Promoting mathematics proficiencies through classroom talk

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Mathematics Proficiencies

Understanding

Fluency

Problem Solving

Reasoning

Mathematics Proficiencies

Understanding

Students make connections between related concepts and progressively apply the familiar to develop new ideas.

Mathematics Proficiencies

Fluency

Students become fluent as they develop skills in choosing appropriate procedures; carrying out procedures flexibly and accurately; and recalling factual knowledge and concepts readily.

Mathematics Proficiencies

Problem Solving

Students solve problems when they use mathematics to represent unfamiliar or meaningful situations and plan their approaches.

Mathematics Proficiencies

Reasoning

Students develop an increasingly sophisticated capacity for logical thought and actions, such as evaluating, explaining and generalising.

A Key Premise

Classroom talk is essential to the development of all four proficiencies

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But how might classroom talk contribute?

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But how might classroom talk contribute?

and

How might this contribution occur?

Classroom Talk

Who gets to speak and does it matter?

Does it matter what they say or
who they say it to?

Similarity and difference in classrooms
around the world

The Learner's Perspective Study

'An International Research Collaboration in Mathematics Education.'

The LPS community

- Australia - Melbourne
- Germany - Berlin
- Japan - Tokyo
- USA - San Diego
- China - Hong Kong/Shanghai/Macau/Beijing
- Sweden - Gothenburg/Uppsala
- South Africa - Durban
- Israel - Tel Aviv
- Philippines - Manila
- Korea - Seoul
- The Czech Republic - Prague
- United Kingdom - Bristol
- Singapore
- Portugal - Lisbon
- Norway - Bergen
- New Zealand - Palmerston North

Investigating Classroom Discourse

The Data Set Analysed

The findings which follow are based on analyses of 110 lessons documented in 22 classrooms in Shanghai, Seoul, Hong Kong, Tokyo, Singapore, Berlin, San Diego and Melbourne, and on 191 post-lesson student interviews.

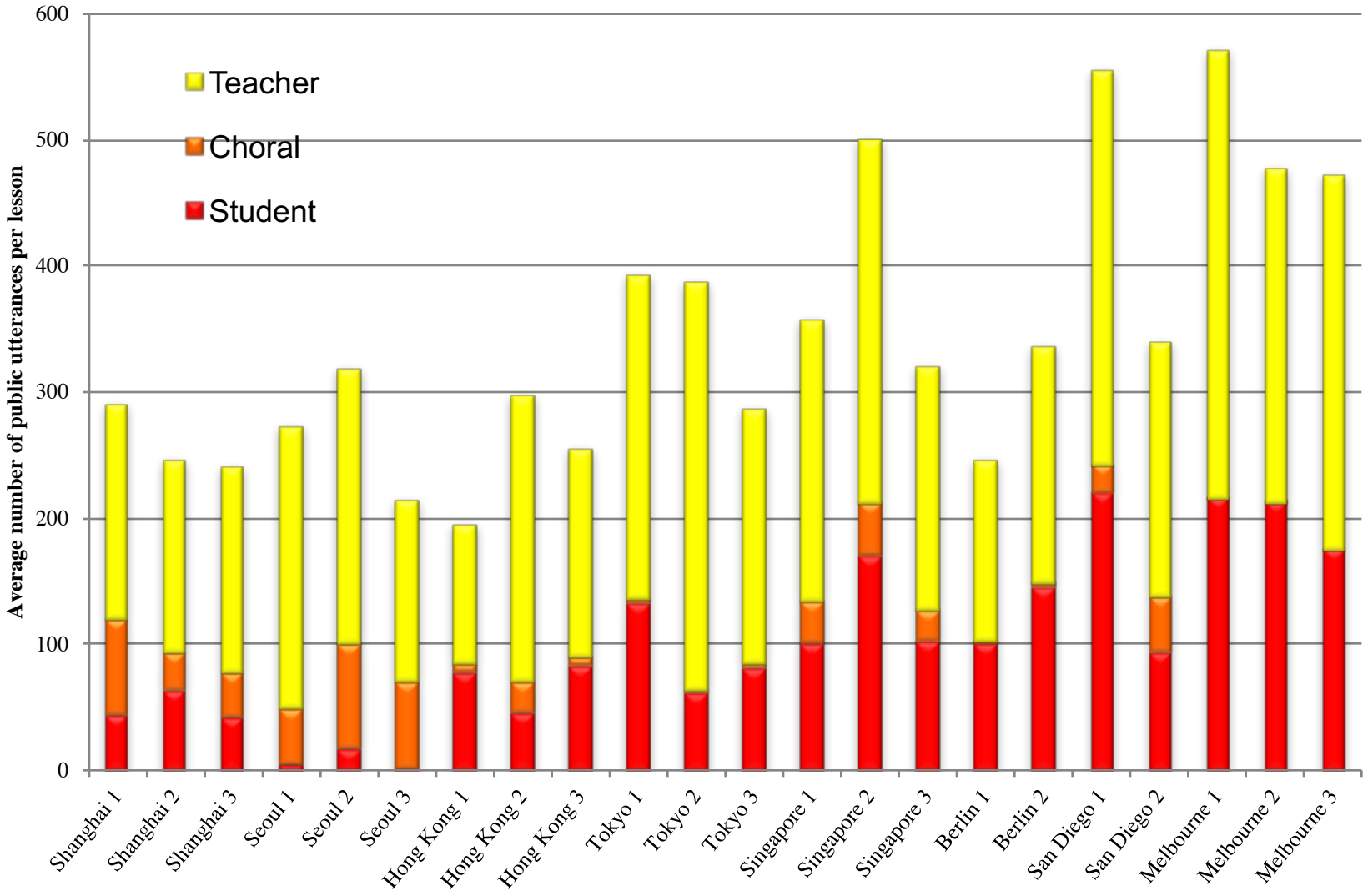
Whole-class Camera
Teacher
Student
Student Camera
Monitoring & Mixing Unit
Teacher Camera

The Lessons of International Comparative Research

International comparative research offers us more than insights into the novel, interesting and adaptable practices employed in other school systems.

It also offers us insights into the strange, invisible, and unquestioned routines and rituals of our own school system and our own classrooms.

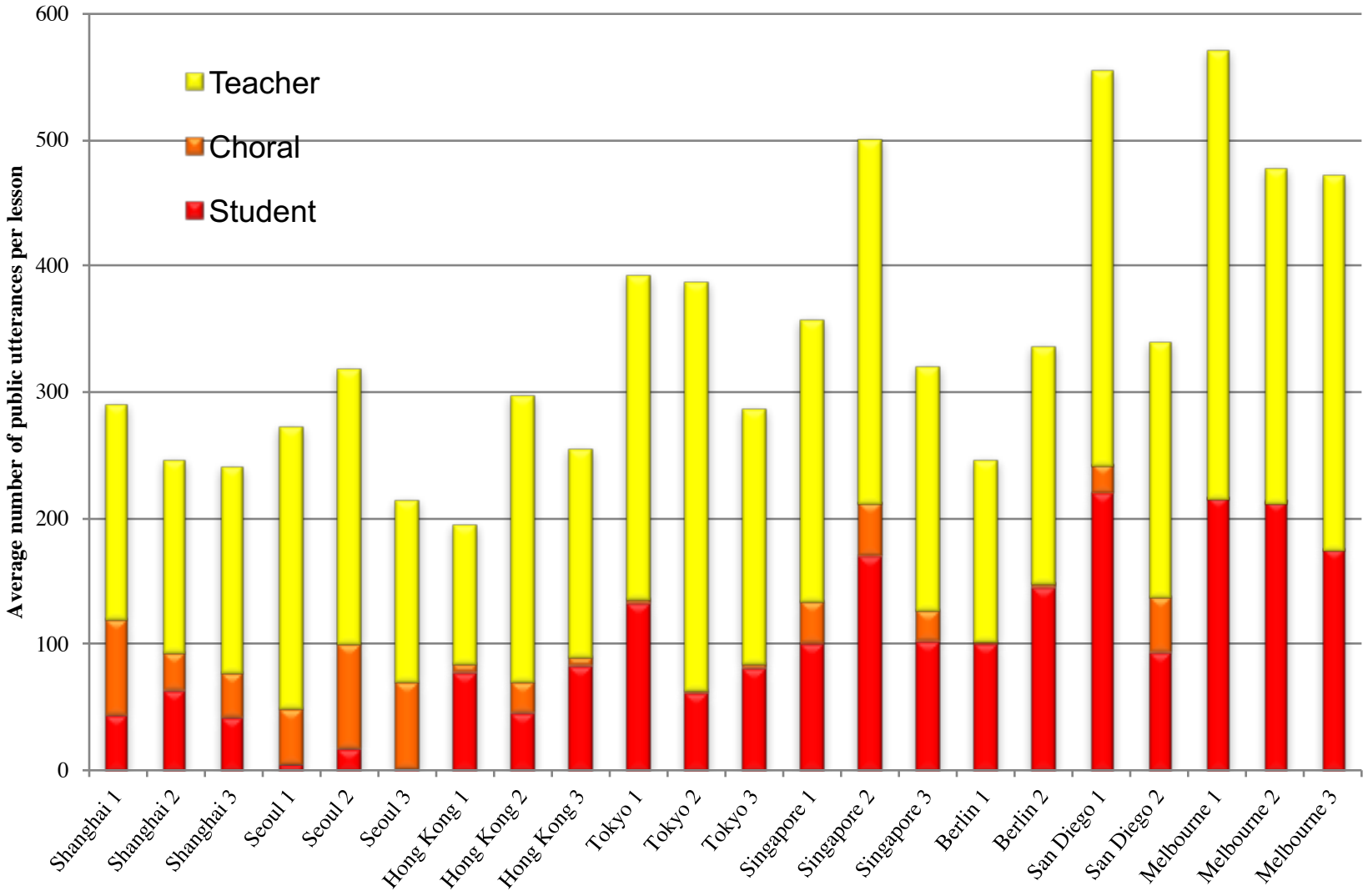
Who is talking? (number of utterances per lesson)*



*Each bar represents an average over five lessons

Find your classroom!

Who is talking? (number of utterances per lesson)*



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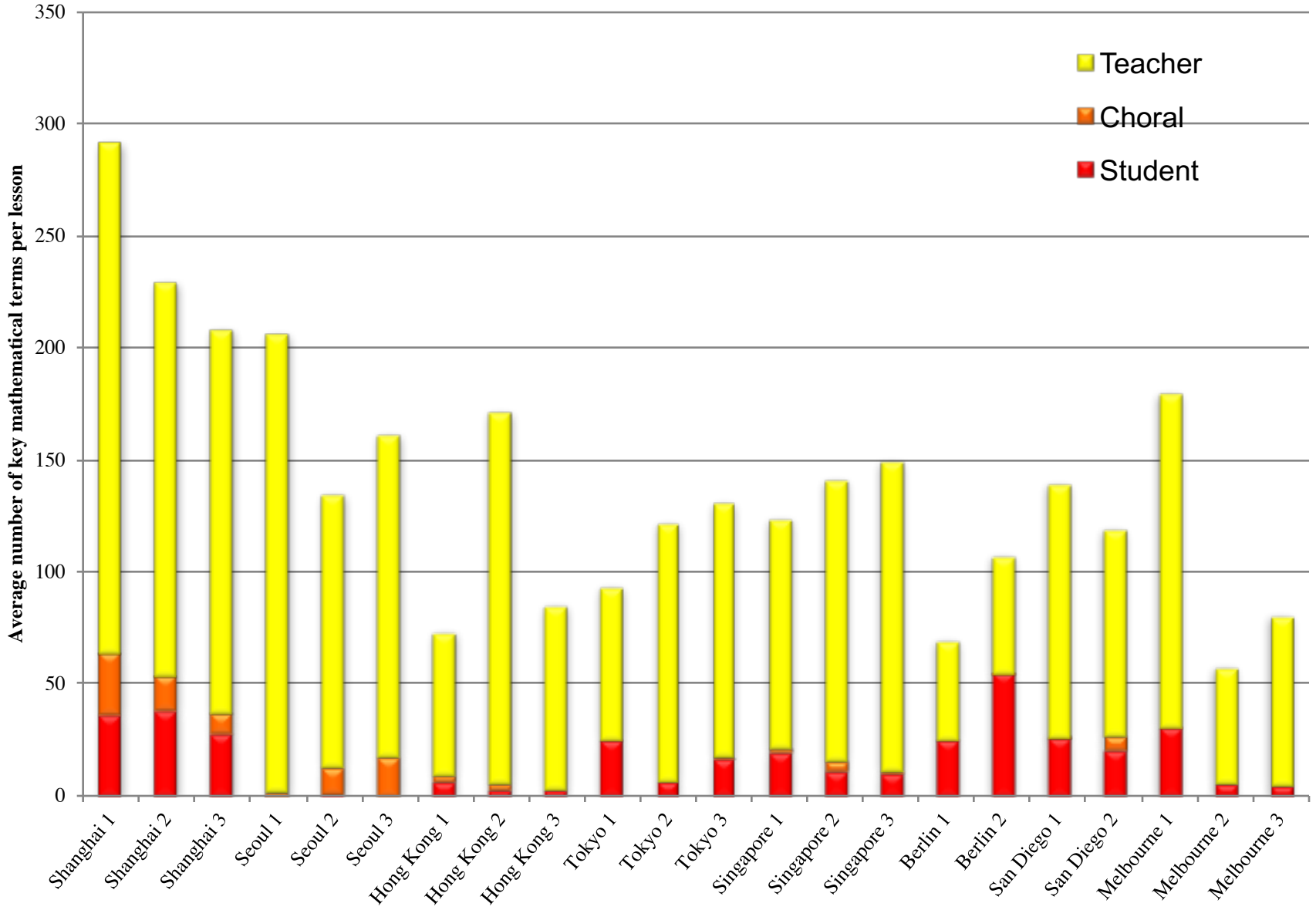
What are they saying? Frequency of Use of Key Mathematical Terms



