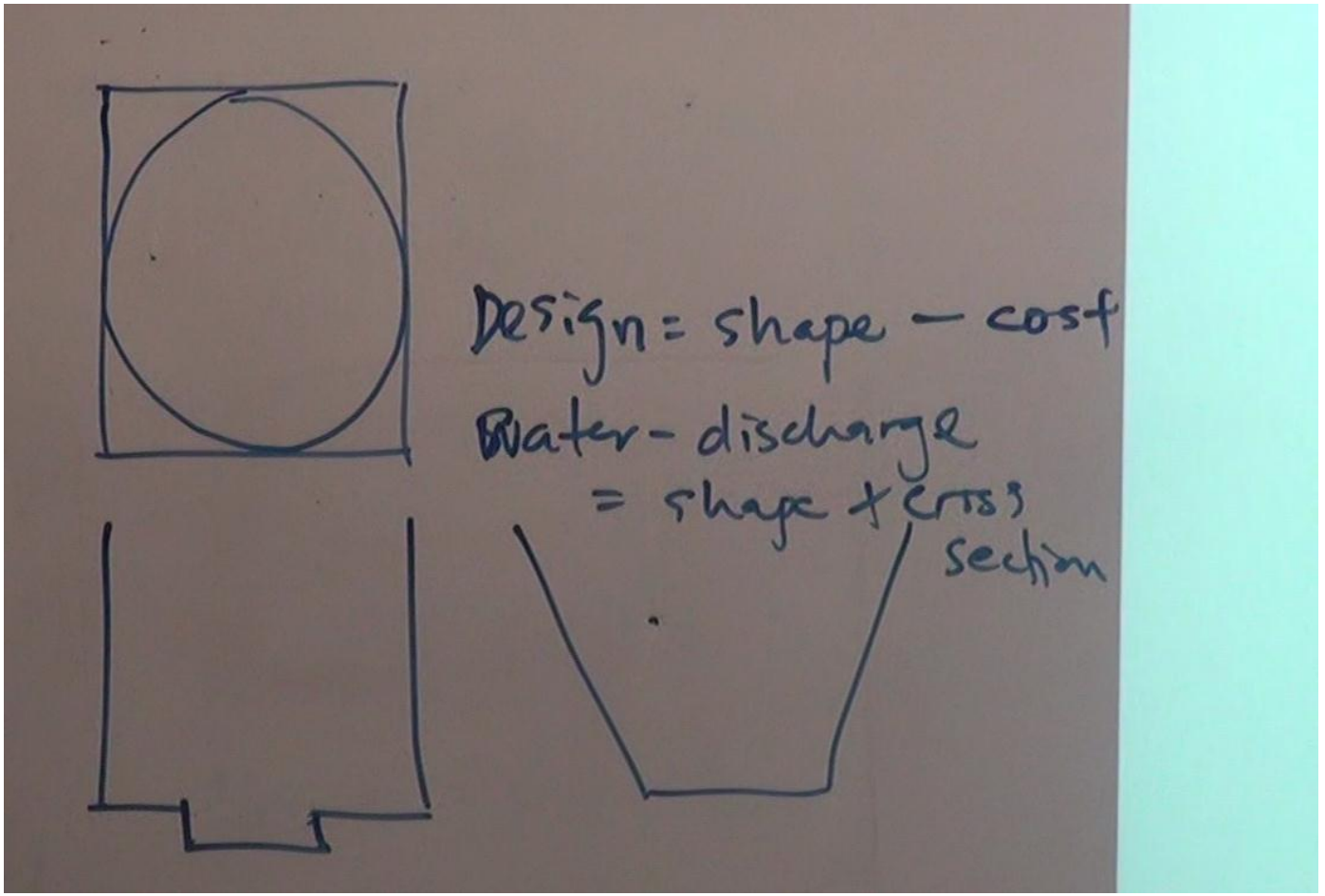
Case study school 2

Suggest **the best drainage system** for Singapore so that it will help to minimize the problem of flash flood



Student A: “You can explain when there’s little rainfall, that this point, instead of being a square, a small amount of water can flow faster.”

Teacher S wanting students to formulate the best drainage system as a weighted sum of various factors



Discussion

Teachers were able to use the proposed framework for modelling instruction to plan and structure a series of modelling tasks that seemingly progressed from a level 1 to a level 2 modelling learning experience

