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Title	Solving mathematics problems with real-life contexts: A case about mobile plans
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Source	<i>5<sup>th</sup> Redesigning Pedagogy International Conference, Singapore, 3 - 5 June 2013</i>

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# Solving Mathematics Problems with Real-life Contexts: A Case about Mobile Plans

CRPP Conference: Redesigning Pedagogy

June 2013

## Speakers

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Download slides as pdf at:

<http://math.nie.edu.sg/kywong/>



## Overview

1. Importance of Solving Problems with Real-life Contexts
2. SMAPP Project
3. Problems with Real-life Contexts; two types
4. Mobile Plan Question
5. Implications

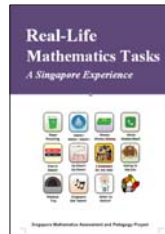
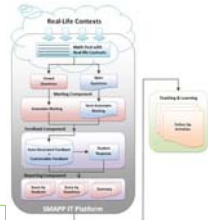


## Importance

- One aim of Singapore Mathematics Curriculum: Students
- *acquire mathematical concepts and skills for **everyday use** and continuous learning in mathematics*
- Similar ability in many mathematics curricula all over the world.



- Singapore Mathematics Assessment and Pedagogy Project
- Sep 2008 – Dec 2012
- IT assessment system
- Two types of maths problems with real-life contexts
- E-book: <http://hdl.handle.net/10497/11492>



Overview



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- Delivered through IT system.

Task Titles	Topics
Paper Recycling	Arithmetic <a href="#">sample</a>
Red or Black	Arithmetic, Algebra
Malacca Trip	Rate, Speed, Algebra, Inequalities
Water Water Water!	Mensuration, Statistics
Up Down Up Down!!	Statistics
Singapore Got Talent	Geometry
Money Money Money	Linear Graphs
Three Rockstars on the Wall	Angles, Parallel Lines
When to Retire?	Numbers, Algebra
Which Mobile Plan?	Statistics, Percentages
Outing to the Zoo	Data handling, Algebra

Overview



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- Day 2, 1615 – 1745: TR717, PAP145
- SMAPP extended tasks; Using mathematical disciplinary tasks to assess mathematical competencies with Singapore Secondary One students; Kok Ming TEO, WAI KWONG Cheang, DONGSHENG Zhao, Lianghuo FAN

Overview



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- “Standard” format; can be used in typical examinations
- 10 questions in two tests; Secondary 1 Express (Grade 7)
- Data collected in March & Sept 2011
- Sample size: 866

Overview



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## Everyday Mathematics Test

Q.	Context (Topic)	Facility Index (Mean as a % of Max Score)
1	Sale (Percentage, discount)	71.7
2	Tourism (Interpretation of table and pie chart, rate)	64.9
3	Kool Biscuits: Reduced fat (Percentage)	61.8
4	Population (Interpretation of table, significant figures, rate)	57.4
5	Types of fires (Interpretation of table, percentage change)	54.6
6	Decibels (Four operations, rate)	40.8
7	Earthquake (Powers of 2)	36.6
8	Mobile plan (Rate, line graph)	34.9
9	Hokkien char mee (Interpretation of chart, percentage)	26.1
10	Math Olympiad (Line graph, bar graph, misuse of graphs)	22.2

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## Mobile Plan Question: Ratings

- On a 4-point scale: Most relevant (3.1); very challenging (3.1); low confidence (2.1); fair interest (2.5).
- Interviewed 78 students; 68% as most relevant.
- *Because when I say this, I know how, now I know that how much when I use my handphone. I know how much I'll have to use and spend wisely. I can learn that you can get like different plans so that you can save money.*
- A problem can be challenging if: *it's more about asking you for your own opinion, so you need to really think through.*

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## Mobile Plan Question (a)

A Telco company offers the following two mobile phone plans to its customers.

Plan	SaverCall	ValueCall
Monthly Subscription	\$25.68	\$48.15
Free Outgoing Calls (minutes)	100	300
All Day Free Incoming Calls		
Local talk time (exceeding free outgoing call minutes)	16.05¢/ min	
Free Local SMS	500	
Local SMS (exceeding free SMS limit)	5.35¢	

(a) If a customer sent 700 local SMS in a particular month, how much did he have to pay for sending these SMS under each plan? Ignore the monthly subscription.

