



INTERDISCIPLINARY MATHEMATICS AND SCIENCE TEACHING THROUGH REAL-WORLD TASKS

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BACKGROUND (1)



“disciplines cannot and should not be taught in isolation, just as they do not exist in isolation in the real world of the workforce” (p. 9).

(The STEM Task Force Report (2014, p.9))

REAL-WORLD TASKS

- Central to the inquiry approach in mathematics and science. (Hubber, Tytler, & Haslam, 2010; Stillman, 2013)
- Potential to engage students in meaningful learning (Kaiser & Maaß, 2007; Widjaja, 2010).

AN EXAMPLE OF INTERDISCIPLINARY CURRICULUM PLAN FOR THE SOLAR SYSTEM

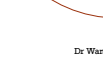

SCIENCE

How are planets similar and how are they different?
How do the inner terrestrial planets differ from the "gas giants"?

Size and distance Scale

MATHEMATICS
Scale models

If we use the same ratio for the size and distance, how large should each planet be? Where should they be placed?





AN INTERDISCIPLINARY APPROACH: WATER CONSUMPTION

Product/Service	Amount
Usage Charges <i>This is an estimated amount. Please call us on 1800 305 696</i>	\$107.99
Water Supply System Charge	\$43.06
Sewerage System Charge	\$88.68
Yarra Valley Water Total	\$239.73
Other Authority Charges	
Waterways and Drainage Charge on behalf of Melbourne Water	\$23.87
TOTAL (GST does not apply)	\$261.60



COMPARE YOUR USAGE →

Your average usage in litres per day



Compare usage last year 2015
This Account 2016

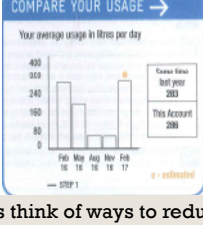
STEP 1 e-estimated

AN INTERDISCIPLINARY APPROACH: WATER CONSUMPTION

COMPARE YOUR USAGE →

Your average usage in litres per day



Compare usage last year 2015
This Account 2016

STEP 1 e-estimated

ACCOUNT DETAILS

Water Usage from 01/12/2016 to 01/02/2017

Water number	Current reading	Previous reading	Usage
00012345	12345	11900	445

In 10 days you used 34 litres, reading 200 litres per day. The table (L) equals 1,000 litres.

Usage

Step	Current value	Previous value	Change
STEP 1	34.000L	33.000L	0.999L

*Usage may differ if recently taken or check an adjusted according to the days in your meter reading period, and applied to daily flows.

*The reading has been calculated based on the usage history.

Usage Readout from 01/12/2016 to 01/02/2017



For the historical and estimated average flow per property, it is based on your water usage and adjusted for seasonal variations.

Usage	Current value	Previous value	Change value
30.000L	0.000L	22.200L	7.800L
Usage volume	Usage value	Usage	
0.000L	0.000L	0.000L	

Total flow volume 0.000L

Let us think of ways to reduce your water consumption.

Design an experiment to test if your way of reducing water consumption works. Present your evidence to your class to convince them your solution works.

AN INTERDISCIPLINARY APPROACH: WATER CONSUMPTION

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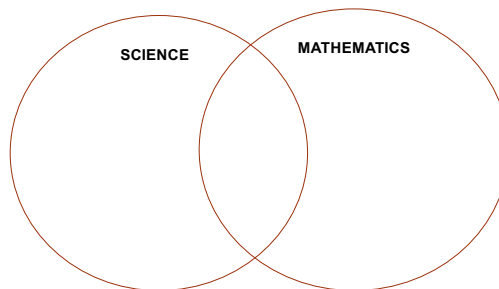
What information can you find out from this water bill?
How do you plan to investigate this?
What representations will you use to convince others that your solution works?



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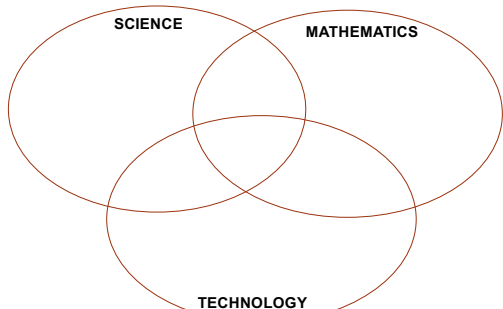
Please identify any links between science and mathematics in 'Water consumption' task.
List key concept(s) students will explore in this task.



