OPEN MIDDLE PROBLEMS

 "Open Middle" problems refer to a specific type of problem design that has been popularized on https://www.openmiddle.com/.. Thanks to Open Middle Lead and Co-Founder Robert Kaplinsky for permitting us to include references to Open Middle in *MathLinks*. They appear in the Review section of many *MathLinks* packets, and in many Packet Resource sections (Essentials Skills or Nonroutine Problems) on the Teacher Portal.

Open Middle problems typically include:
- a "closed beginning," meaning that each problem starts with a particular prompt and structure;
- a "closed end," meaning that each problem ends with a correct answer or set of equally correct answers;
- an "open middle," meaning that there are multiple pathways or approaches for solving the problem.

Why: Open Middle problems appear to be procedural in nature, but turn out to be more challenging once students begin to solve them (i.e. higher depth of knowledge than traditional practice). Often it is relatively easy to find a result fitting the structure, but quite difficult to find an optimal or target result. At the very least, students do a large amount of skills practice when thinking that they are only doing one problem. At best, students are thinking deeply about the structure of the problem, and making and testing conjectures.

Prepare ahead: Try the problem before assigning it to gain insight into the strategies and struggles students may encounter. Think about good questions to ask to promote thinking and perseverance, and to help students get "un-stuck."

Launch the activity: Use below-grade level open middle problems to help students gain confidence and establish norms for discussion.
- Write the problem on the board or distribute it on paper.
- Give students time to work alone first.
- Ask students to share solutions, and record them on the board for discussion.
- Encourage students to share strategies and generalize when appropriate.

Accountability/Follow-up:
- Consider sending an open middle problem home for families to work on together.

OPEN MIDDLE PROBLEM: DIVIDING BY A ONE DIGIT NUMBER

Use the digits 1 through 9 at most one time each.

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1. Fill in the boxes to create any whole number quotient.
    Answers will vary. For example, 126 ÷ 3 uses 4 different digits -> the result is 42

2. Fill in the boxes to create the greatest whole number quotient.
    Greatest: 987 ÷ 1 uses 4 different digits -> the result is 987

3. Fill in the boxes to create the least whole number quotient.
    Least: 126 ÷ 9 uses 4 different digits -> the result is 14

 *Let us know if you find a better answer.

OPEN MIDDLE: FRACTIONS AND DECIMALS

Use the digits from 0 to 9 at most one time each.
It is "fair game" for students to discuss whether or not
rounding is allowed.

$$\frac{\Box}{\Box} = \Box.\Box$$

1. Create any fraction and decimal that are equivalent.
    Answers will vary. For example, $\frac{2}{4}$ = 0.5; $\frac{6}{2}$ = 3.0; $\frac{6}{5}$ = 1.2
    both examples use 4 different digits)

2. Create the largest decimal value.
    Largest: $\frac{9}{2}$ = 4.5
    (the example uses 4 different digits)

3. Create the smallest fraction value.
    Smallest: $\frac{1}{5}$ = 0.2 (exact); $\frac{1}{6} \approx$ 0.2 (rounded)
    (these examples use 4 different digits)

 *Let us know if you find a better answer.