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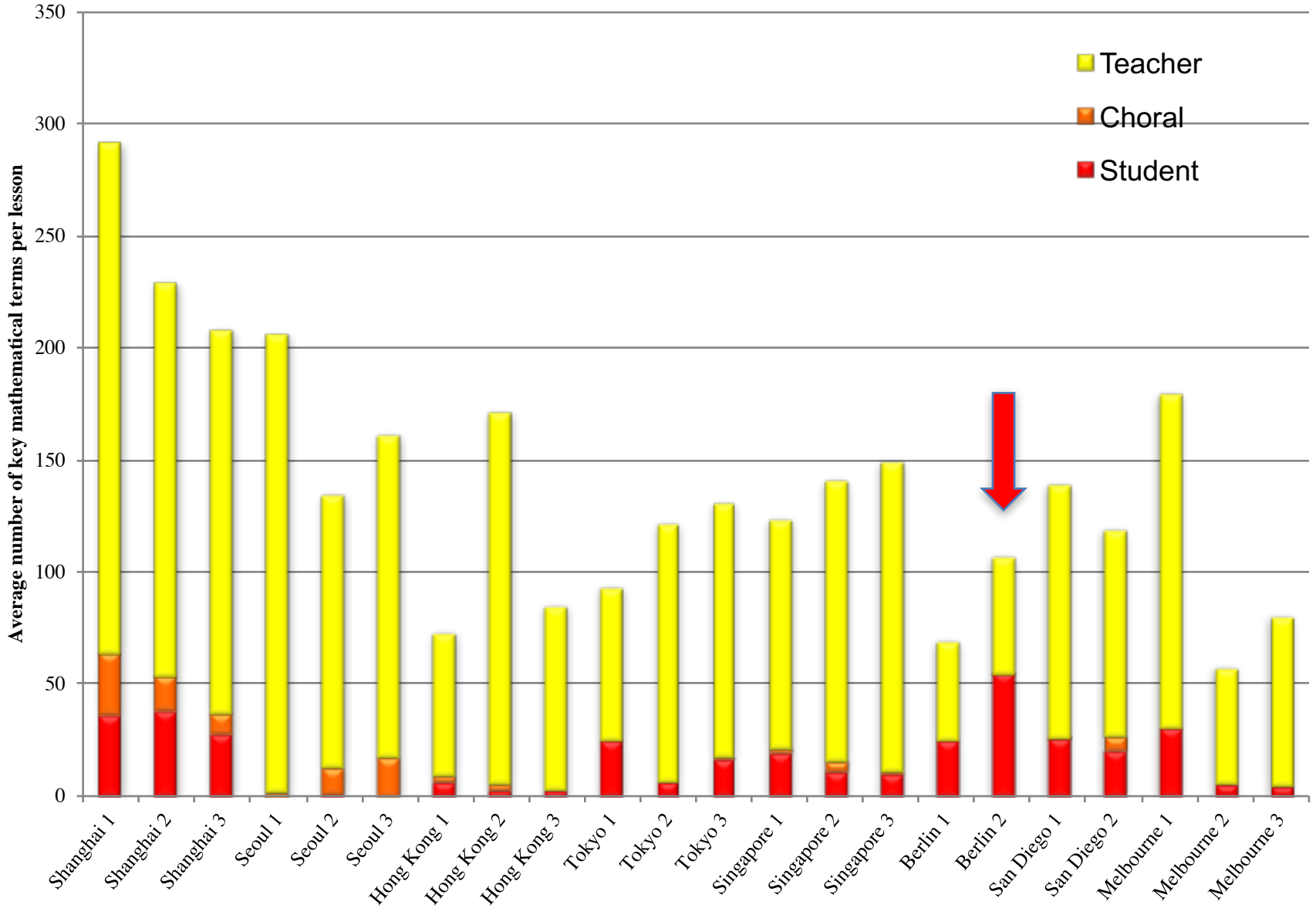

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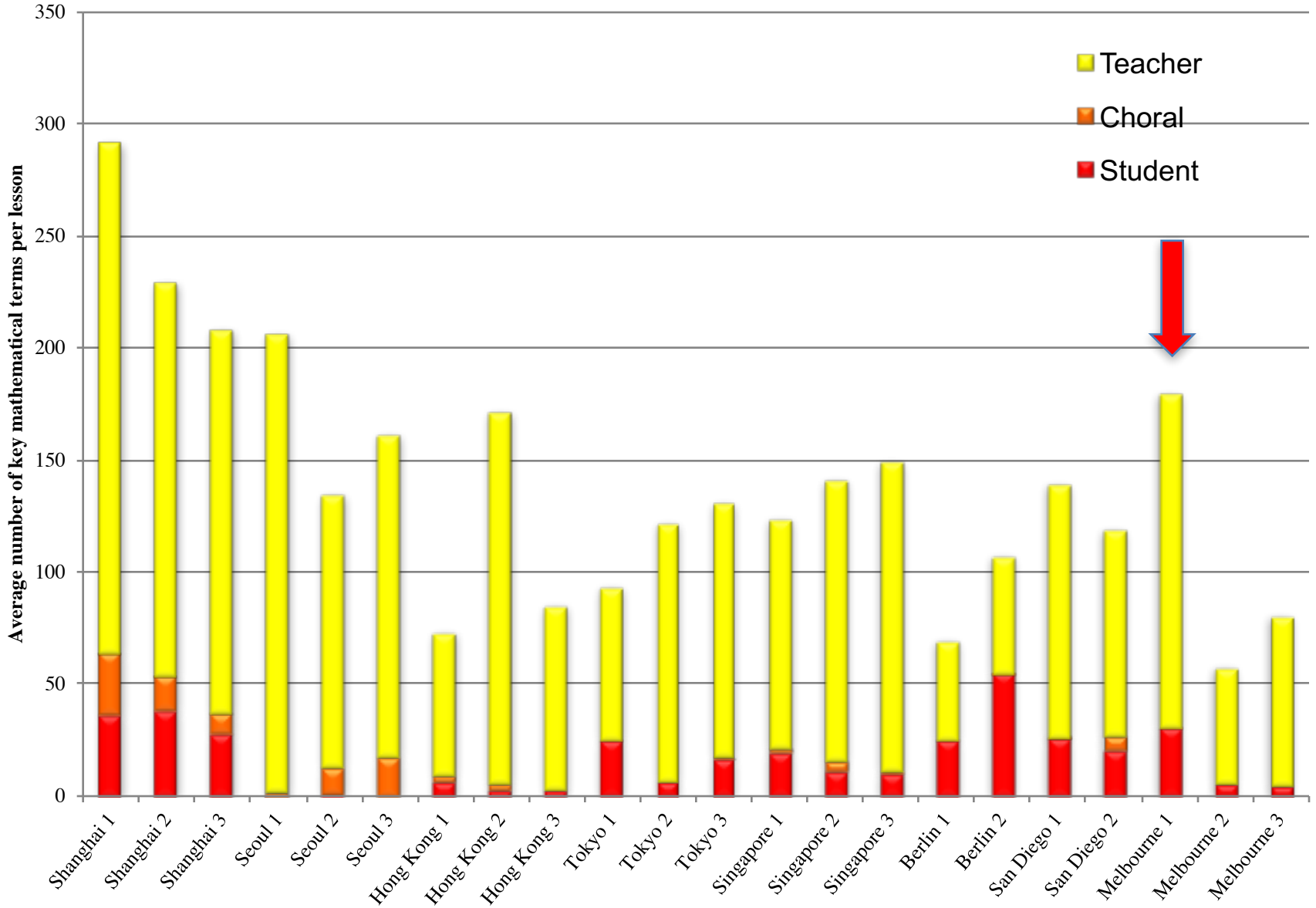

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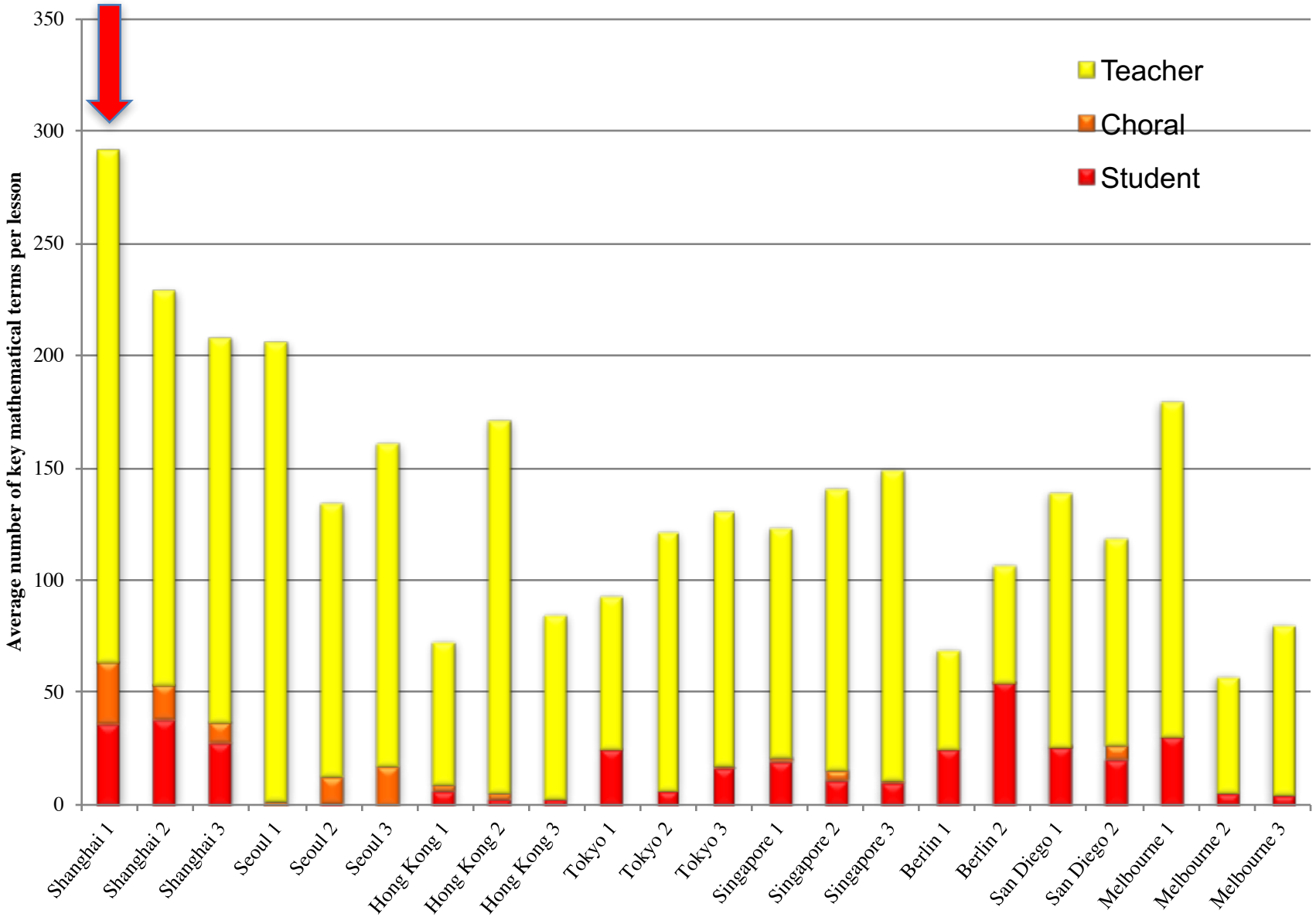