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YOU MIGHT IDENTIFY ANOTHER DISCIPLINE THAT STUDENTS WILL EXPLORE. IF SO, PLEASE REPRESENT IT



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EXPLORATION AS A STARTING POINT

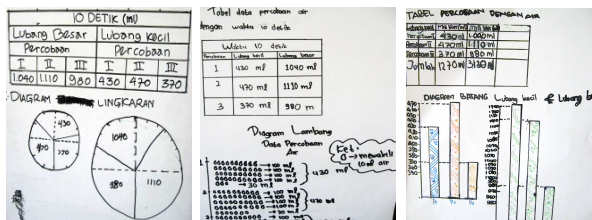
You are going to collect data of water flowing through two plastic bottles with different size of holes in 10 seconds. For each bottle, you should collect the data three times. Your task as a group is to represent the data so that others could understand them. Please think of as many different ways as you can to represent the data.



© Widjaja, W., Julie, H., Prasetyo, A.B. (2009). *Potret dan Kajian Proses Pembelajaran Matematika di Beberapa SD PMRI*. Laporan Penelitian Hibah Strategi Nasional DIKTI 2009 Nomor: 378/SP2H/PP/DP2M/VI/2009.

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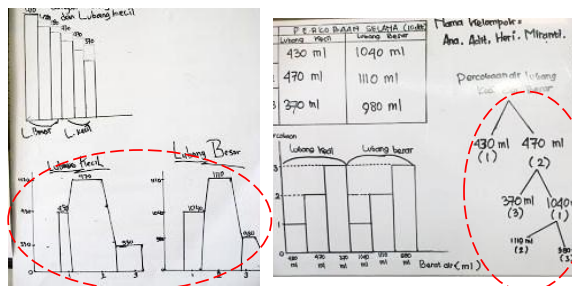
VARIOUS DATA REPRESENTATIONS



© Widjaja, W., Julie, H., Prasetyo, A.B. (2009). *Potret dan Kajian Proses Pembelajaran Matematika di Beberapa SD PMRI*. Laporan Penelitian Hibah Strategi Nasional DIKTI 2009 Nomor: 378/SP2H/PP/DP2M/VI/2009.

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WHAT DOES 'DIFFERENT' MEAN?



misinterpreted 'different' representations as any representations that "look different"

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EXERCISING CLASSROOM SOCIAL MATHEMATICAL NORMS



Revisiting the use of tree diagram (Widjaja, W., 2012, p. 34)

Andi: This is just *copying a model of the tree diagram* that is commonly used to factorise numbers.

Sinta: What do you mean by 1, 2, and 3?

Andi: These numbers 1, 2, and 3 refers to the order of experiments, data from experiment 1, of experiment 2, and of experiment 3.

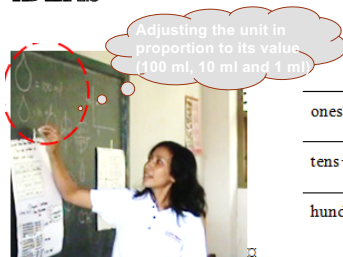
Jose: How do you differentiate the data from the small and the big holes?

Andi: The ones below are data of experiments using the big hole.

Hari: I don't understand.

Widjaja, W. (2012). Exercising sociomathematical norms in classroom discourse about data representation: Insights from one case study of a grade 6 lesson in Indonesia. *The Mathematics Educator* 13(2), 21-38

INTERPRETING STUDENTS' IDEAS



Adjusting the unit in proportion to its value (100 ml, 10 ml and 1 ml)

	☐
ones ☐	○○○○
tens ☐	○○○
hundreds ☐	○

"No, that was not what I had in mind"
(Jose)

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MODELLING A COOLING OFF COFFEE

Cooling of Coffee Project

How does a cup of hot coffee cool with time? Is it possible to model the cooling of coffee?

1. List factors or variables in the problem.
2. Collect data to help construct a model. Record your data.
3. What is a suitable model? (Look for an existing model to develop one).
4. What is your method of solution?
5. Carry out your solution method and interpret the solution.
6. Examine assumptions and suggest ways to refine the model

Figure 1. The Cooling of Coffee Project (Keng-Cheng, 2009, 36-37).