- (i) Under the SaverCall plan: \_\_\_\_\_ [1M] **[\$10.70; 32% ✓]**  
 (ii) Under the ValueCall plan: \_\_\_\_\_ [1M] **[\$10.70; 31% ✓]**

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## Mobile Plan Question (a): Results

	(a) (i)	(a) (ii)
Correct Answer + Working	9	5
Correct Answer, no Working	23	26
Wrong Answer + Working	18	16
Wrong Answer, no Working	43	46
Others	3	3
Blank	4	4

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## Mobile Plan Question (a): Reading?

- 10.3 %: added the monthly subscription to the cost of sending the SMS.

- M1F-2:**

(a) If a customer sent 700 local SMS in a particular month, how much did he have to pay for sending these SMS under each plan?

$$700 - 500 = 200 \quad 1070 \text{¢} + 100 = \$10.70 [2]$$

$$5.35\text{¢} \times 200 = 1070\text{¢}$$

$$10.70 + \$25.68 = \$36.38$$

(i) Under the SaverCall plan: ~~\$10.70~~ \$36.38

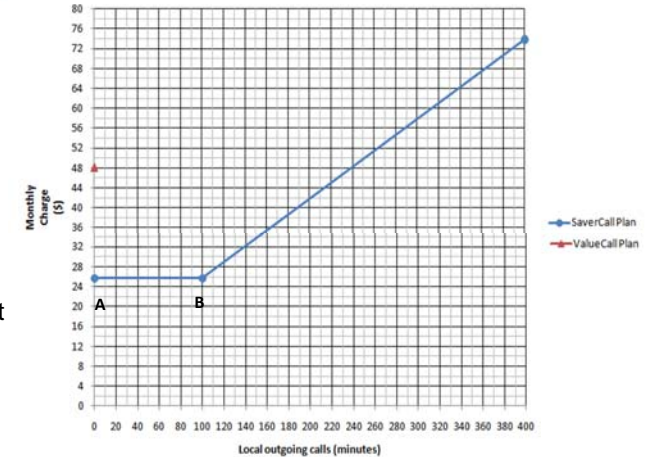
(ii) Under the ValueCall plan: ~~\$36.38~~ \$0.70 + \$48.15 = \$48.85

- B1B-15:** Because there's monthly subscription. So I thought for every month the bill come you must add the amount to it.
- Attend to instruction? Personal experience?



## Mobile Plan Question (b)

The graph below shows the monthly charges (subscription plus calls) for different local outgoing calls (minutes) for the SaverCall plan. Ignore the SMS sent for this question. Explain why the graph from A to B is horizontal.



No charge for first 100 minutes [1M; horizontal] as it is in the monthly subscription [1M; value \$25.68]



## Mobile Plan Question (b): Results

Free calls + Monthly subscription (2)	8
Free calls (1)	56
Incoherent, etc.	24
Blank	12

mean: 0.71

Ability to explain?  
Adequate explanation?

**M1F-9:**

Because there's this 'all day free incoming calls' that are placed together and it's the same, thus, it is horizontal.



## Mobile Plan Question (c) (i)

Plan	SaverCall	ValueCall
Monthly Subscription	\$25.68	\$48.15
Free Outgoing Calls (minutes)	100	300
All Day Free Incoming Calls		
Local talk time (exceeding free outgoing call minutes)	16.05¢/ min	
Free Local SMS	500	
Local SMS (exceeding free SMS limit)	5.35¢	

(c) Ignore the SMS sent for this question.

(i) Find the monthly charge (subscription plus calls) for making 400 local outgoing calls (minutes) under the ValueCall plan.

Extra calls:  $(400 - 300) \times 16.05\text{¢} = \$16.05$  [1M];

Add Subscription:  $\$48.15 + \$16.05$  [1M];

Final answer:  $\$64.20$  [1M]





## Mobile Plan Question (c) (i): Results

Great variety of incomplete workings, wrong answers  
Units: wrong conversion or missing, 5%

M1E-7: Extra zero!

$$\begin{aligned} 16.054 \times 100 &= 16054 \\ 48.15 &= 48054 \\ 1605 + 48015 &= 49620 \\ 49620 &= 49.62 \end{aligned}$$

