Prepare problems and use them in whole-class instuction

Teachers should set aside time for problem-solving activities with the entire class instead of limiting problem-solving to individual homework assignments. Teachers should try to include a variety of problems in these activities. Finally, teachers should ensure that students understand the language, context, and math concepts of the problems included in lessons and homework.



How to carry out the recommendation

- 1. Include both routine and nonroutine problems in problem-solving activities.
- 2. Ensure that students will understand the problem by addressing issues students might encounter with the problem's context or language.
- 3. Consider students' knowledge of math content when planning lessons.

Potential roadblocks

- 1. Teachers are having trouble finding problems for the problem-solving activities.
- 2. Teachers have no time to add problem-solving activities to their math instruction.
- 3. Teachers are not sure which words to teach when teaching problem-solving.

Reference: Woodward, J., Beckman, S., Driscoll, M., Franke, M., Herzig, P., Jitendra, A., Koedinger, K. R., & Ogbuehi, P. (2018). *Improving mathematical problem solving in grades 4 through 8* (NCEE 2012-4055). U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance. <u>https://ies.ed.gov/ncee/wwc/PracticeGuide/16</u>





How to carry out the recommendation

1. Include both routine and nonroutine problems in problem-solving activities.

Routine problems can be solved using approaches that students have already learned. Nonroutine problems, on the other hand, require using approaches that students are less familiar with or that are less obvious from the problem. When the goal of a lesson is to help students understand the meaning of an operation or mathematical idea, teachers should select routine problems. Routine problems do not necessarily have to be simple—they also can be complex, multistep problems that involve problem-solving approaches students are already familiar with. When the goal of a lesson is to develop students' ability to think strategically, teachers should select nonroutine problems.

Example of a routine problem for a student who has learned about solving linear equations

Solve for *x*: 20 + 8x = 60

Note. Adapted from page 12 of the practice guide referenced on the first page of this document.

Example of a nonroutine problem for a beginning algebra student

There are 20 people in a room. Everybody high-fives with everybody else. How many high-fives occurred?

Note. Adapted from page 12 of the practice guide referenced on the first page of this document.

2. Ensure that students will understand the problem by addressing issues students might encounter with the problem's context or language.

The problems a teacher selects for a lesson may include unfamiliar vocabulary or contexts, making it challenging for students to focus on the math content. This is a particularly critical issue for English learners and students with disabilities. To ensure students' understanding without lessening the mathematical challenge, teachers can:

- Choose problems with language or contexts that are appropriate for the students' background.
- Clarify unfamiliar language or contexts in existing problems.
- Reword problems that contain unfamiliar words or phrases for students.

3. Consider students' knowledge of math content when planning lessons.

Teachers should consider the concepts, skills, and vocabulary their students will need to solve problems included in lessons. For example, when finding the area of a circle, students may need to review the definitions of *radius* and *pi* as well as the concepts of *perimeter* and *area*. A brief review of the skills and vocabulary needed to understand and solve a problem may not only benefit struggling students but also help all students see how the knowledge they already have applies to more challenging problems.

Potential roadblocks and how to address them

Roadblock	Suggested Approach
Teachers are having trouble finding problems for the problem-solving activities.	Teachers can reference supplementary materials (for example, books on problem-solving), ask colleagues for additional problem- solving activities, or search the internet for examples. Useful resources on the internet include "Problems of the Week" from the Math Forum (<u>https://www.nctm.org/mathforum/</u>), and practice problems from standardized tests such as the PISA (<u>http://www.oecd.org/pisa/</u>), SAT (<u>https://collegereadiness.collegeboard.org/sat/practice</u>), or TIMSS (<u>https://nces.ed.gov/timss/</u>).
Teachers have no time to add problem-solving activities to their math instruction.	To make time during lessons, teachers can replace some of the problems students are required to solve during seatwork with fully solved problems that students can review and use as problem- solving models.
Teachers are not sure which words to teach when teaching problem- solving.	Math coaches and specialists can provide lists of word and phrases essential for teaching a given unit. Teachers can also work with colleagues to identify words students need to understand and solve problems. They can also look for important terms in class textbooks or state math standards.



For more information on the research evidence and references to support this recommendation, or for more detailed explanation from the What Works Clearinghouse committee who developed this recommendation, please refer to the practice guide cited at the bottom of the first page of this document.