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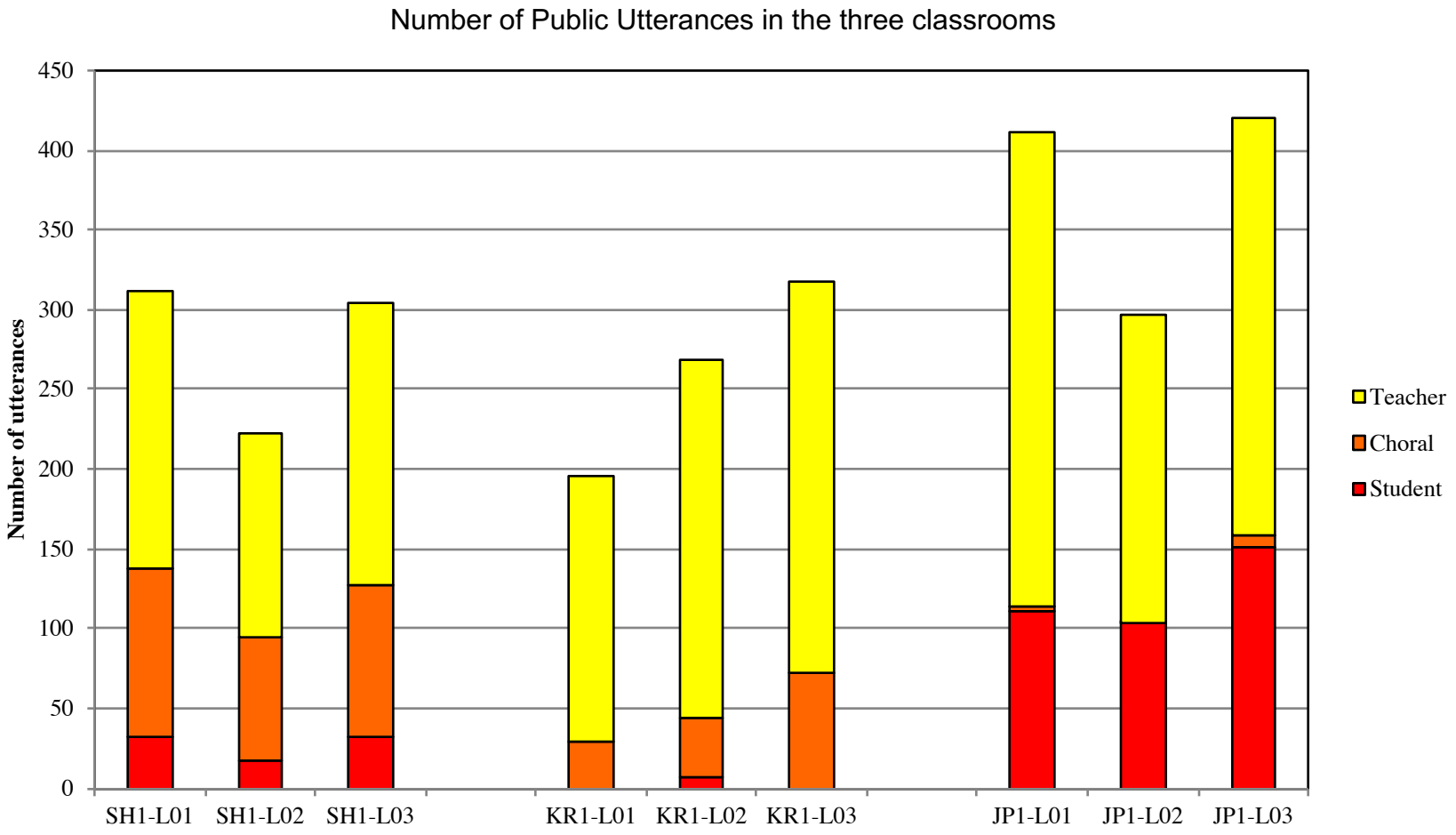
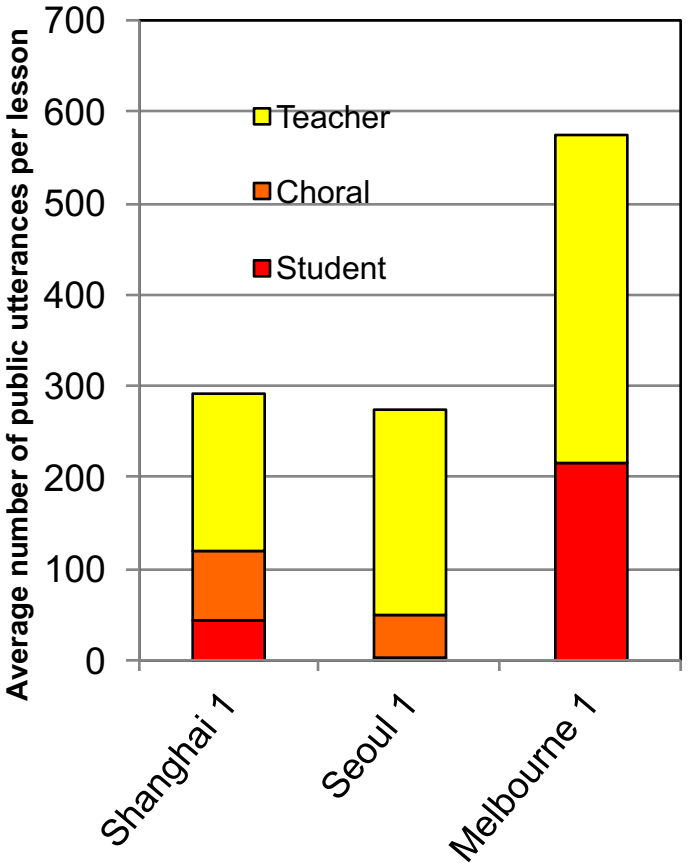
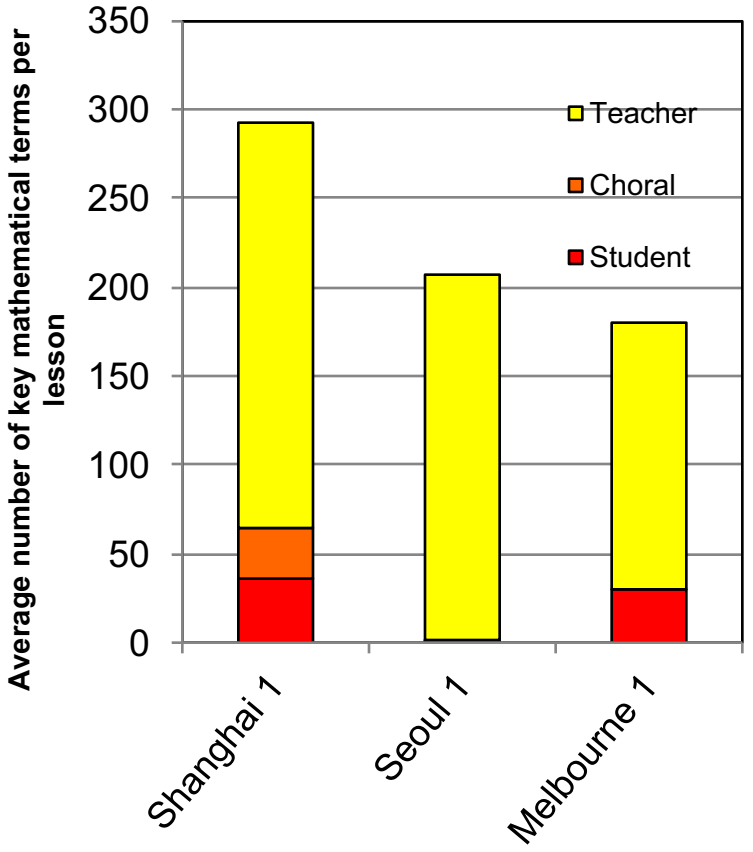
Public speech in three mathematics classrooms



A tale of three maths classrooms

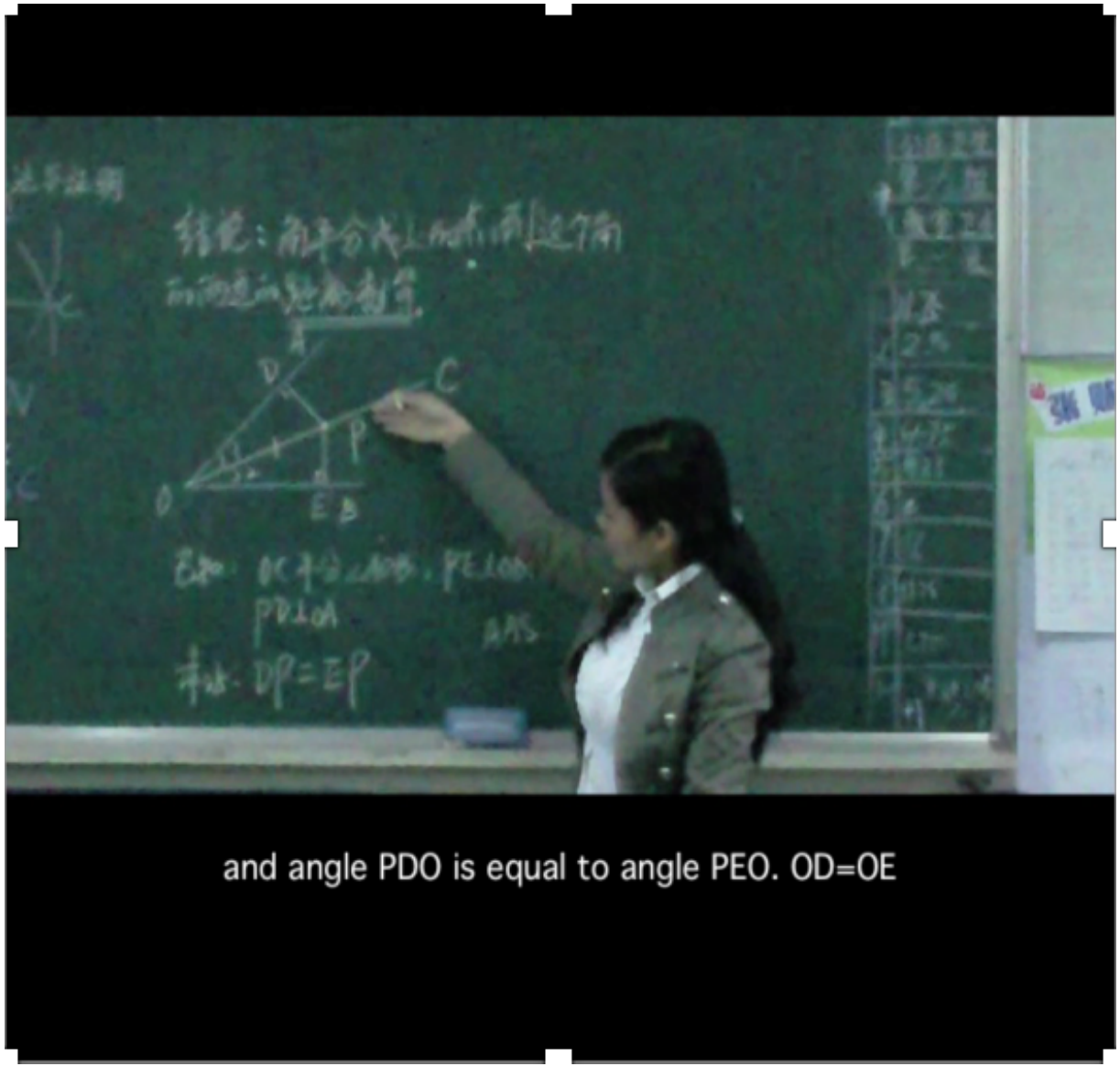


Public Utterances



Key Mathematical Terms

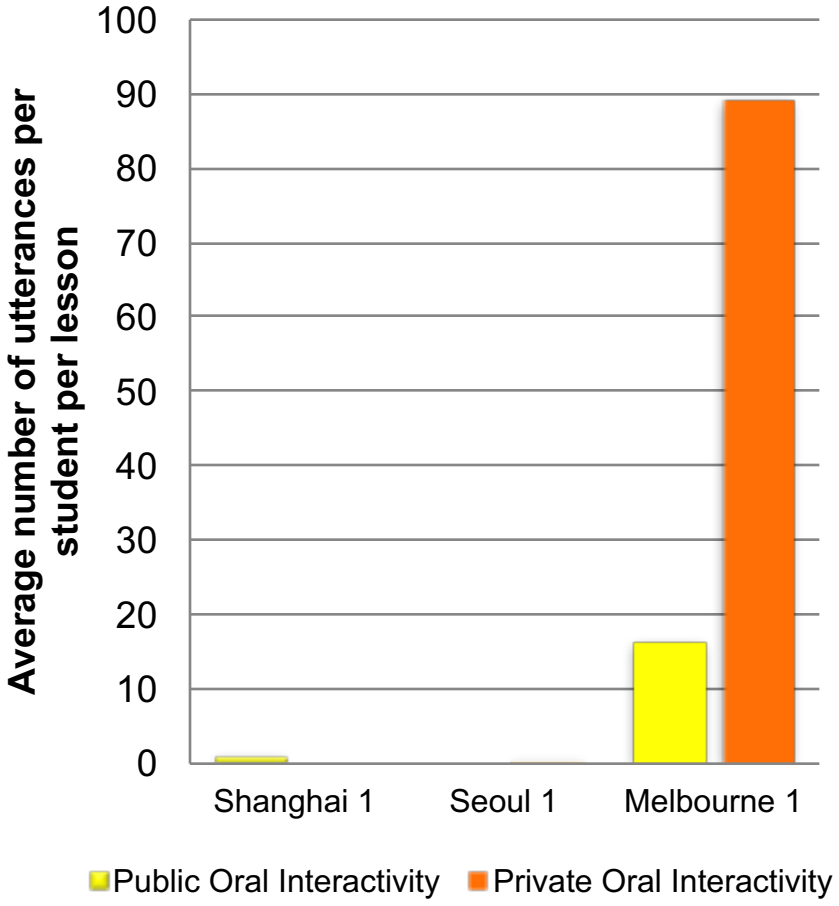
One Chinese Classroom



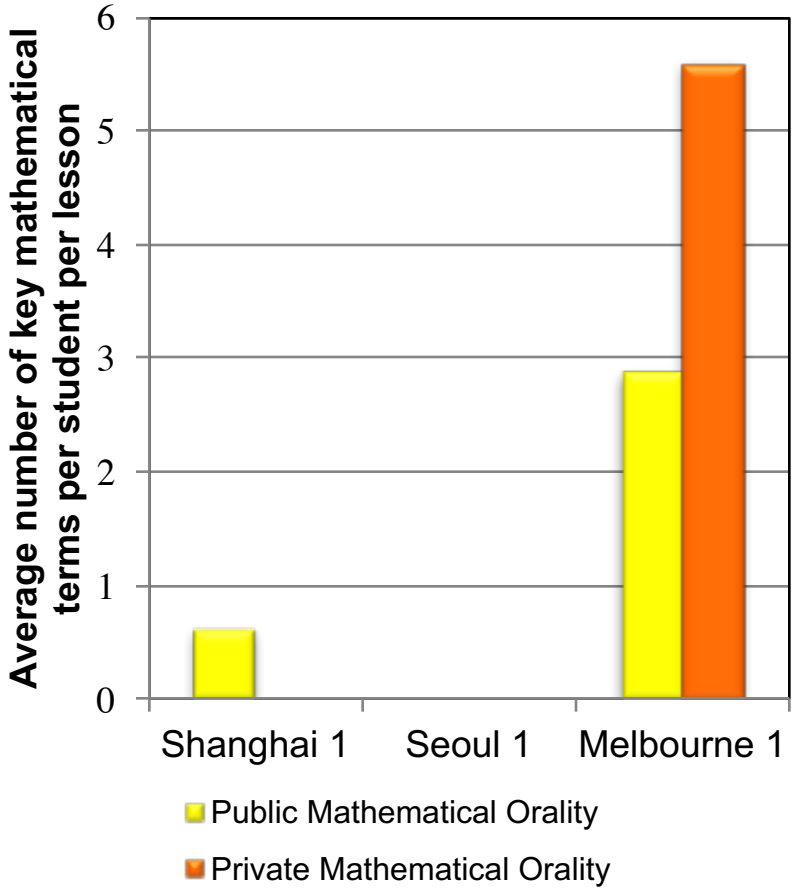
Teacher-Student Interactions

“How are you going boys?” “Are there any strategies to help you win? “What if rolling an improper fraction works to your advantage?” “Show me what you mean.”

