Developing Mathematical Proficiency
The potential of different types of tasks for student learning

Handouts

Contents

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Handout 1: The Five Strands of Mathematical Proficiency

Conceptual Understanding	The comprehension of mathematical concepts, operations, and relations.	• Enables students to connect ideas to what they already know • Supports retention and prevents common errors
Procedural Fluency	Skill in carrying out procedures flexibly, accurately, efficiently, and appropriately.	• Learning procedures can strengthen and develop mathematical understanding, while understanding makes it easier to learn skills
Strategic Competence	The ability to formulate, represent, and solve mathematical problems.	To come up with answer to a problem, students must: • follow a solution method and adapt as necessary • understand the quantities in the problem and their relationships • represent the relationships mathematically • have the mathematical skills required to solve the mathematical problem
Adaptive Reasoning	The capacity for logical thought, reflection, explanation, and justification.	As students reason about a problem they can: • build their understanding • carry out the needed computations • apply their knowledge • explain their reasoning to others
Productive Disposition	The habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy.	Requires frequent opportunities to: • make sense of mathematics • recognize the benefits of perseverance • experience the rewards of sense making in mathematics

Adapted from: https://mathequality.wordpress.com/2012/06/25/nrcs-five-strands-of-mathematical-proficiency/

Handout 2: Task A

Percent Change Game

Use these 12 numbers to fill in the gaps below.

10, 20, 25, 35, 40, 50, 60, 70, 75, 80, 90, 100

$____ increased by ____% = $____

$____ increased by ____% = $____

$____ decreased by ____% = $____
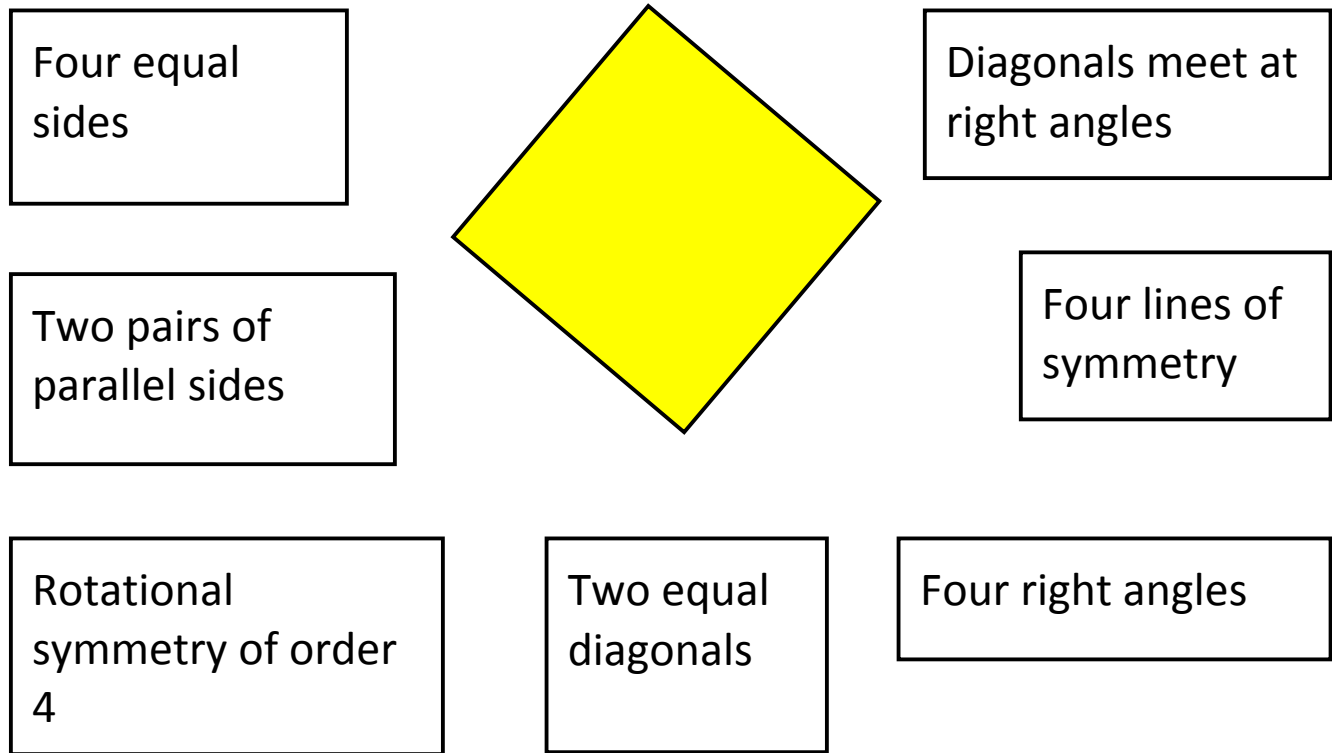
$____ decreased by ____% = $____