M1F-13:  $100 \times 16.054 = 16054$   
 $\rightarrow = \$1.60$

3 marks	35
2 marks	7
1 mark	17
0 mark	19
Blank	22

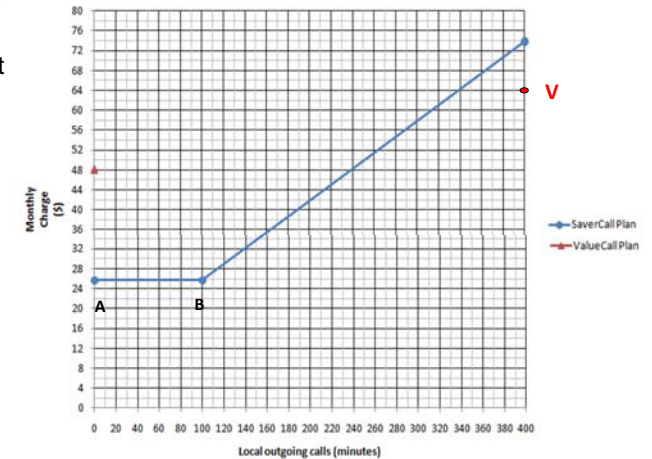
mean: 1.36



## Mobile Plan Question (c) (ii)

Ignore the SMS sent for this question.

(ii) On the graph, mark the point V to show the monthly charge for making 400 local outgoing calls (minutes) under the ValueCall plan. [2M]



(400, 64.2); must be at x = 400; y = 64.2 or c(i) value.



## Mobile Plan Question (c) (ii): Results

Correct (2 marks)	25; c(i) correct 7; c(i) wrong or blank
Wrong (0 mark)	53
Blank	15
V at x = 400	18
Both coord wrongly plotted	15
V not plotted, line passes through it	9

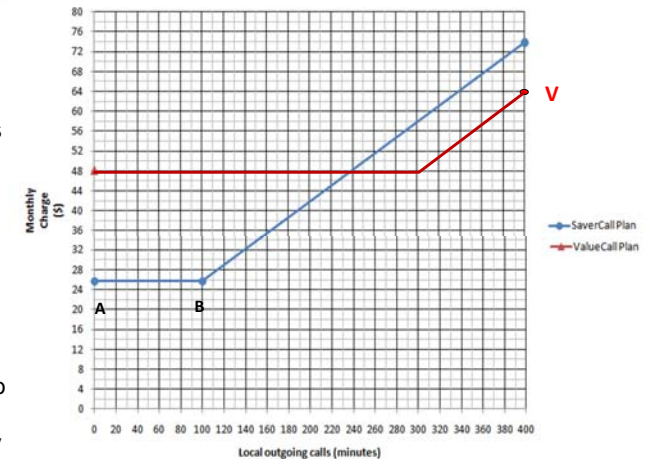
mean: 0.64

- Some students not confident of location of point.
- Some did not see link between (c) (i) and (ii).



## Mobile Plan Question (c) (iii)

(iii) On the graph, plot the line to show the monthly charges under the ValueCall plan to cover local outgoing calls (minutes) from 0 minutes to 400 minutes. [3M]



Horizontal (0, 48.15) to (300, 48.15) [1M]

Slant (300, 48.15) to V [1M]

Neat, accurate [1M]



## Mobile Plan Question (c) (iii): Results

3 marks	20 (all correct) 15 (correct line, V wrong label, missing)
2 marks	6
1 mark	17 (mainly horizontal)
0 mark	21
Blank	21

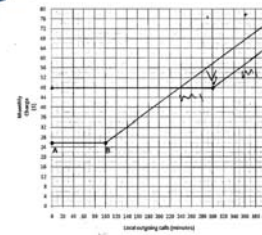
mean: 1.34

- Great variety of wrong lines, labels, etc.
- Most graphs were neat and accurate.

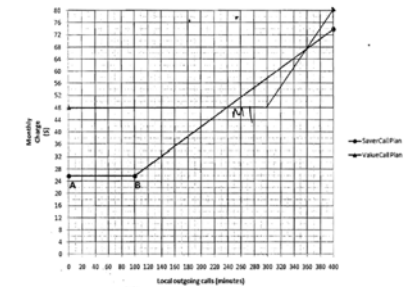


## Mobile Plan Question (c) (iii); Samples

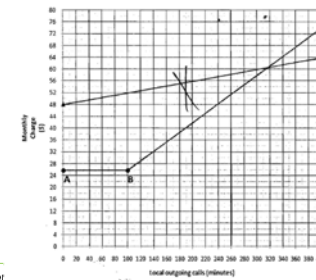
Ok, wrong label for V.



Partial, correct shape.