Three classrooms – the student experience



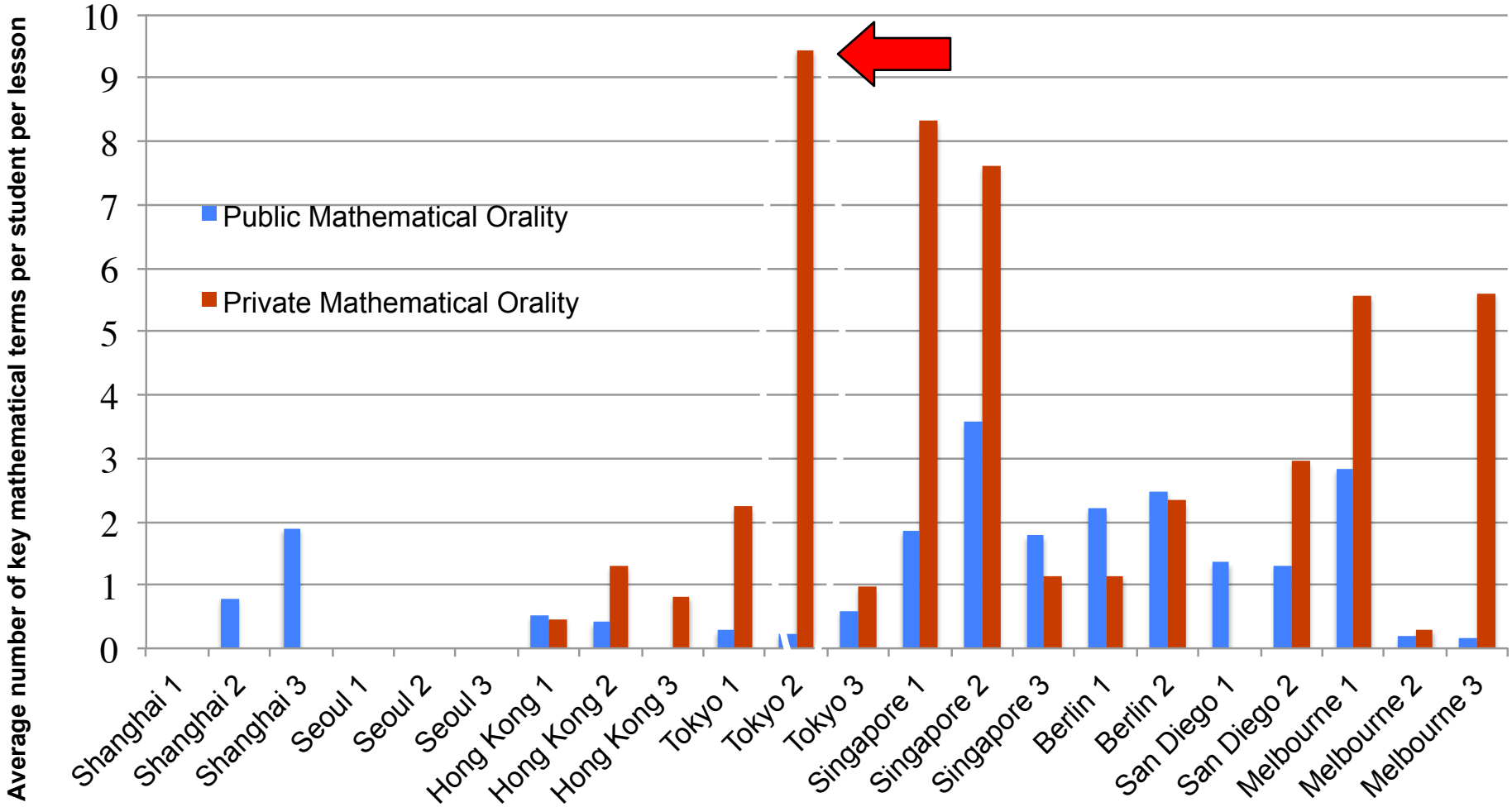
Public and Private Utterances



Key Mathematical Terms

n(SH1=50; SE1=36; ME1=25)

Individual student spoken mathematics - “public” and “private”



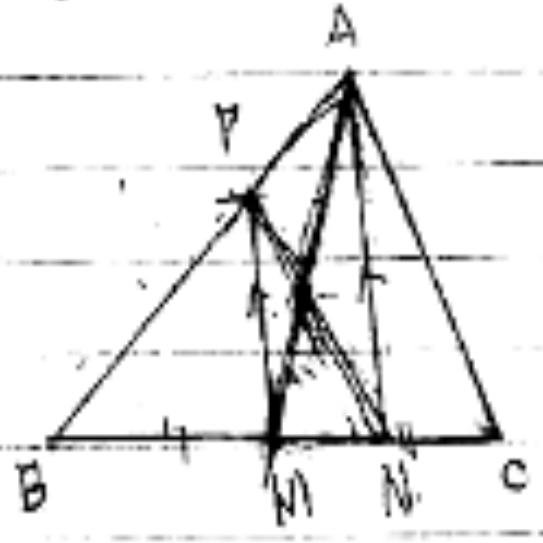
*Each bar represents an average over five lessons or ten students

Sample student-student "private" interaction - Classroom transcript (Tokyo School 2 – lesson 2, 29:46:12 – 33:15:19)

- WADA Um, you drew a **middle point** [mid-point] here, right? So if you just draw a line from here, wouldn't that do?
- KAWA Can you draw a line from P?
- KAWA You're kidding. What did you say? Are you saying that you can draw a line from here?
- WADA Yes. If you draw a line from there, if goes over the **middle point** [mid-point] so there is no problem there.
- KAWA Really? Let's try then.
- KAWA What was the name of the **theorem** again?
- WADA **Middle point** [Mid-point] **connection theorem**.
- KAWA That's it! But it isn't **parallel** there. Are you going to try drawing it there?
- WADA [To Tsutahara] Doesn't this work when you draw a **parallel line** by free hand and then draw a line that goes along P?
- TSUT I don't understand what you're talking about.

Wada's work

Q 次の△ABCの点Pを通り、
面積を2等分する直線を
引け。



Sample student-student "private" interaction - Classroom transcript (Tokyo School 2 – lesson 2, 29:46:12 – 33:15:19)

- KAWA Where's the **bottom line** [base] then?
- WADA This is the **bottom line** [base], I bet. God, I don't know which one is the **bottom line** [base] now.
- KAWA This one has to be the **bottom line** [base].
- WADA This has to be the (height), this one.
  This is the **height**. I got it now!
- KAWA Is this the **height**? Is it all right if it's now **parallel**?
- WADA Well, it doesn't have to be **parallel**. No need for that.
- KAWA But then which two become equally in half?
- WADA What the hell are you saying?
- KAWA Aren't we doing the one that we have to divide in half or something like that?
- WADA Yes, that's the one we're talking about.
- KAWA I'm starting to get mixed up now.
- WADA Well, I'm starting to get a headache.

SO WHAT?

What are the benefits of student classroom talk?

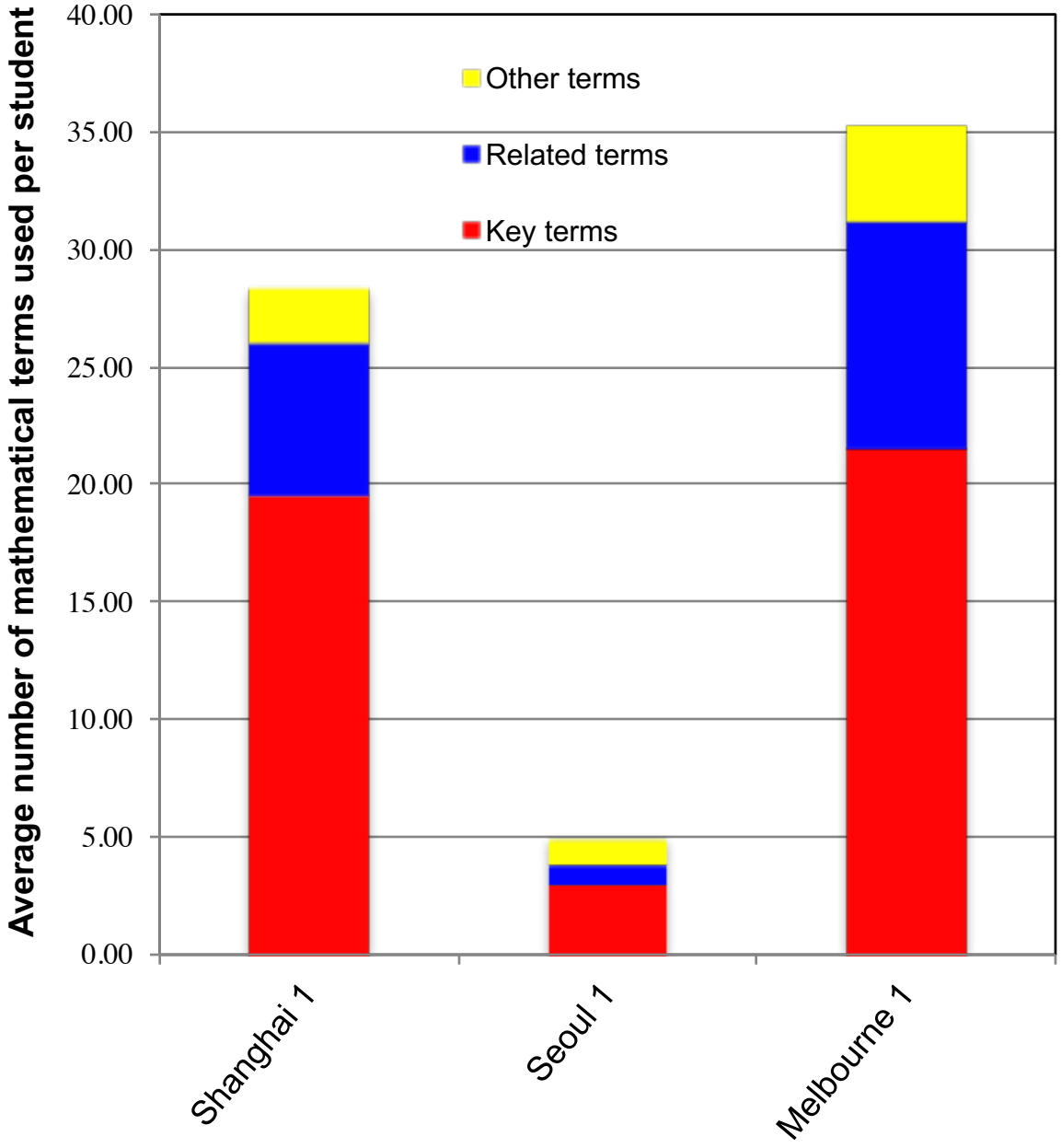
Post-Lesson Student Interview

Question 1. What was the lesson about?

Question 2. What did you learn?

[Research Question: What use did students make of technical mathematical terms in answering these two interview questions?]

Frequency of Student use of Mathematical Terms in Post-lesson Interviews



*Each bar represents an average over ten students

Classroom Talk

Who gets to speak and does it matter?

Does it matter what they say or
who they say it to?

Similarity and difference in classrooms
around the world

Classroom Talk

The judicious combination of public and private speech by both teacher and students can support the development of

Understanding

and

Fluency

Classroom Talk

What of

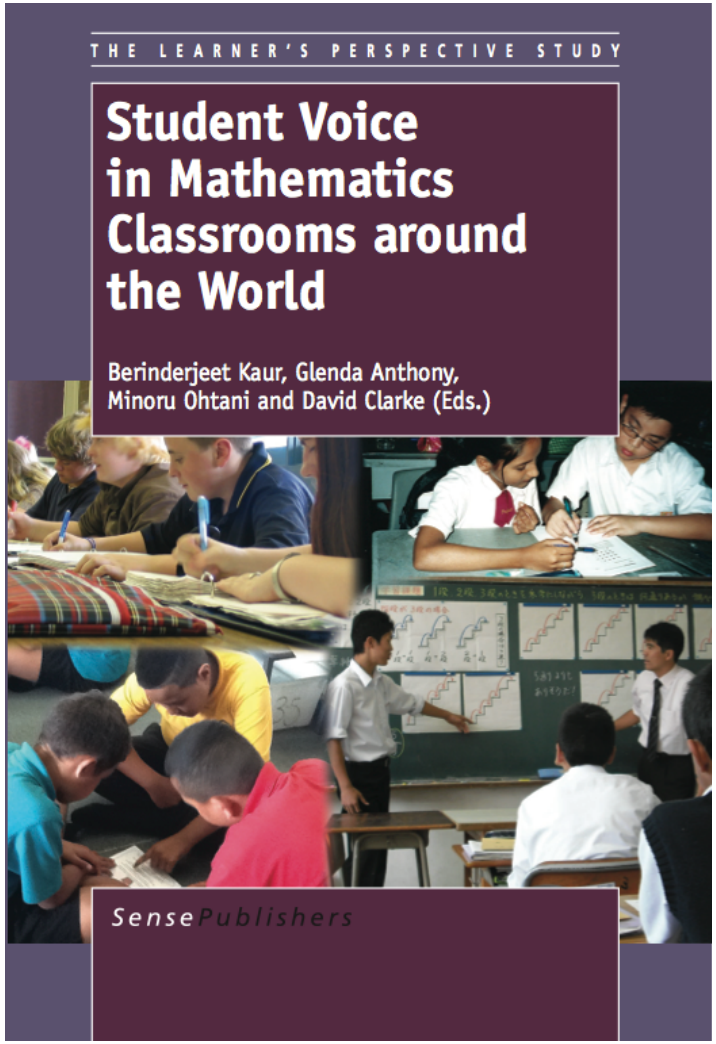
Problem Solving

and

Reasoning?

The importance of student speech

The significant role of peer articulation and explanation in facilitating learning has been documented across cultures (Kaur, Anthony, Ohtani & Clarke, 2013).



Collaboration in the Classroom

Collaboration creates the conditions for classroom talk

And, therefore, for

The development of understanding, fluency, problem solving and reasoning

Collaboration in the Classroom

Why encourage collaboration?

Creating the conditions for meaningful collaborative activity

Why encourage collaboration?

Collaboration as a Learning Tool
[Several learning theories support this]

Shared cognitive load

Students as learning resources for one another

The value of learning from peers

Initiation into the discourse of mathematics

Why encourage collaboration?

Collaboration as a Learning Tool

[Several learning theories support this]

Shared cognitive load

[Cognitive Load Theory]

Students as learning resources for one another

[Distributed Cognition]

The value of learning from peers

[Educational Neuroscience]

Initiation into the discourse of mathematics

[Commognition]

Collaboration and the needs of industry

“In an environment requiring constant, it is the very (high level) generic skills that industry are now seeking for the changed business landscape.”

