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5:55 min

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Matching Visuals to Purpose in Problem Solving

Asha Jitendra, Ph.D., August 2011

Topic IMPROVING MATHEMATICAL PROBLEM SOLVING IN GRADES 4 THROUGH 8

Practice PROBLEM-SOLVING INSTRUCTION

Highlights

- Dr. Jitendra begins with purposes for using visual representations to facilitate deep understanding of problems through a mental representation that leads to transfer of learning to new situations and increased retention.
- She demonstrates how two representations, percent bar model and strip diagram, can be used to represent relationships within a problem and to convert this representation to an equation.
- Dr. Jitendra explains that struggling students need to understand the visual representation in order to focus on the problem-solving process.
- She makes recommendations for linking underlying mathematical concepts, such as computational procedures, ratio, and proportions, to various visual representations.
- Dr. Jitendra also explains how instructional goals impact the use of visual representations, and she recommends students explain their diagrams to identify misconceptions that can be addressed during instruction.

About the Interviewee

Asha Jitendra is the Rodney Wallace Professor for the Advancement of Teaching and Learning in the Department of Educational Psychology at the University of Minnesota. She was a professor for 14 years in the College of Education at Lehigh University and faculty at the Center for Promoting Research to Practice. Her current research investigates instructional and curricular interventions to enhance elementary and middle school students' mathematical problem-solving performance. Dr. Jitendra has managed several federal research grants, and her most recent work is supported by grants from the Institute of Education Sciences (IES) at the U.S. Department of Education and the National Institutes of Health at the U.S. Department of Health and Human Services. Her scholarly contributions comprise more than 90 publications. She has published in top-tiered peer-reviewed journals in special education, educational psychology, and school psychology. She is the co-author of the IES Practice Guide on *Improving Mathematical Problem Solving in Grades 4 Through 8*. Dr. Jitendra and her colleagues were recognized by the American Psychological Association with an award for an outstanding article in the *Journal of School Psychology*. Her work on mathematical problem solving includes her published curriculum text *Solving Math Word Problems: Teaching Students with Learning Disabilities Using Schema-Based Instruction*. She has presented nationally and internationally on effective instructional strategies for enhancing the academic performance of children with learning difficulties. Dr. Jitendra serves on seven editorial boards. In addition, she served as the associate editor of the *Journal of Learning Disabilities* and edited two special issues (on textbook evaluation and modifications for students with learning problems, in *Reading and Writing Quarterly*; on mathematics assessment, in *Assessment and Effective Intervention*).

Full Transcript

00:05 I am Asha Jitendra, professor of special education at the University of Minnesota. I served on the panel for Improving Mathematical Problem Solving Practice Guide.

00:16 Visual representations play a prominent role in problem solving, especially in the first stage of the problem-solving process, to facilitate understanding. Successful problem solvers are able to translate and integrate information in the problem to generate a coherent mental representation that they then use to plan to solve the problem. There are also many uses or purposes for visual representations. They include summarizing and organizing information, making coherent the abstract relationships, reducing working memory demands, and also reasoning about the story situations. When visual representations are used appropriately, they can lead to deep understanding of the problem, and that in turn makes possible transfer of learning to new problems and increases retention.

01:20 I would like to take an example from the Practice Guide and illustrate how different types of visual representations can be used. In this problem, during a sale, prices were marked down by 20%. The sale price of an item is $84. What was the original price of the item before the discount? Using the percent bar model, we can organize information in the problem and make concrete the relationship between the original, the decrease, and the final amount. This model clearly represents the information described in the problem.

01:55 We can use the relationship depicted in the visual representation and convert it into an equation. In this representation, the translation from the visual representation to an equation is direct.

02:13 Using the same problem, this time let's use the strip diagram to show how we can represent the information in the problem. It is important to understand that 20% is the same as twenty-hundredth or one-fifth of the whole. So the strip diagram here shows how the original amount is divided into five equal parts, and one of the five parts represents the discount amount and four of the five parts represents the sale price. From the strip diagram, we can get the equation 4/5 of X equals 84.

02:51 Visual representations such as schematic diagrams, strip diagrams, tables, and percent models that show relationships

described in the problem are much more powerful tools than pictorial or iconic representations that focus attention on the surface details or the physical appearance of elements described in the problem.

03:16 For struggling students who may have cognitive working memory deficits, providing them with a visual representation can enhance problem solving because it would reduce the working memory demands and allow them to focus on the problem-solving process. Although there is evidence that these students can benefit or can be taught to use visual representations to enhance their problem-solving performance, encouraging them to just visualize the problem or draw a diagram may not be very effective. These students' difficulty in problem solving is related to the representation used. The representation needs to be understood in order for it to be useful.

04:07 Selecting an appropriate visual representation is not easy. One consideration is to select a visual representation that appropriately links it to the underlying mathematical concept. Area models and number line diagrams can be excellent models for improving student understanding of fractions and formal computational procedures. Schematic diagrams, strip diagrams, tables, percent bar models are excellent for understanding and solving ratio, proportion, and percent problems. What is important is that we need to make sure that the visuals provide an effective means of visualizing the problem to facilitate problem solving or understanding of the problem.

04:57 When the goal is to use external visual models, then instruction needs to focus on helping students identify and represent the relationships described in the problem onto a diagram. When the goal is to have students generate a diagram, instruction needs to be multifaceted and focused on understanding of diagrams and their purpose, how to generate a diagram, and use diagrams as tools to reason with.

05:28 Having students explain their use of a visual representation or how quantities in the problem are represented in the diagram is useful in understanding students' misconceptions that would

then allow us to identify and address any learning problems during instruction.

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