Issues with planning level 2 modelling task

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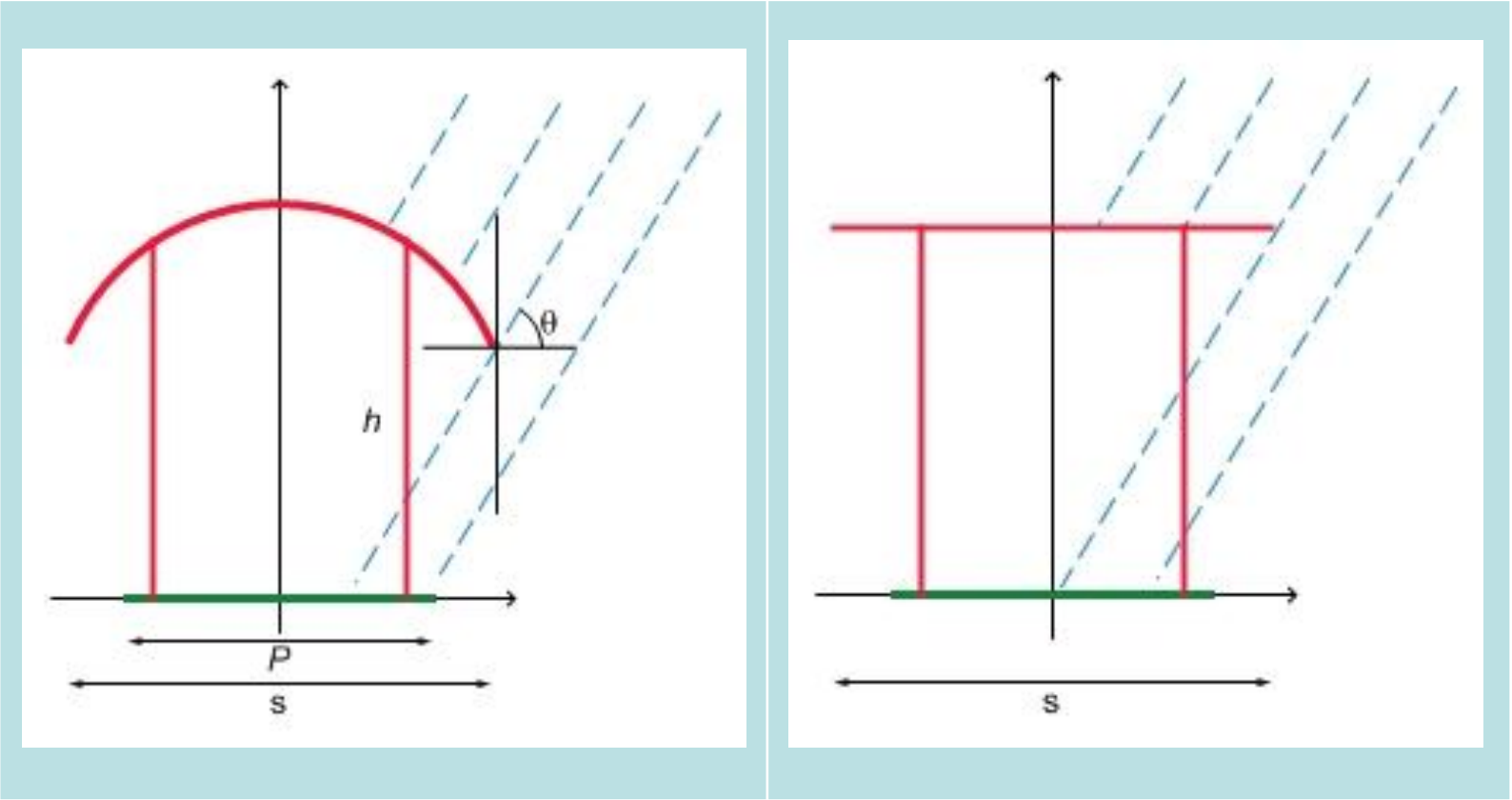
How to solve the problem/model

- In both case study schools, decision making mathematics used was not appropriate
- Case study school 1: rank factors affecting best shelter cover shape needs to be quantified
- Case study school 2: weighted factors affecting best drainage system index needs to be quantified

Possible Lesson Image



(a) parabolic top (b) flat top

Figure 1: Diagram that shows two possible cross-sectional shapes of the cover for the walkway.

In order to facilitate students to determine the dimensions of the parabolic cross-sectional shape of the cover that will provide maximum cover from the rain, teacher B1 also worked out a plausible mathematical solution as follow:

Referring to Figure 1(a),

Let cross-sectional curve of shelter be $f(x) = ax^2 + b$
Assuming some span of cover, s, width of pavement p such that $s > p$, height of support h, and angle of strike of rain, θ, then,
Cross-sectional length of pavement and some constant length of $\frac{s}{2} - \frac{p}{2}$ that will get wet from rain =

$$f\left(\frac{s}{2}\right)\tan\left(\frac{\pi}{2} - \theta\right)$$
$$= \left(\frac{as^2}{4} + b\right)\tan\left(\frac{\pi}{2} - \theta\right), \text{where } a\left(\frac{p^2}{4}\right) + b = \mathrm{h}$$
$$= \left(\frac{as^2}{4} + \mathrm{h} - \frac{ap^2}{4}\right)\tan\left(\frac{\pi}{2} - \theta\right)$$

Conclusion

- Although the framework is essential and useful in planning modelling instruction, it is not sufficient
- Independent modelling experience may be necessary for teachers to apply the framework more rigourously
- Future work: school based professional development for teachers