“Industry is after “inter-professional collaboration where professionals and non-professionals with diverse skills and knowledge work to facilitate positive outcomes for a client.”

“Industry representatives believe that it is easier to up-skill someone technically than it is to teach the necessary interpersonal and intrapersonal skills for workplace practice and career success.”

(Collet & Hine, 2013)

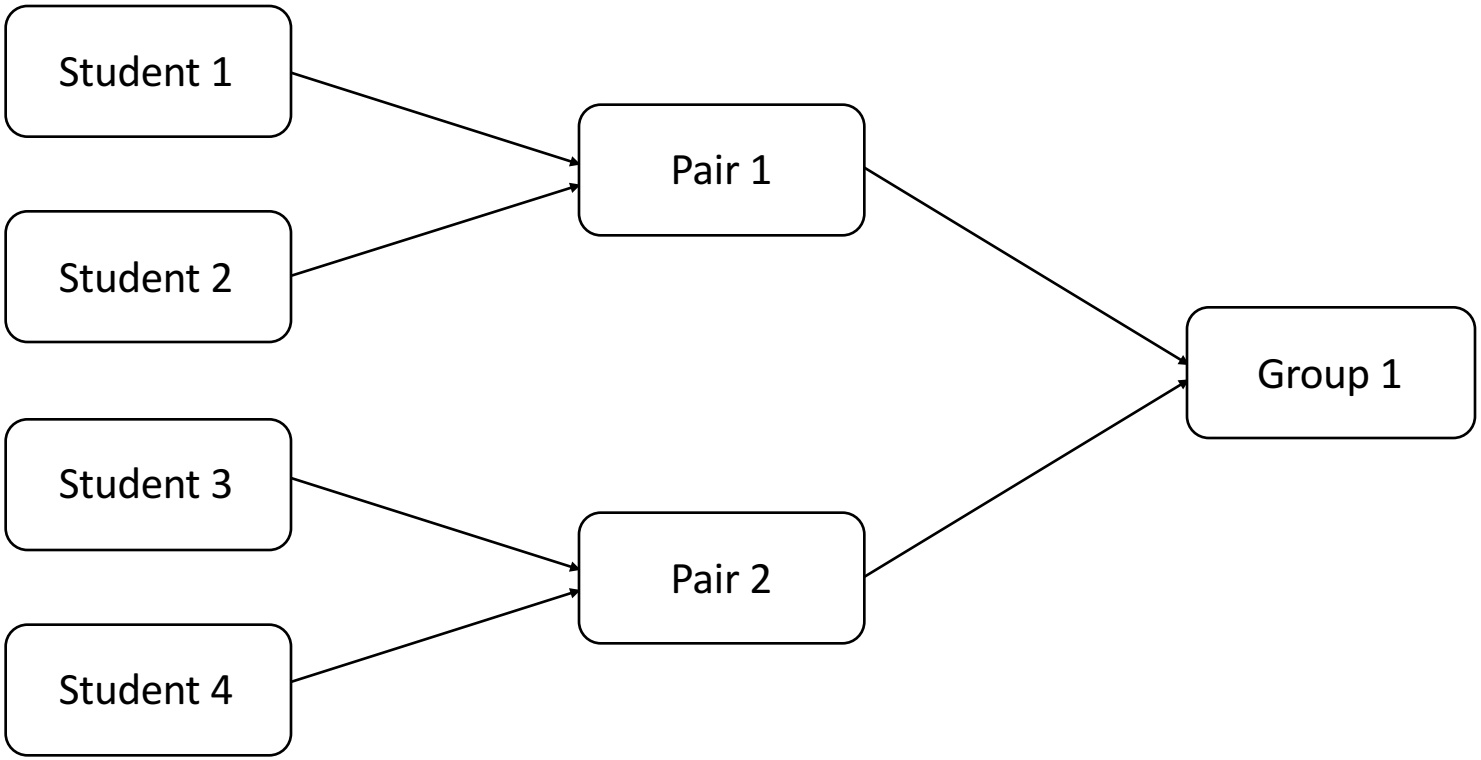
Collaborative Skills are a legitimate and important learning goal

The Social Unit of Learning Project

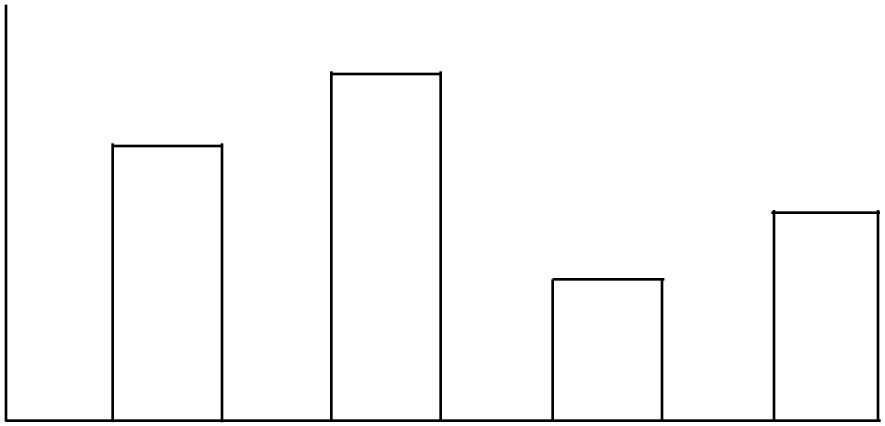
https://pursuit.unimelb.edu.au/articles/high-tech-classroom-sheds-light-on-how-students-learn

The Social Unit of Learning Project

Activity Structure



Task One
(Individual work)



What might this be a graph of?
Label your graph appropriately.
What information is contained in your graph?
Write a paragraph to describe your graph.

Household Task

The average age of five people living in a house is 25. One of the five people is a Year 7 student.

What are the ages of the other four people and how are the five people in the house related? Write a paragraph explaining your answer.

Audrey

Katie

Pedram

Poya

We chose these ages a we wanted a variety of ages
We know this is one of the many answers as we
have used addition subtraction division and multiplication
to make our answer as precise as it can be
Our page has been written on the working out sheet
we worked as a pair to get the final answer of

Year 7 12yrold
old br her 16yrold
1 Mle sister- 7 y old
Mum 45
Dad 45

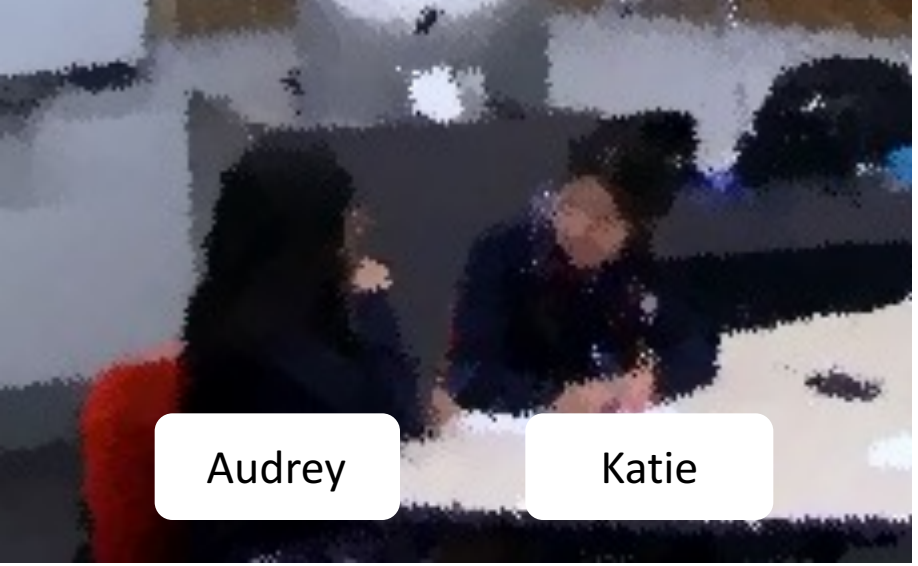
← Solution

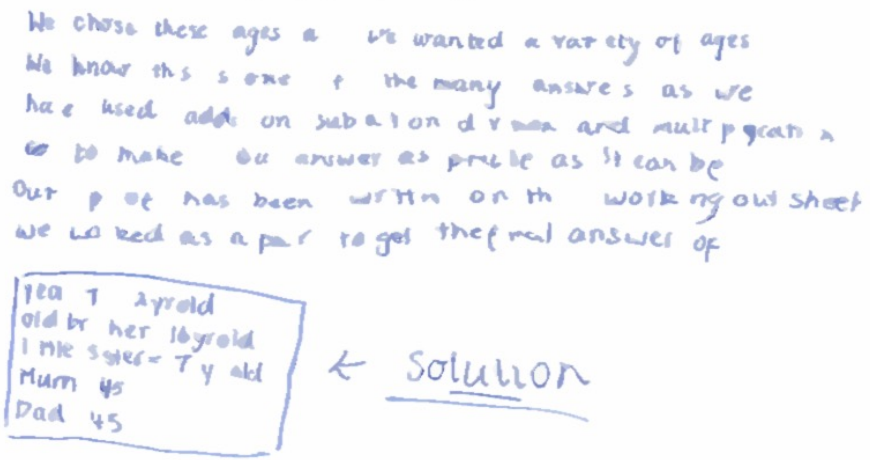
20+10+10+42+13 125

125 5 25

Father 42
mother 40
Eldest child 20
middle child 13 → year 7
youngest child 10

The average 25





Pair One

Katie: Look, look. So if five people, the average is 25, yeah? Okay. So it's x.

Audrey: Which is 25 . . .

Katie: The unknown. . .

Audrey: Times five. . .

Katie: Yeah. So the unknown divided by five people and that equals the average. So basically, if you . . . 25 . . .

Audrey: The age that equals to 125.

Katie: Five times . . .

Audrey: Maybe we should make the person 13.

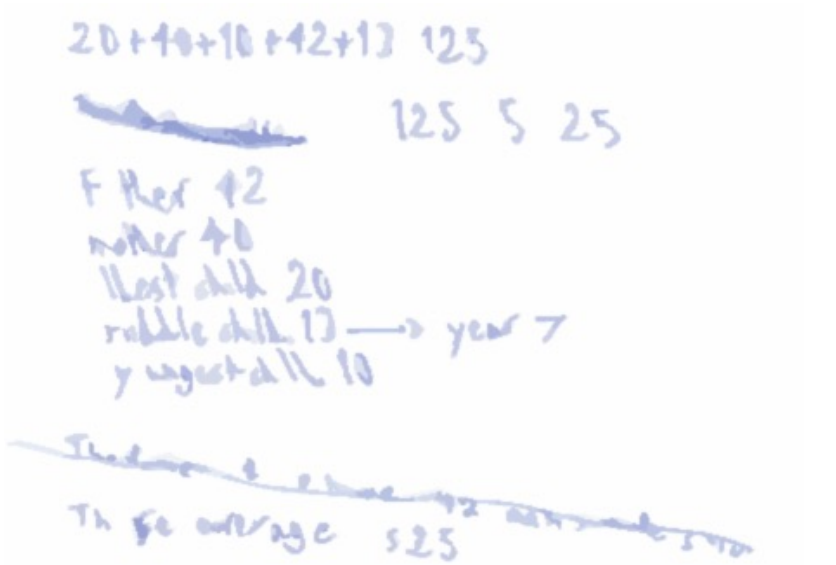
Poya: You're writing a math equation.

Pedram: Yeah. It's a math equation because it's a maths problem.

Poya: It says write a paragraph.

Pedram: I am going to write a paragraph, you dumb-ass.

Poya: Okay. Well what - what's going to be in the paragraph? Numbers, equal sign?



Pair Two

Small Group Interaction

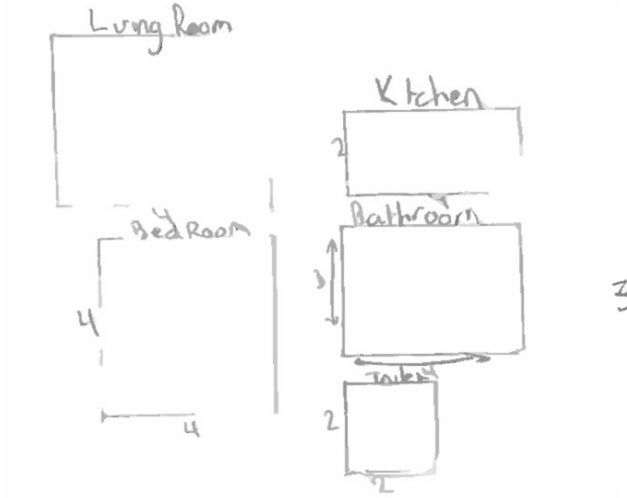
Fred's Apartment

Fred's apartment has five rooms. The total area is 60 square metres.

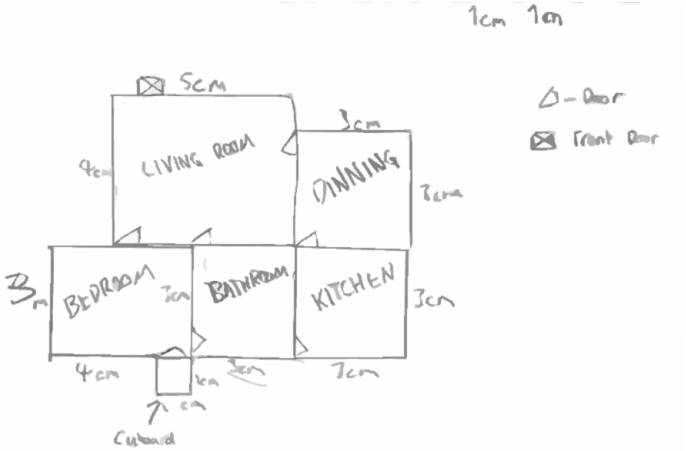
1) Draw a plan of Fred's apartment.

2) Label each room, and show the dimensions (length and width) of all rooms.

