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COLLABORATIVE PROBLEM SOLVING

Collaborative Problem Solving is process in which teachers *facilitate* students' learning through the Standards for Mathematical Practice and productive persistence. Students use precise terms and clear statements to verbally articulate the meaning of a problem and possible solution pathways. After solving and writing a draft to justify solution strategies and reasoning, students share responses. Second drafts are completed. Using Collaborative Problem Solving; your students will *live* the Mathematical Practices in a risk-free environment as they learn independence, self-reliance, and resourcefulness.

Collaborative Problem Solving

- Empowers students to reflect on their own thinking and learning
- Enables teachers to analyze student thinking for instructional implications
- Aligns with the Common Core Standards for Mathematical Practice and Productive Persistence
- Can be used in K-12 classrooms

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Collaborative Problem Solving moves through **Polya's** four stage problem solving process:

1. Understand: Identify what is unknown and what is known.
2. Plan: Develop a plan based on what is unknown and known.
3. Solve: Execute the plan.
4. Look Back: Assess the solution's reasonableness by re-contextualizing it.

Guiding questions for Polya's problem solving stages

Understand:	**Plan:**
1. How would you restate the problem in your own words, *without using numbers*? 2. What do you need to find out and what do you know? 3. In what ways can you use a previous problem solving (or life) experience to help you understand this problem?	1. Which *strategy* will you choose to solve? Diagram or drawing? Solve a simpler problem? A combination of more than one? Explain your choice. 2. Which *method* will you use to solve? Paper and pencil? Mental math? Explain. 3. What predictions can you make about the answer? Explain your reasoning.
Solve	**Look back**
1. Which strategy did you execute? Did you switch strategies? Explain. 2. What was the most challenging part of solving? How did you face the challenge? 3. Which skills and concepts did you utilize to help you solve the problem?	1. How can you tell if your answer makes sense? 2. What ideas and concepts did you use to (a) solve the problem and (b) assess its reasonableness? 3. What are some other ways to solve this problem?

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Collaborative Problem Solving involves and engages every student in the class. Problems should be constructed so that the solution can be obtained using a variety of pathways. The Collaborative Problem Solving process:

Understand: (1) A problem is presented to the class. Students think independently about how they would paraphrase the problem without using numbers. (2) They share with a partner or in small groups. (3) Students come to consensus as a class. All students demonstrate comprehension of the problem.

Plan: (1) Students think about how they would solve the problem *without solving it* and then verbally exchange solution *strategies* in small groups. (2) The entire class reconvenes to discuss and compare solution strategies. Embedded in discussions are appropriate math vocabulary and sense-making justifications.

Solve: (1) Students solve the problem independently. Using a rubric as a guide, students write a paragraph describing their solution strategies and justifying their answers. (2) One or two volunteers, selected by the teacher for the clarity and quality of their responses, read their first drafts to the class. Using the rubric as a guide, students score their classmates' responses. (3) Through a class discussion, students collaborate to upgrade the responses to full-credit anchor papers. This third discussion about the original problem solidifies conceptual understanding for the majority of students.

Rubric: Is my response complete?

Full credit response

- The question posed is answered clearly and completely in a topic sentence.
- The solution is correct.
- Math terminology is appropriately used.
- The solution is explained step by step.
- The solution is justified using re-contextualizing and includes a "check" or explanation using logical reasoning.

Look back: (1) All students reflect on the discussions and the anchor paper(s) they created as a class. (2) All students write a second draft.

Teacher Reflection Students' work is complete, but the reflection process is just beginning for the teacher. Once teachers read students' papers, she takes time to *think about* students' responses. She ponders:

- Did my students understand the problem?
- What solution strategies were used? What does that reveal about students' conceptual understanding?
- What terminology did students use? What terms did they neglect to use?
- Did the explanatory paragraph clearly articulate the process and rationale for the solution?

The answers to these questions inform and drive instruction, both for work with the Standards for Mathematical Practice *and* the Content Standards for the coming days and weeks.