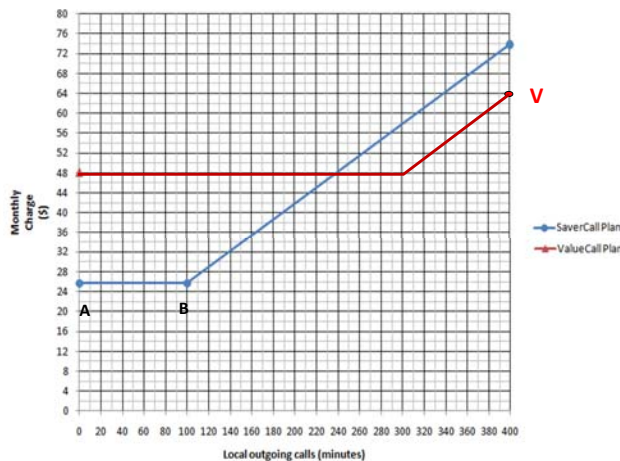
No credit, wrong shape.



## Mobile Plan Question (d)

(d) If you make 260 minutes of local outgoing calls per month, which is a cheaper plan? Ignore the SMS sent.

Explain how you arrive at your answer by referring to the two graphs only, without further calculations. [2M]



Explanation must refer to graphs.

2M: point of intersection, location of lines, etc.

1M: correct direction.



## Mobile Plan Question (d): Results

2 marks	8
1 mark	5
0 mark	50
Blank	37

mean: 0.20

- 58% correctly selected ValuePlan, only 7% obtained full credit for explanation
- 15% used the information in table instead of graphs
- 8% chose SaverPlan; wrong

Saver Call  
 $260\text{min} - 100\text{min} = 160\text{min}$   
 $160\text{min} \times 16.05\$/\text{min} = 2568\$/$   
 $\$25.68$   
 $\$25.68 + 25.68 = \$51.36$

Value Call  
 do not need to pay for phone call because 300 minutes is free and only 260 minutes of calls are made. Hence, only need to pay \$48.15.

Ans: ValueCall.



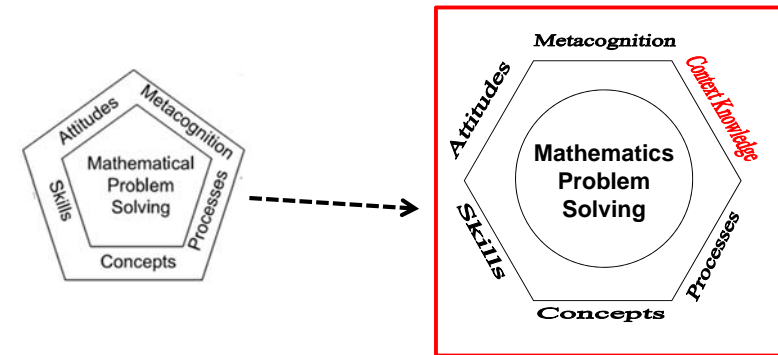
## Implications: Teaching

- Poor explanations; “could reflect an underdeveloped mathematical thinking, underdeveloped language skills, or both” (Staples & Truxaw, 2012, p.277); provide opportunities to solve similar tasks
- Graphs: Translate answers to graphs, gather information from graphs, unfamiliar graphs
- Follow instructions
- Units (dollars and cents)



## Implications: Curriculum Framework

- Familiar vs. novel contexts; gain knowledge about new real-world contexts
- An enhanced curriculum framework?



## Implications: Research

- Interview to probe problem solving strategies
- Extend to more topics, other mathematical processes



## Abstract

The ability to solve mathematics problems with real-life contexts is an important goal of mathematics education in numerous countries. The 2013 Singapore mathematics curriculum states that “Students should have opportunities to apply mathematical problem-solving and reasoning skills to tackle a variety of problems, including open-ended and real-world problems”. Research is needed to assess this ability in a variety of everyday contexts in order to give teachers strong evidence about the success and difficulties students encounter when they solve these “everyday” mathematics problems.

This paper reports on how 860 Secondary 1 Express students in Singapore solved a problem about selecting a mobile plan from two given phone plans. This problem is relevant to students of this age group, and it requires simple computations and graph skills. The overall mean score was low, being 5 out of 14 maximum possible marks. The students had difficulty with explaining their thinking and working with graphs that looked different from the standard ones. Implications for teachers include planning meaningful lessons to take into account student ability, helping students to work with extended work problems, and designing appropriate everyday mathematics problems to evaluate skills covered in the syllabus. Future research should include task-based interviews to understand student thinking when they solve this type of problems