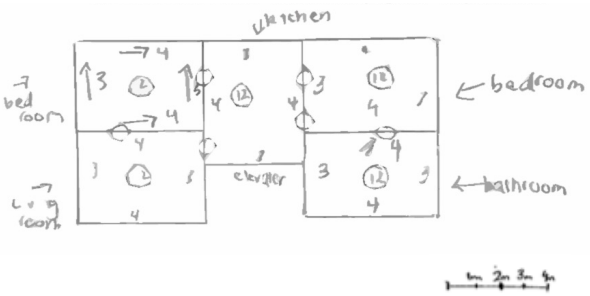
Group 1



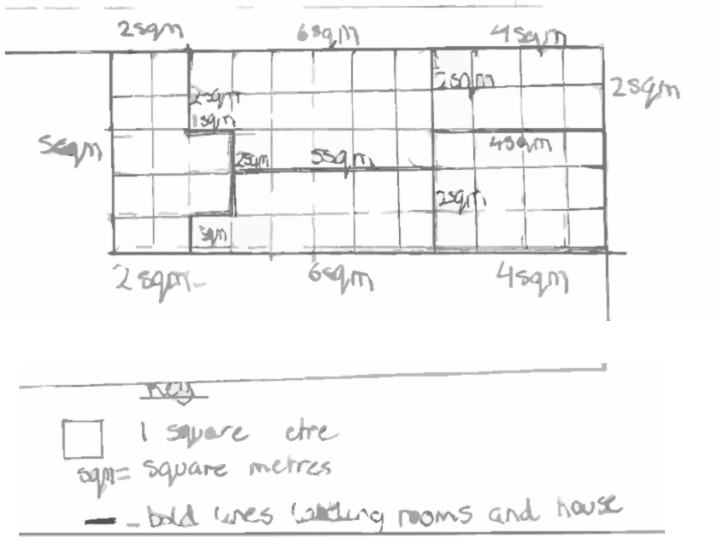
Group 2



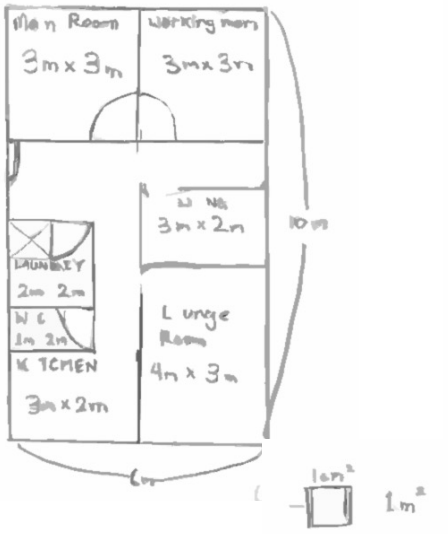
Group 3



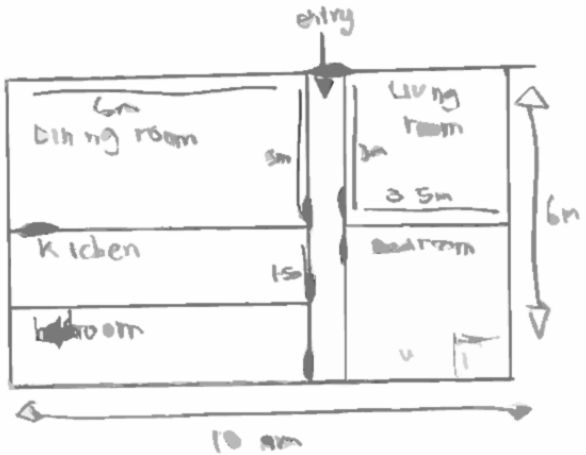
Group 4



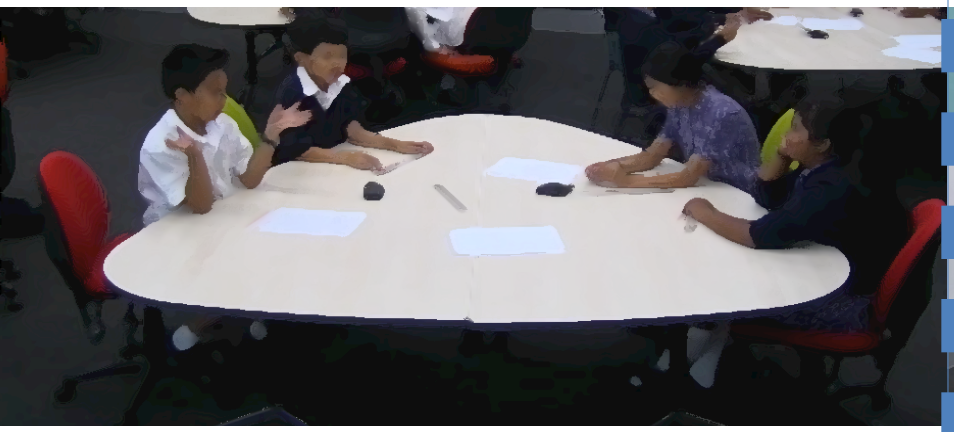
Group 5

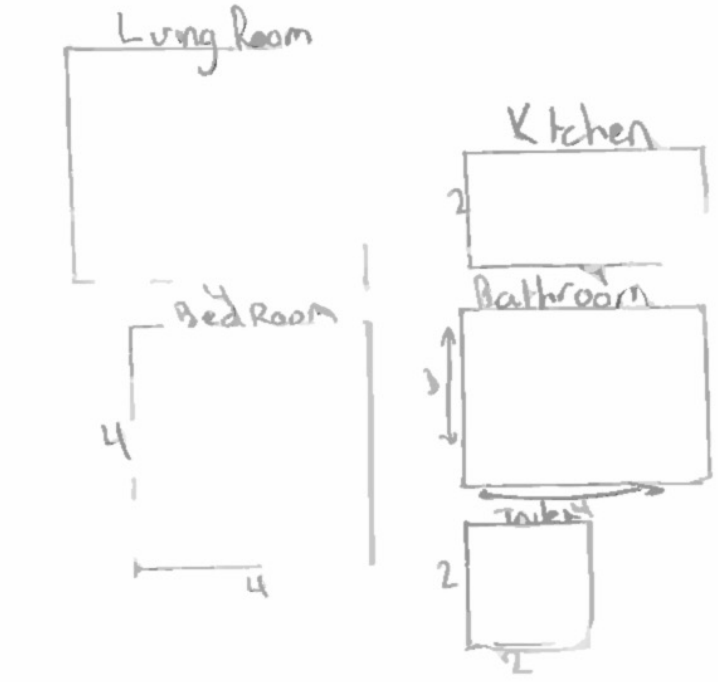


Group 6

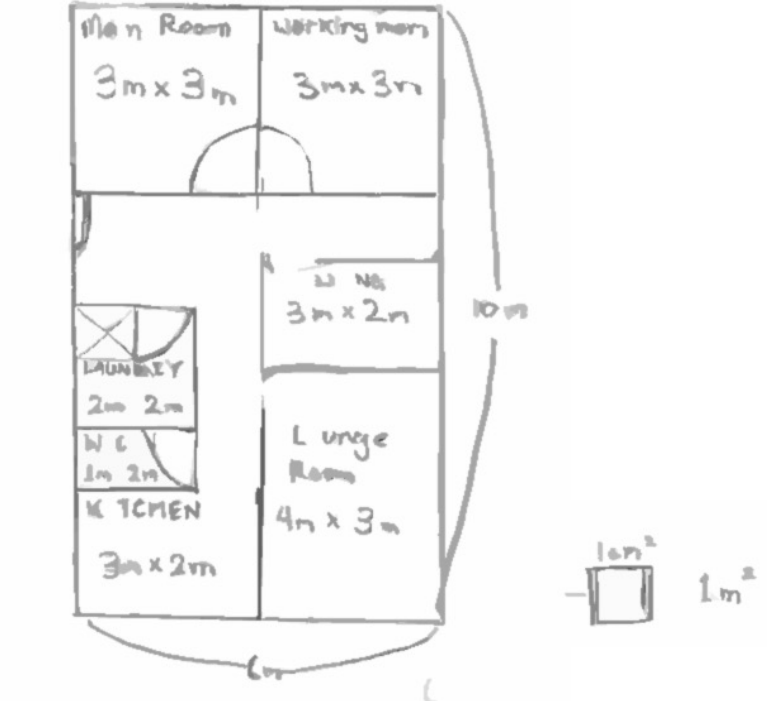


Group 1

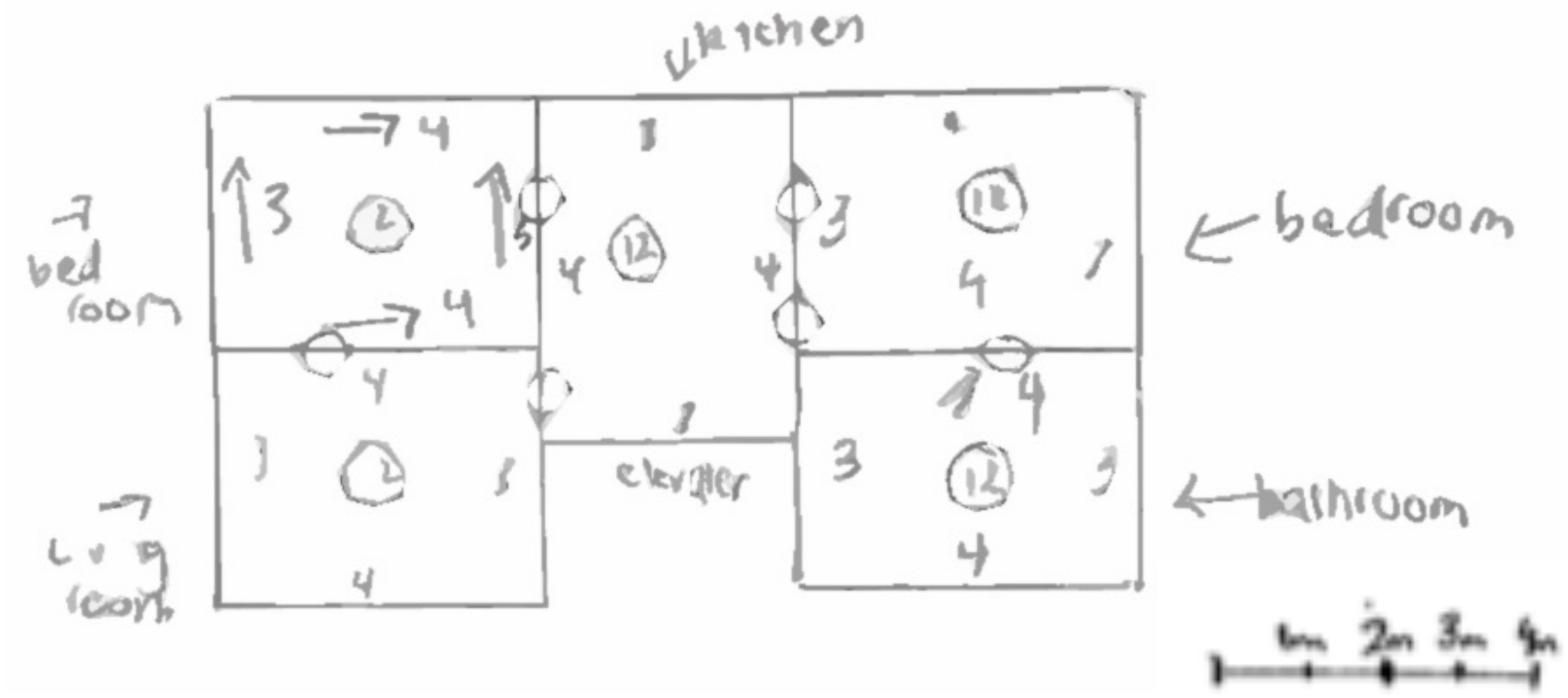




Group 5




Audrey
Katie
Pedram
Poya


kitchen
bedroom
bed room
elevator
bathroom
1m 2m 3m 4m


Audrey
Katie
Pedram
Poya

Small Group Interaction

Pedram: Can you even do anything? I'm angry at you.
Poya: You're angry at me because I didn't do anything?
Pedram: I'm angry at you because you're not doing anything and you're saying I'm…
Katie: Guys, just - just calm down. We have to work as a group.
Audrey: [Reading from the board] … divided by five.
Katie: We have to work as a group.
Pedram: I'm not even going to give you the pen. Here, have this.