You score a point for each number **used only once** – and in a correct expression.

Try to get the highest score you can.

(Maximum score: 12 points)

Adapted from http://www.foster77.co.uk/Percentage%20Change%20TASK%20SHEET.pdf

Handout 3: Task B

Describing and Defining a Square

| Four equal sides |

| Two pairs of parallel sides |

| Diagonals meet at right angles |

| Four lines of symmetry |

| Rotational symmetry of order 4 |

| Two equal diagonals |

| Four right angles |

Which *pairs* of statements *define* a square? Which do not?

A lesson called 'Describing and Defining Quadrilaterals' based on this task, can be found on the Mathematics Assessment Project website (http://map.mathshell.org/)

Handout 4: Task C

Always, Sometimes or Never True?

Here is a collection of mathematical statements or conjectures:

If you add the same number to the top and bottom of a fraction, the fraction increases in value.	If you divide the top and bottom of a fraction by the same number, the fraction gets smaller in value.
If you multiply 12 by a number, the answer will be greater than 12.	If you divide 12 by a number, the answer will be less than 12.
Prices increased by 20%. They then decreased by 20%. There was no overall change in prices.	Jill got a pay rise of 3%. James got a pay rise of 2%. Jill therefore got the greater pay rise.

Consider each statement in turn and decide whether it is always, sometimes or never true.

- If it is always true, show some examples, and then try to provide an explanation as to why it is always true.
- If it is never true, explain why.
- If it is sometimes true, give examples and define precisely when it is true and when it is not true.

Handout 5: Task D

Schoolteachers and Dentists

There are about 320 million people in the US.

- About how many school teachers are there?
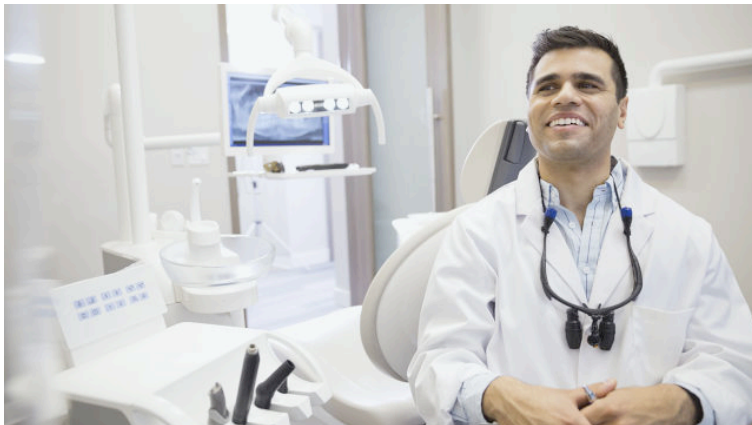
- About how many dentists are there?

Estimate some other facts and check them out.

Adapted from http://www.bowlandmaths.org.uk/pd/pd_01.html

Handout 6: Reflection

Think about tasks that are already in use (either by you or well known tasks) and categorise them under the five strands of mathematical proficiency:

Description of Task	Conceptual Understanding	Procedural Fluency	Strategic Competence	Adaptive Reasoning	Productive Disposition

Which of the five strands of mathematical proficiency do students currently have the most opportunity to develop in your classroom?

Describe how you plan to include a balance of the mathematical proficiency strands in your curriculum over the coming weeks.