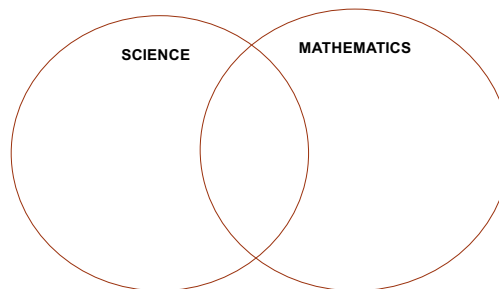


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Please identify any links between science and mathematics in 'Modelling a cooling off coffee' task.

List key concept(s) students will explore in this task.



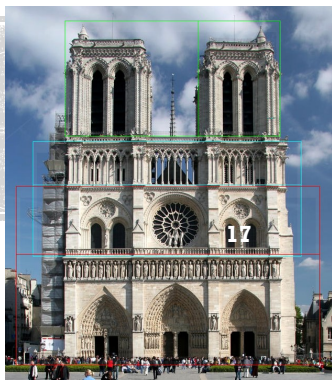
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Phi and the Golden Section in Architecture

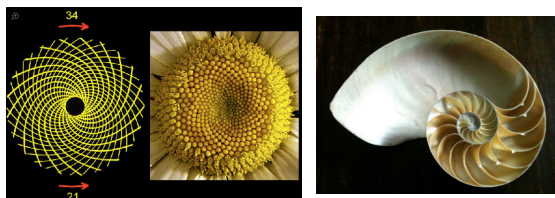
<http://www.goldennumber.net/architecture/>

Phi (Φ), the Golden Section, has been used by mankind for centuries in architecture



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THE GOLDEN RATIO IN NATURE



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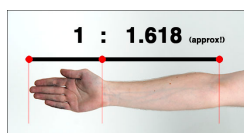
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RATIO IN HUMAN BODY

Let's investigate the ratio of:

- The length of your foot to the length from your wrist to your elbow.
- The wrist circumference to the neck circumference

Dole, S. (2008, p. 18)



<http://nrich.maths.org/7668>

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DISCUSSION



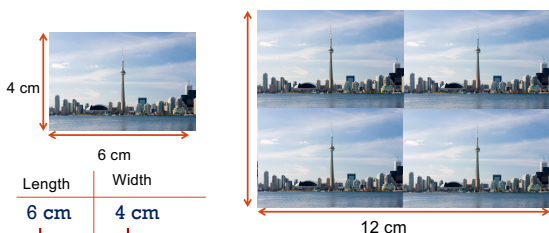
If the photo is enlarged so that it is now 12 cm long, how wide will it be?

What is the area of the paper if we are to print this new photo?

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DISCUSSION



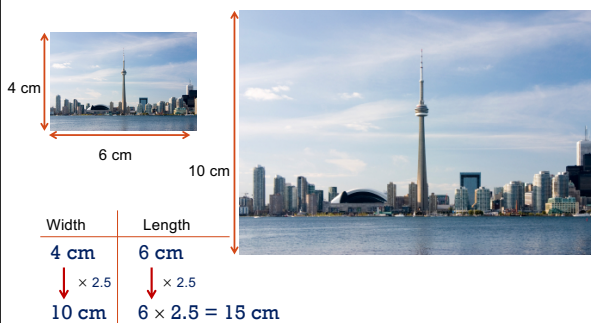
A common misconception is $4+6=10$ by using additive thinking. ❌

The area of the paper to print this new photo is 4 times of the area of paper to print the original photo.

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DISCUSSION

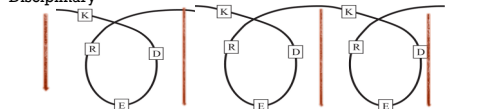


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increasing levels of integration

Disciplinary Multidisciplinary Interdisciplinary Transdisciplinary



Students learn concepts and skills separately in each discipline

Students learn concepts and skills separately in each discipline, but in reference with a common theme

Students learn concepts and skills from two or more disciplines that are tightly linked so as to deepen knowledge and skills

By undertaking real-world problems or projects students apply knowledge and skills from two or more disciplines

A continuum of STEM approaches to curriculum integration adapted from Vasquez, Snider, & Comer, 2013 (p. 73)



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