$$x + y = xy$$

Developing language and communication in the secondary mathematics classroom

Guide to symbols

Please do not take pictures – ethics, data protection or copyright restrictions in place

Avoid asking questions – it will spoil something that is coming up later

This slide will involve you talking to each other

Think! – what do you see, what do you notice, what does it mean?

$$x + y = xy$$

The project team

Developing Language-Responsive Mathematics Classrooms

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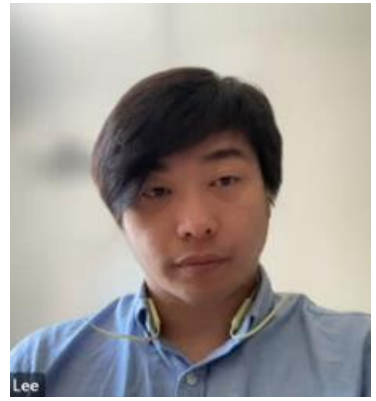

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Anonymised Teachers

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Initial research questions

- RQ1: How can mathematics teachers support linguistically disadvantaged students when thinking about and working on mathematically demanding tasks?
- RQ2: How can mathematics teachers support students to engage in mathematical classroom interactions around these demanding tasks?

Research design

Collaborative Design Research

- Collaborating with 7 experienced mathematics teachers
- 3 mathematical topics: linear equations, angles in parallel lines, introduction to probability
- Task guidance following design principles
- Concept guidance focused on existing research
- Professional development focused on talk moves
- Up to 3 design cycles

Data collected

- Recordings of all meetings with collaborators
- Video recordings of all professional development sessions
- Video recordings of mathematics lessons with the teachers involved
- Student assessments in the 3 topics

What is language-responsive teaching?

Teaching practices that support the learning, development, and engagement of children from diverse linguistic backgrounds.

- Combining explicit teaching of (Academic) English language with course content
- Incorporating children's home languages into the classroom and other learning environments
- Amplify not simplify language

(Lucas, Villegas & Freedson-Gonzalez, 2008).

What is language-responsive teaching?

- Historically limited to vocabulary instruction (Zwiers et al., 2017)
- Expanding view of “diverse linguistic background”
- Inclusion of the “social practices embedded in specific historical, linguistic, economic, and political contexts” (Murillow & Shaw, 2016, p. 315).

What is language-responsive mathematics teaching?

- Explicit and implicit teaching of the language of doing and learning mathematics (not necessarily formal mathematics)
- Including the demands of argumentation and explanation
- Including diagrammatic, graphical and dynamic representations

Learners make sense of mathematics using their existing language resources (Moschkovich, 2013; Adler 2001; Planas & Setati-Phakeng, 2014) while also expanding these resources (Zwiers et al., 2017)

Curriculum and Instruction

Design principles

Version 1, US and practice context:

- Support sense-making
- Optimize output
- Cultivate conversation
- Maximize linguistic and cognitive meta-awareness

(Zwiers et al., 2017)

Curriculum and Instruction

Design principles

Version 2, International Research context:

- Engage students in rich discourse practices
- Establish various mathematics language routines
- Connect language varieties with multimodal representations
- Include students' multilingual resources
- Use macro-scaffolding to sequence and combine language and mathematics learning
- Compare language pieces (form function, etc.) to raise students' language awareness

(Erath et al., 2021)

Our version

Outputs - Algebra

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$6 + 2 =?$

$6 + 2 = 8$

$6 + 2 = 4 + ?$

$=$

$6 + 2 = 2(3 + 1)$

$6 + 2 = 2 + 6$

$6 + 2 = 9$

Key Concepts

- Meaning of =

How did the words you used change with each of the equations, if they did?

Were there any relationships between the words you used and the meanings you had for the symbol?

$$=$$

$$6 + 2 =?$$

$$6 + 2 = 8$$

$$6 + 2 = 4 + ?$$

$$6 + 2 = 2(3 + 1)$$

$$6 + 2 = 2 + 6$$

$$6 + 2 = 9$$

=

Which meaning of '=' is needed?

Which words support this meaning?

Connect the words used to the symbol =

$$x + y = xy$$

$$x + y = xy$$

- x plus y equals xy
- x add y is the same as x times y
- x added to y is x times y
- x added to y is equal to x multiplied by y
- x added to y is equal to y multiplied by x
- The sum of x and y is the same as the product of x and y

Meaning-related language

- Parts of the whole
- Increasing less quickly

- Language used for explaining meanings

(Prediger & Neugebauer, 2021; Zentgraf & Prediger, 2024)

Rich discourse practices

- Explaining meanings
- Arguing, justifying and reasoning
- Reporting and modelling procedures and processes
- Naming and labelling
- Increasing explicitness and precision

(The Standards Unit: Improving learning in mathematics, 2000)

Students’ reasoning

Students’ reasoning

Rich discourse practices

- Explaining meanings
- Arguing, justifying and reasoning
- Reporting and modelling procedures and processes
- Naming and labelling
- Increasing explicitness and precision

Angles in parallel lines

Naming and labelling

- Naming objects
- Naming actions
- Distinction between naming and labelling

Teachers’ reasoning

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Research design

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Data analysis

Stage 1
Task-based episodes

Stage 2
Coding for quality and quantity of both discourse and mathematics

Stage 3
Coding for teacher and student moves

Stage 4?
Connections across and within codes

Average ratings for Stage 2 coding

Note: ratings are on a scale of 1 (low quality or quantity) to 4 (high quality or quantity)

Stage 3 teacher moves

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Stage 3 student moves

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Some stage 3 results

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Some more stage 3 results

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Relationships between teacher moves and student moves

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