Collaboration as multi-layered practice

Students engaged in collaborative group work must function at three modes (at least):

- mathematical – e.g., *can I do the maths?*
- socio-mathematical – e.g., *what is an acceptable answer?*
- social – e.g., *what are my obligations to the other group members and theirs to me?*

Collaboration as multi-layered practice

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- social – e.g., *what are my obligations to the other group members and theirs to me?*

- THESE ARE ALL PRESENT IN YOUR CLASS

Developing Proficiencies

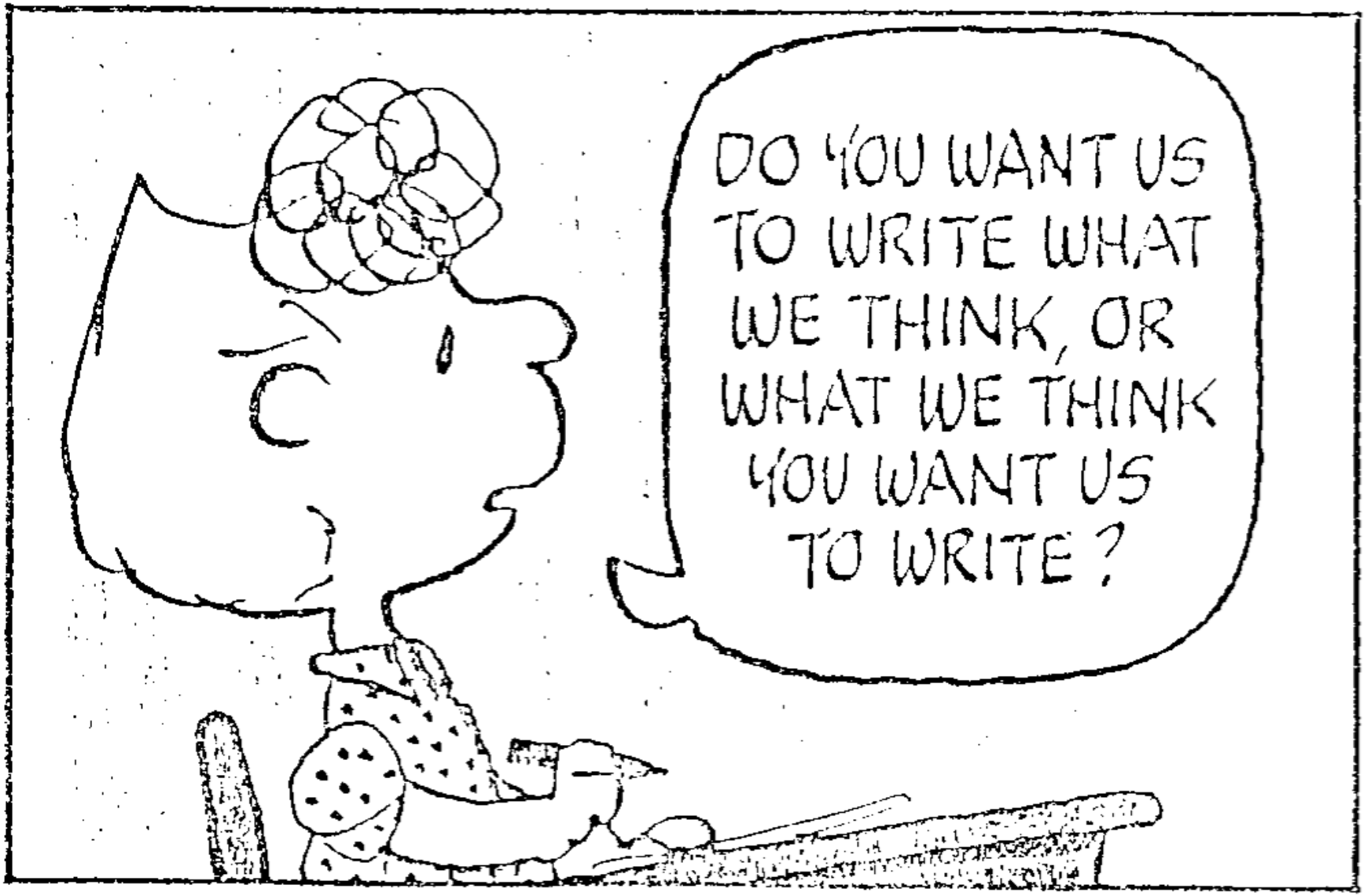
Why don’t we just tell them?

SCAFFOLDING

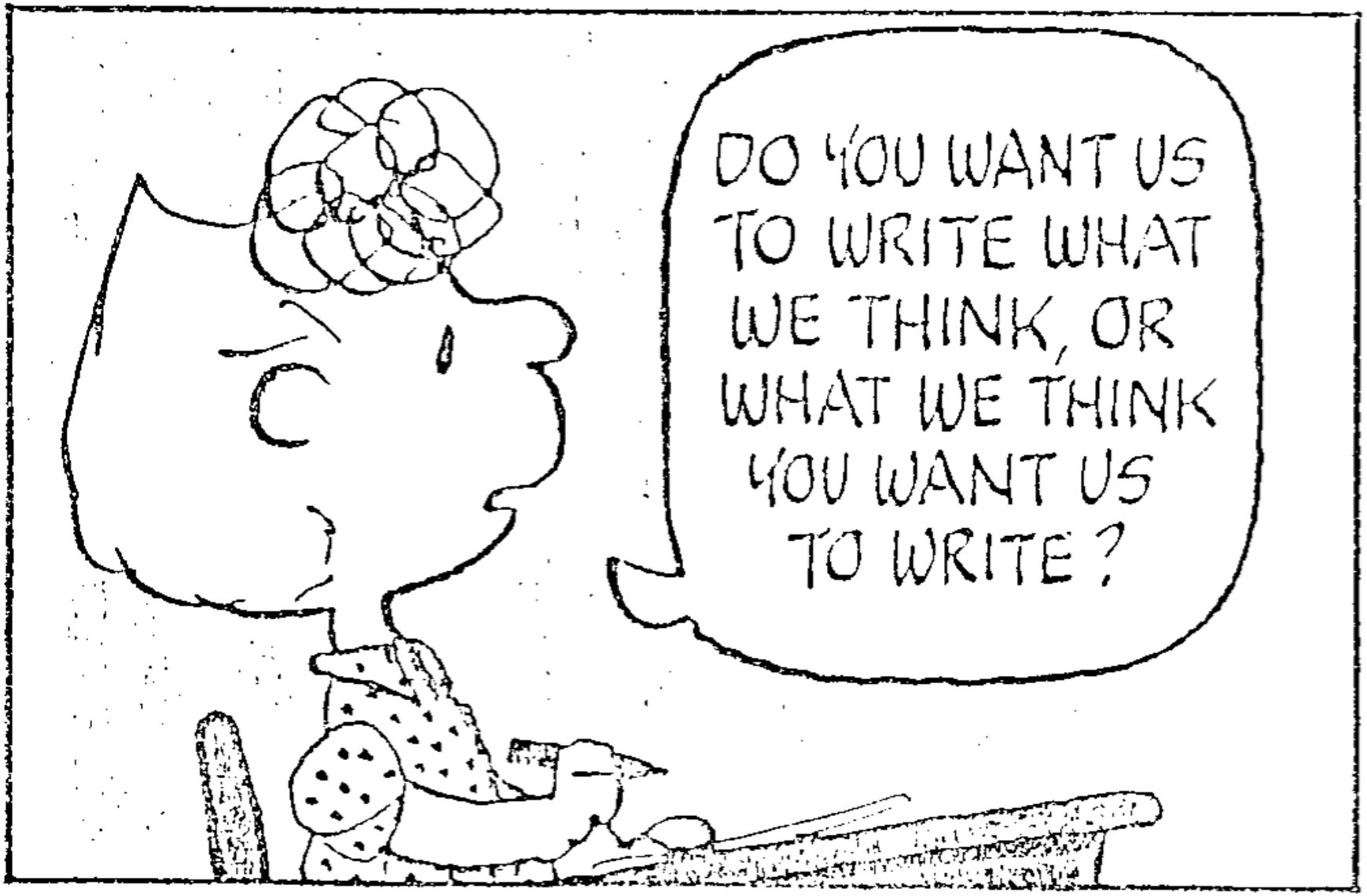
Elicitation and Initiation

Whose knowledge is driving the conversation?

The Socio-Cognitive



The Socio-Cognitive (le contrat didactique)



Creating the Social Conditions for Collaboration

Group Goals and Individual Accountability

(Slavin, 1988 and elsewhere)

Competencies as Sophisticated Practice

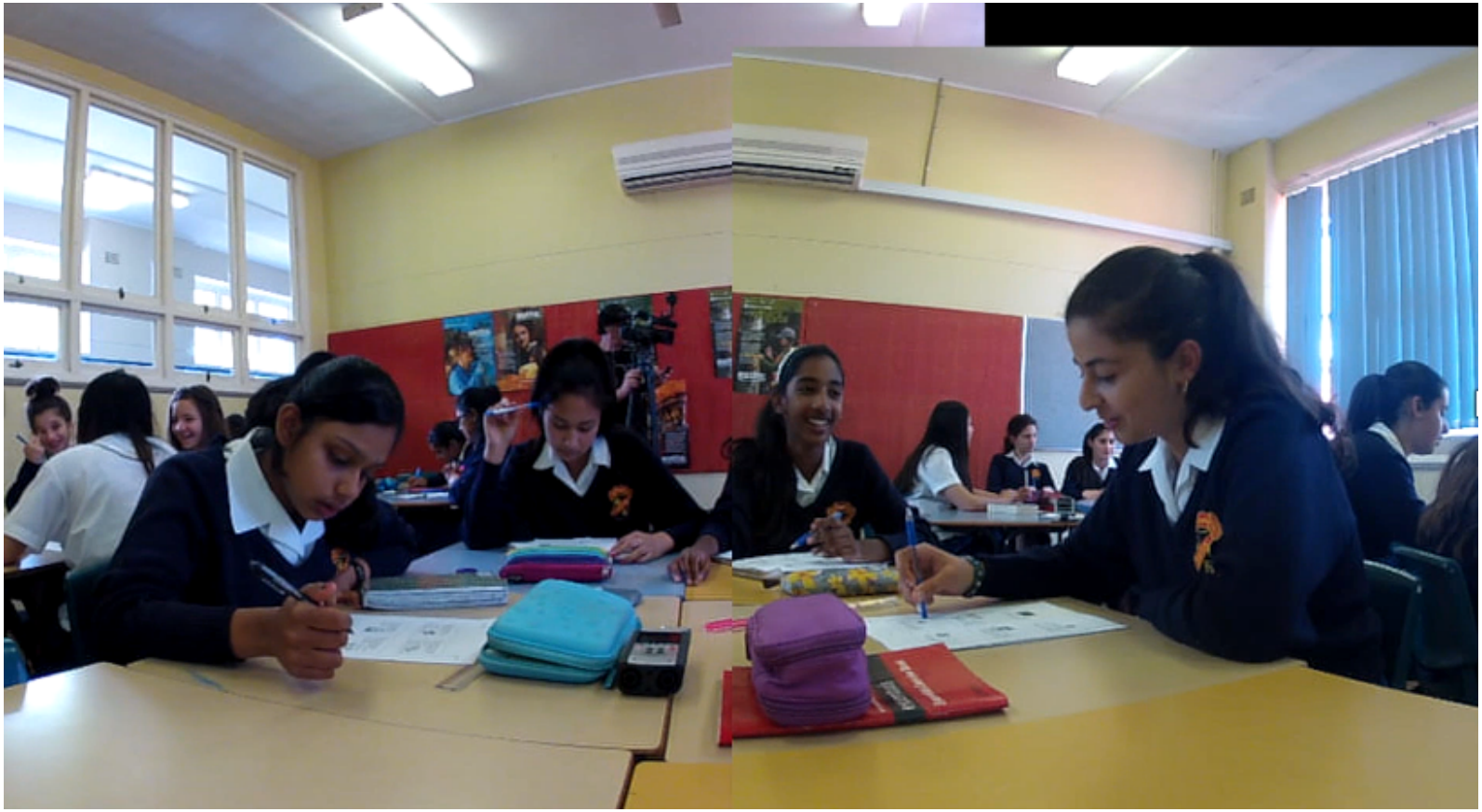
Understanding

Fluency

Problem Solving

Reasoning

Promoting Mathematical Reasoning



Competencies as Sophisticated Practice

Understanding

Fluency

Problem Solving

Reasoning

The importance of “because . . . “

Facilitating Sophisticated Practice

Engagement

Content and Skills

Collaboration

Understanding

Engagement

Choosing activities that are challenging and appealing

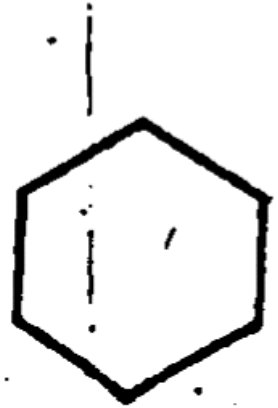
Engagement

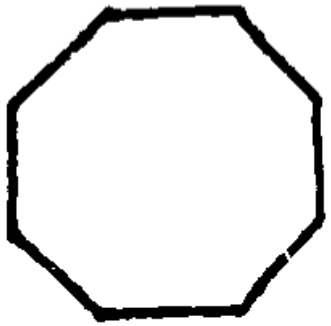
Choosing activities that are challenging and appealing

And which are accessible to every student at some level

Consider this task

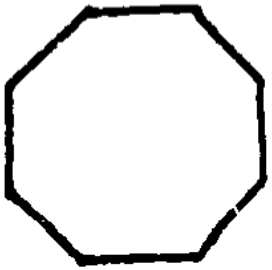
2. Name these shapes.





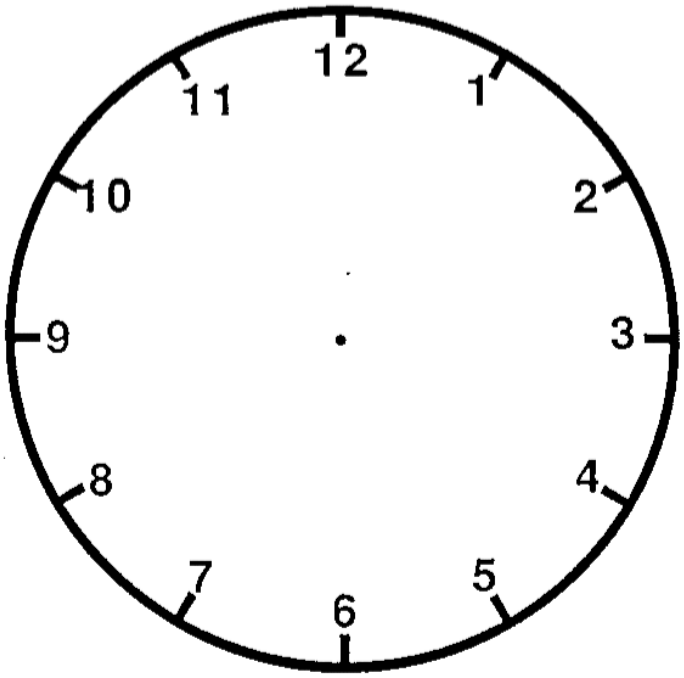
2. Name these shapes.

