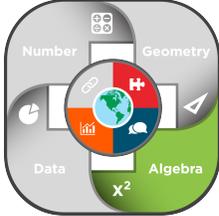


## Teach students to intentionally choose from alternative algebraic strategies when solving problems



*Students benefit from learning multiple algebraic strategies to bring to bear on problem-solving. Strategies are more general and abstract than memorized algorithms. Using strategies both requires students to have and provides them with more flexibility in solving problems. Students should not be expected to memorize all possible strategies but have access to multiple strategies for a given problem.*

### How to carry out the recommendation

1. Teach students to recognize and generate strategies for solving problems.
2. Encourage students to articulate the reasoning behind their choice of strategy and the mathematical validity of their strategy when solving problems.
3. Have students evaluate and compare different strategies for solving problems.

### Potential roadblocks

1. I'm worried about confusing my students by teaching them multiple strategies for solving a problem. They have a hard enough time learning one strategy! Isn't it easier for them to master one strategy for solving algebra problems?
2. My special education students need a very structured process for solving algebra problems. Introducing multiple strategies and asking students to choose among strategies might be hard on them.
3. I can't seem to teach my students multiple strategies without them becoming confused. I presented and compared five algebra strategies for solving quadratic equations during one class period, and my students didn't understand. What should I do?
4. Teaching students to use and compare multiple strategies requires knowledge of many strategies and our textbook presents only one strategy.
5. How can I stay on schedule teaching everything required to meet state standards and still have time to teach students to use multiple strategies?



*Reference:* Star, J. R., Foegen, A., Larson, M. R., McCallum, W. G., Porath, J., & Zbiek, R. M. (2019). *Teaching strategies for improving algebra knowledge in middle and high school students* (NCEE 2015-4010). U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance.  
<https://ies.ed.gov/ncee/wwc/PracticeGuide/20>



## *Recommendation 3: Teach students to intentionally choose from alternative algebraic strategies when solving problems*

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### How to carry out the recommendation

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#### **1. Teach students to recognize and generate strategies for solving problems.**

Teachers can provide well-known, as well as lesser-known, strategies for approaching algebraic problems so that students can observe which are effective and efficient in various cases. Teachers should provide solved problems to demonstrate multiple strategies for a single problem as well as strategies that are effective across multiple problems. Doing so will reinforce the flexibility of strategy use. In both whole-class instruction and partner work, students should discuss and communicate why a particular strategy is useful. The practice guide referenced on the first page of this document provides examples for teachers to examine:

- Example 3.1 on page 28 presents conventional and alternative solution strategies for several problems.
- Example 3.2 on page 29 shows two students using different strategies to solve the same problem and includes prompts that teachers might use to encourage discussion and deeper analysis.
- Example 3.3 on page 29 presents two different problems solved using the same strategy and includes solution steps, labels for those steps, and verifications of the solutions.

Teachers should introduce one or two strategies at a time to allow students to process new information. They should then work with students to determine which strategies are most effective and efficient through reflective questions that teachers provide or students develop themselves. Students should begin by examining solved problems and then discuss and select strategies for solving other problems during group and individual work. Finally, after students solve a problem, teachers can challenge them to use a different strategy to solve it.

- Example 3.5 on page 31 in the practice guide referenced on the first page of this document presents multiple strategies for solving quadratic equations and possible solutions using those strategies.
- Example 3.6 on page 32 presents multiple strategies for solving linear equations and possible solutions using those strategies.

#### **2. Encourage students to articulate the reasoning behind their choice of strategy and the mathematical validity of their strategy when solving problems.**

To help students better understand their choices and goals in problem-solving, teachers should provide multiple opportunities to analyze problem structures, determine solution strategies, describe reasoning while solving problems, and analyze other students' solution strategies. Students should demonstrate their strategic thinking for each step of the solution process, both verbally and in writing. Teachers can provide a model as well as a list of guiding questions such as "What do you notice about the structure of this problem?" and "How does that point you toward a particular strategy to solve it?" Students can work in pairs or small groups while teachers monitor for missteps and misconceptions.

## Recommendation 3: Teach students to intentionally choose from alternative algebraic strategies when solving problems

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### Prompts to encourage students to articulate their reasoning

- What did you notice first about the problem structure? How did that influence your solution strategy? What strategy is appropriate for solving this problem, and why?
- What choices did you have to make in solving this problem?
- What goal were you trying to achieve?
- How did you get your answer? How do you know it is correct?
- Describe to another student how to solve this problem.
- What was most difficult about this problem? Did you run into any challenges? If so, what did you do to overcome them?

*Note. Taken from Example 3.7 on page 33 in the practice guide referenced on the first page of this document.*

### 3. Have students evaluate and compare different strategies for solving problems.

Once students have mastered a strategy, teachers should have them make comparisons across similar and different problem structures and strategies to identify relationships. Teachers should support students in considering how a solution strategy is similar to and different from others they have encountered. Teachers could encourage students to think about the accuracy, efficiency, and applicability of various problem-solving strategies. Guided discussion using worked problems can be helpful as students move from teacher-mediated to more individual work.

## Recommendation 3: Teach students to intentionally choose from alternative algebraic strategies when solving problems

### Potential roadblocks and how to address them

Roadblock	Suggested Approach
<i>I'm worried about confusing my students by teaching them multiple strategies for solving a problem. They have a hard enough time learning one strategy! Isn't it easier for them to master one strategy for solving algebra problems?</i>	Students are not expected to become experts in all strategies but to clarify their thinking when choosing the most appropriate one for a given problem. Teachers can focus on teaching one strategy at a time and then ask students to compare a new strategy with an established one. Different students may be more comfortable with certain strategies, so allowing them to explore multiple strategies will be helpful.
<i>My special education students need a very structured process for solving algebra problems. Introducing multiple strategies and asking students to choose among strategies might be hard on them.</i>	Teachers can provide explicit instruction to students with disabilities while still teaching them alternative strategies. Instruction should include both the steps and a clear rationale for application. Asking students to simply memorize a single strategy without building their understanding of how and why it is appropriate to a given problem type will lead to challenges for students in special education.
<i>I can't seem to teach my students multiple strategies without them becoming confused. I presented and compared five algebra strategies for solving quadratic equations during one class period, and my students didn't understand. What should I do?</i>	Students may not need diagrams to solve problems, but they will need them to notice and understand structural components. Make this explicit to students and continue to model the use of diagrams.
<i>Teaching students to use and compare multiple strategies requires knowledge of many strategies and our textbook presents only one strategy.</i>	The full practice guide provides lists of strategies for quadratic and linear system equations. Teachers can share strategies with one another in professional learning communities and create class posters or handouts for their students to access.
<i>How can I stay on schedule teaching everything required to meet state standards and still have time to teach students to use multiple strategies?</i>	Teachers can incorporate alternative and multiple strategies into existing lessons to develop students' critical thinking and algebraic reasoning. The focus should be on helping students reason algebraically and recognize when an alternative strategy might provide a solution that is more effective or efficient.



*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.*