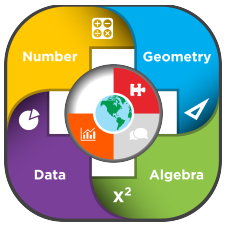
This document provides a summary of **Recommendation 3** from the WWC practice guide *Improving Mathematical Problem Solving in Grades 4 Through 8*. Full reference at the bottom of this page.

Teach students how to use visual representations



Translating quantitative information into an algebraic or arithmetic form is a critical component of the problem-solving process. Students who learn how to represent this information visually before translating it into an algebraic or arithmetic form tend to be more effective at problem-solving. When teaching students to use visual representations (e.g., graphs, diagrams, number lines, and tables), teachers should choose visuals that are appropriate for the problem at hand and their students, then use them consistently for similar problems so as not to overwhelm students with too many differing examples.

How to carry out the recommendation

1. Select visual representations that are appropriate for students and the problems they are solving.
2. Use think-alouds and discussions to teach students how to represent problems visually.
3. Show students how to convert the visually represented information into mathematical notation.

Potential roadblocks

1. Students do not capture the relevant details in the problem or include unnecessary details when representing a problem visually.
2. The class text does not use visual representations.

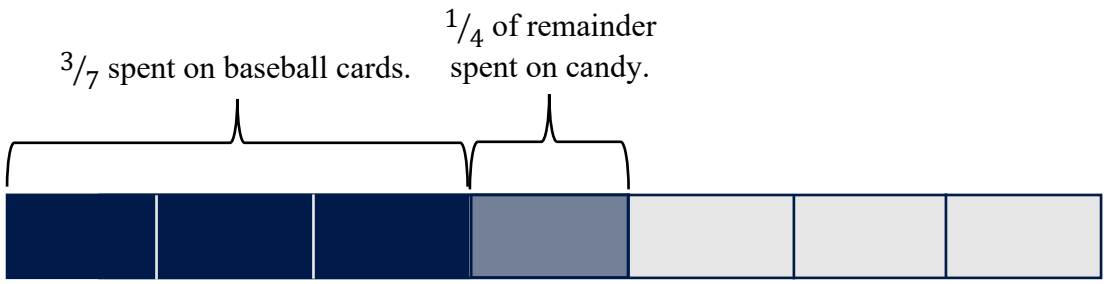
Reference: Woodward, J., Beckman, S., Driscoll, M., Franke, M., Herzig, P., Jitendra, A., Koedinger, K. R., & Ogbuehi, P. (2018). *Improving mathematical problem solving in grades 4 through 8* (NCEE 2012-4055). U.S. Department of Education, Institute of Education Sciences, National Center for Education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

Below are two examples of how visual representations might be used to solve problems. For additional examples, see page 24 of the practice guide referenced on the first page of this document.

Problem

Ben spent $^3/_7$ of his allowance on baseball cards and then $^1/_4$ of what remained on candy. After this, he had $50 left. How much did he start with?

Sample Strip Diagram



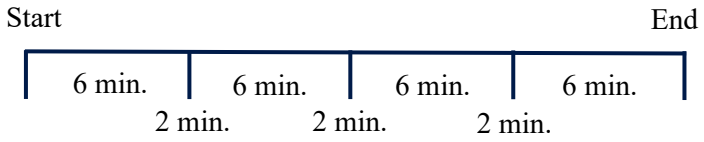
This diagram depicts the original amount of money that Ben had, divided into 7 equal parts. It can be seen that 3 of the 7 parts have not been spent. From this diagram, there are multiple approaches to creating an equation.

Note. Adapted from page 24 of the practice guide referenced on the first page of this document.

Problem

Jackie usually jogs 4 laps around a track and each lap takes 6 minutes. Because of injury, she needs to rest for 2 minutes between each lap. How long does it take her to complete the 4 laps?

Sample Schematic Diagram



This diagram illustrates Jackie running 4 laps with each lap taking 6 minutes. As she runs, Jackie needs to take a 2-minute break between each lap. From this diagram, an equation, such as $(6 \times 4) + (2 \times 3) = x$, can be created to find the total number of minutes Jackie takes to run 4 laps.

Note. Adapted from page 25 of the practice guide referenced on the first page of this document.

How to carry out the recommendation

1. **Select visual representations that are appropriate for students and the problems they are solving.**

   Rather than using all visual representations recommended for a particular type of problem, teachers should select the visual representations they think will work best for their students. Teachers should use selected representations consistently for similar problems so as not to overwhelm students with too many examples and give students time to learn how to successfully use the selected representations. If students still struggle with a representation after a reasonable amount of time, teachers should consider using a different type of representation.

2. **Use think-alouds and discussions to teach students how to represent problems visually.**

   Teachers should demonstrate the thought process behind connecting a problem to a visual representation by thinking aloud when explaining a new representation. Thinking aloud goes beyond teachers telling students what they are doing; it involves teachers explaining why they are taking the particular steps. Teachers should explain how they identified the type of math problem and why they think the selected representation is appropriate for that problem. They should demonstrate how to identify the information in a problem that is relevant to solving it. For an example of thinking aloud, see page 27 of the practice guide referenced on the first page of this document.

3. **Show students how to convert the visually represented information into mathematical notation.**

   Teachers should show students how to translate quantities and relationships in visual representations into math equations. Sometimes, all this translation requires is removing boxes, arrows, and other visual elements from the representation. With more complicated examples, teachers may need to provide more explicit illustrations of the connection between the representations and mathematical notation.

Potential roadblocks and how to address them

Roadblock	Suggested Approach
Students do not capture the relevant details in the problem or include unnecessary details when representing a problem visually.	If students are missing relevant details in their visual representations, teachers can ask guiding questions to build on students' thinking and refine their representations. Once the representations are refined, teachers can ask students why their initial representations did not work. If guiding questions do not work, teachers can demonstrate how to alter students' representations to represent the problems appropriately and eliminate unnecessary detail. Teachers should be sure to point out elements of the representations that were done right so that students are encouraged to continue trying.
The class text does not use visual representations.	Teachers can incorporate visual representations into lessons using media such as whiteboards, overhead projectors, or interactive whiteboards. Teachers can tap colleagues or math coaches for useful visual representations or develop their own. The internet and professional development materials may have useful examples.

REL CENTRAL
Regional Educational Laboratory at Marzano Research

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.