Sqtory



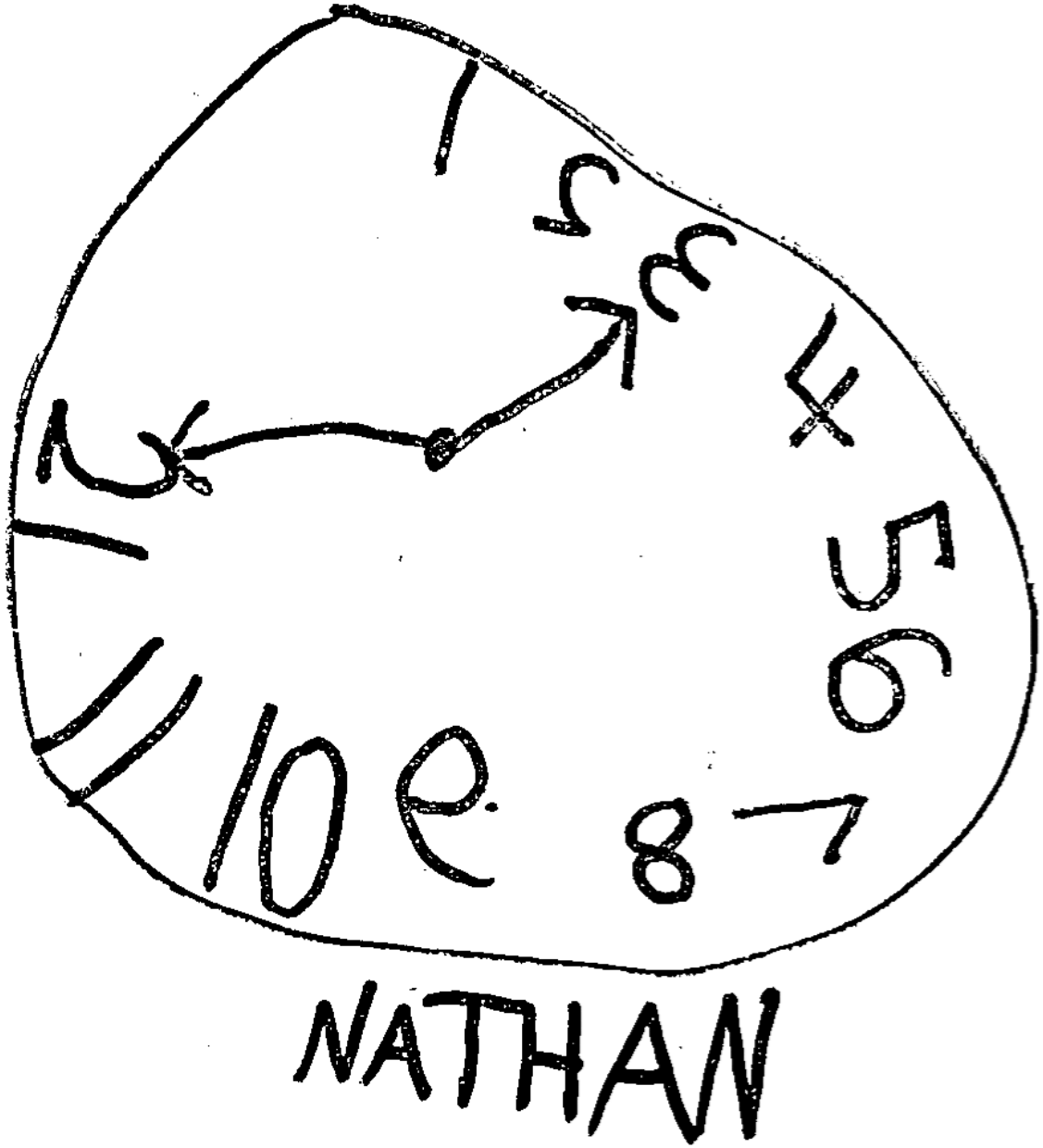
~~Sqtory~~

FROM A GRADE 6 CLASS TEST.

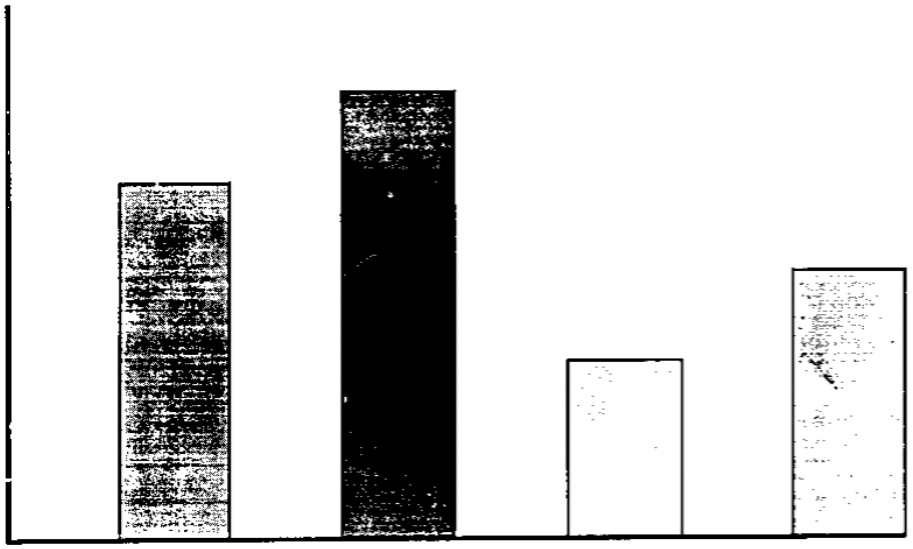


On the clock face shown, mark in hands to show the time 3 o'clock.

Draw a clock face showing the time as 3 o'clock

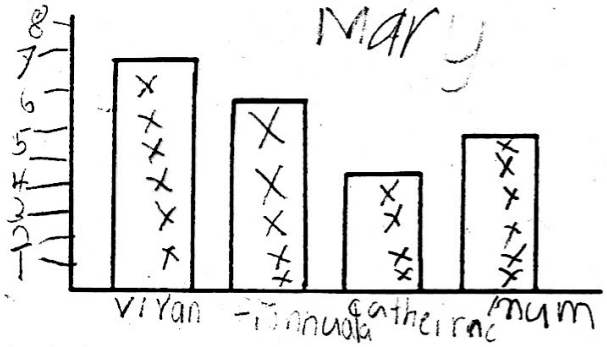

NATHAN

What might this be a graph of?



Label your graph appropriately. What information is contained in your graph?

What might this be a graph of?



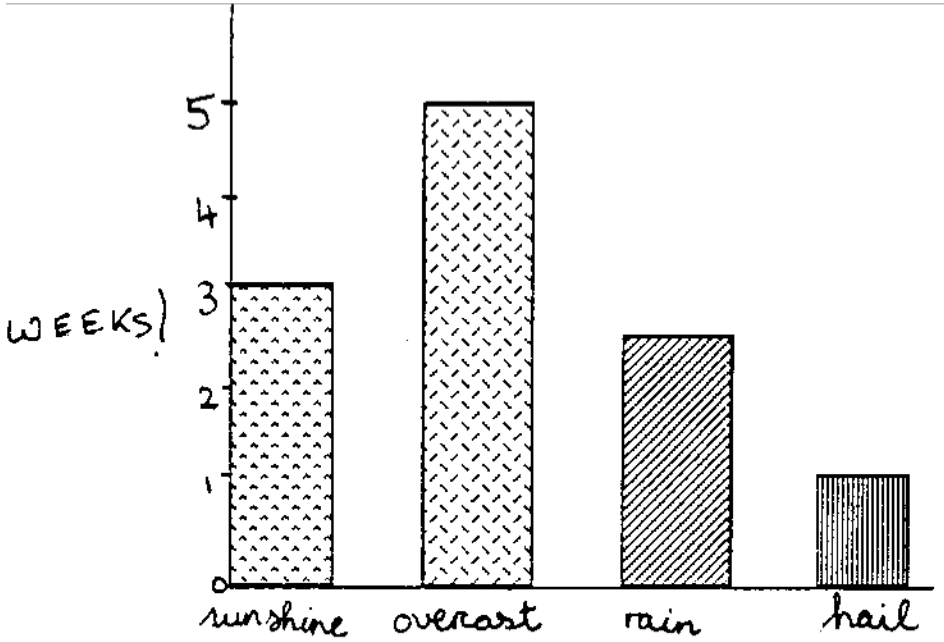
Label the graph appropriately
What information is contained in your graph?

6 Pepel like vivan

11 Pepel like mum

11 Pepel like Theres

11 Petel like Isabelle



What do you think that this might be the graph of?

wheather chart

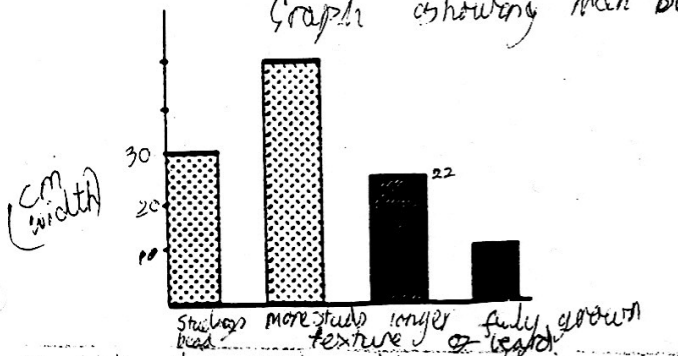
Write down everything you can know about your graph?

The sunshine bar is three cms high
The Overcast bar is five cms high
The Rain bar is rounded of to three cms
The Hael bar is one cm

Y3 Middle Group. Siobhan Sweeney

What do you think this might be the graph of?

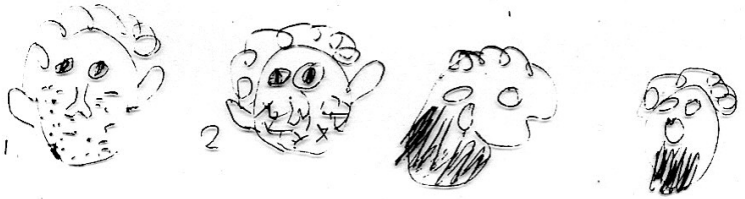
Graph showing man beard.



I think this graph might be showing the story of a man and on his chin had the studs of a beard he only had it for about 30cm (width) on his face but then after a bit of growing and he decided to grow it 50cm (better width) on his face then he kept hesitating and chopping bits off that when he had decided about 10 times the little hairs of the beard were making a criss cross pattern.

Later after 2years he chopped 32cm off (the width) so the total width so he had 28cm (width) left and it was quite thick and long. 2year later he cut more off the width so there was about 12cm of the width left but all of this 12cm's was very very thick so you could see no skin through it.

His face ended up looking like this:



Proficiencies as the Meta-curriculum

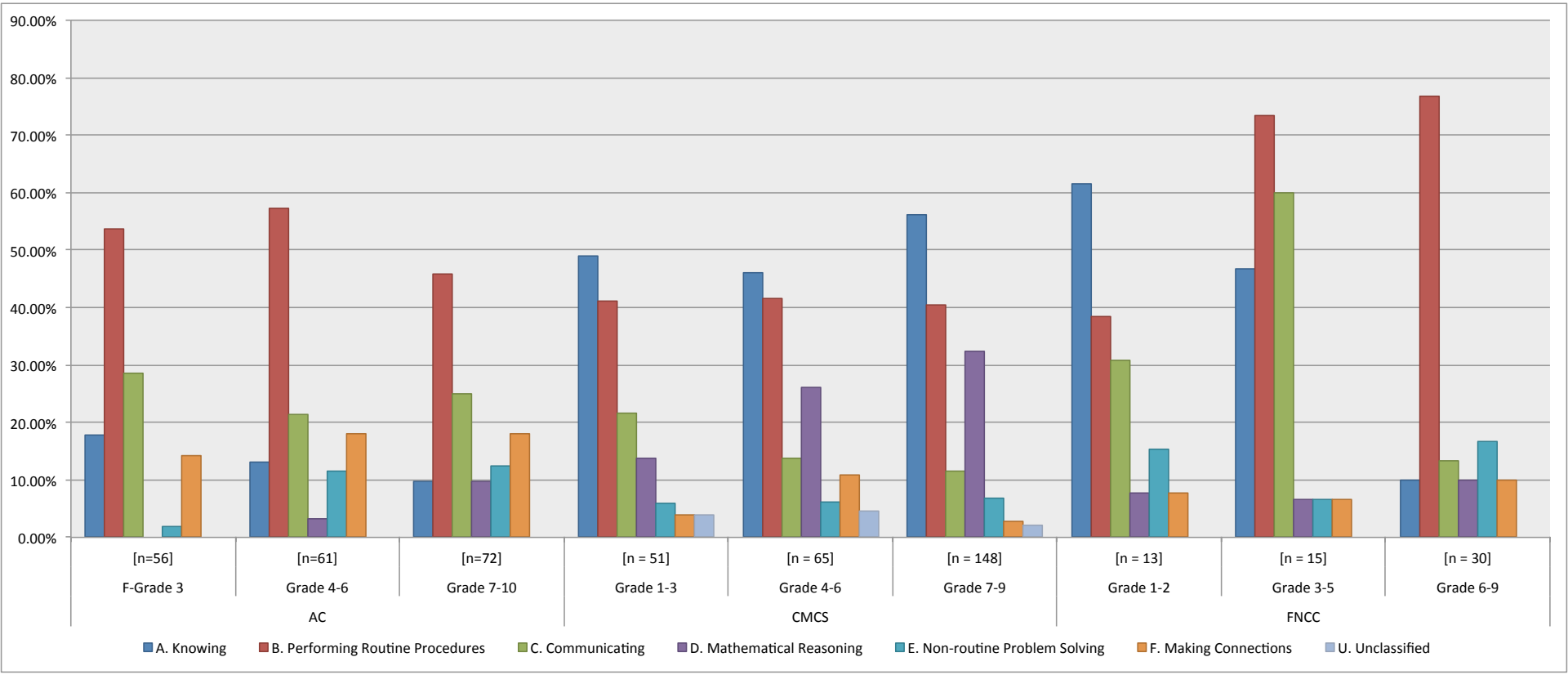
Performance Expectations:

A. Knowing
B Performing Routine Procedures
C. Communicating
D. Mathematical Reasoning
E. Non-routine Problem Solving
F. Making Connections
U. Unclassified

Australian Proficiencies:

- **Understanding**
- **Fluency**
- **Reasoning**
- **Problem Solving**

Performance Expectations in Australia, China and Finland



Classroom Talk

Who gets to speak and does it matter?

Does it matter what they say or
who they say it to?

Similarity and difference in classrooms
around the world

Collaboration in the Classroom

Why encourage collaboration?

Creating the conditions for meaningful collaborative activity

Studying Collaboration in China

Collaboration as the key to promoting productive classroom talk

Challenging and engaging students

The value of student-student interaction

Developing proficiencies

Time to talk!

For more information, contact:

d.clarke@unimelb.edu.au