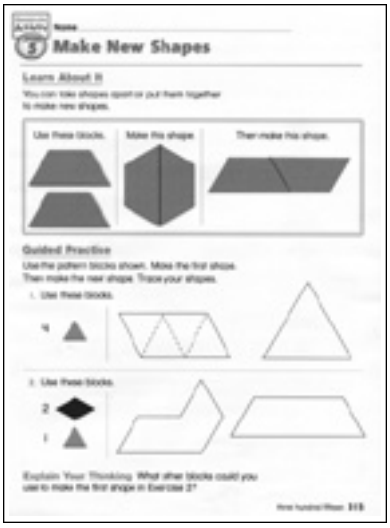
Houghton Mifflin Mathematics

# Manipulatives Enhance the Learning of Mathematics

**Dr. Jean M. Shaw**

Program Author of Houghton Mifflin Mathematics ©2002

and Professor Emerita of Elementary Education at University of Mississippi

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Manipulatives take many forms in elementary and middle grades classrooms where students are learning mathematics by doing mathematics. Base-ten blocks, two-colored counters, fraction strips, beans, and geometric solids are a few of the many manufactured and teacher-made manipulatives that students might use during their K–6 mathematics experience. Manipulatives have been used over the long term for many years at the primary and early elementary grades. However, as students progress through their later elementary and middle grades mathematics learning, it is important for instructional materials to continue including manipulatives. The National Council of Teachers of Mathematics (NCTM) Principles and Standards for School Mathematics emphasizes the importance of using manipulatives and visual representations,

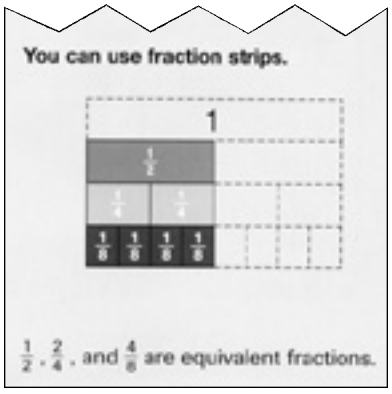
as well as mathematical modeling, in each of its standards at all grade levels. This paper discusses some of the ways manipulatives can be used to enhance and deepen mathematical understanding for all students.

## Building Understanding and Clarifying Concepts

Manipulatives help students develop conceptual understanding of mathematical ideas by representing the ideas in multiple ways. For example, consider comparing unit fractions with unlike denominators such as 1/2 and 1/8. The symbol

for halves looks like it represents a smaller number (with 2 in the denominator) than eighths (with 8 in the denominator). At a symbolic level, many students would have difficulty understanding that the answer will be greater

than 1/2. However, when students use fraction models to represent each fraction in the algorithm and see that 1/2 is greater than 1/8, they begin to build mental images of the relative size of fractional parts of wholes. With this clearer visual understanding, there is obviously less confusion in the students' minds as to why smaller denominators suggest larger parts and larger denominators represent smaller parts.

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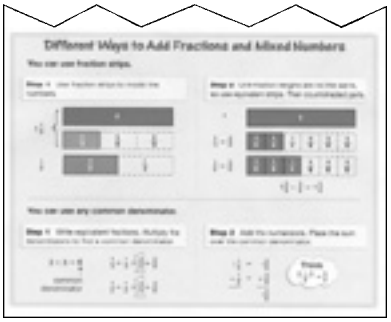
When there is less confusion, deeper understanding can begin to take hold, develop, and grow, thereby laying the groundwork for future mathematics learning. It is also important to recognize that when there is less confusion or conflict of mathematical ideas in a student's mind, then there are fewer meaningless rules to remember or commit to memory. For example, through visual and tactile work, students know and understand why visualizing and comparing fractions is somewhat different from working with whole numbers. Students can then deepen that understanding and explain why the symbolic representation for fractions is not the same as the relative magnitude of whole numbers. Students do not need to rely on rules to understand what symbols represent.

This "ownership" of knowledge has other benefits as well. Healthy attitudes bring with them intrinsic rewards. If a student fully understands a concept or idea, then fear of the subject matter is lessened. In mathematics this is particularly important since "The wealth of knowledge that mathematics and science impart for understanding the world has such breadth that it is easy to overlook the dimension of depth." (A Report to the Nation, p. 14) Teachers are charged with the responsibility of ensuring that students grapple with problems, thus building a deeper understanding of mathematics and the roles it plays in all of our lives.

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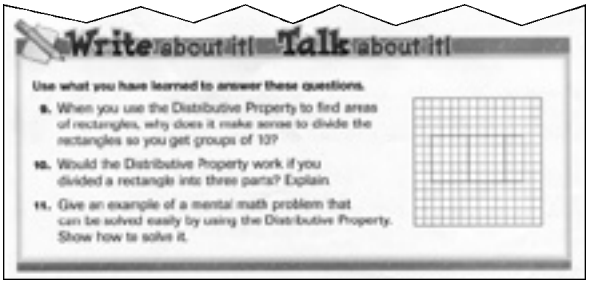
### Engagement, Communication, and Multisensory Experiences

In addition to helping students build deeper mathematics understanding and gain the benefits of healthy attitudes toward mathematics as a discipline, manipulatives and models are valuable resource tools for engaging students in the language and communication of mathematical ideas and concepts. "Students need opportunities to test their ideas on the basis of shared knowledge in the mathematical community of the classroom to see whether they can be understood and if they are sufficiently convincing." (NCTM, p. 61) When students

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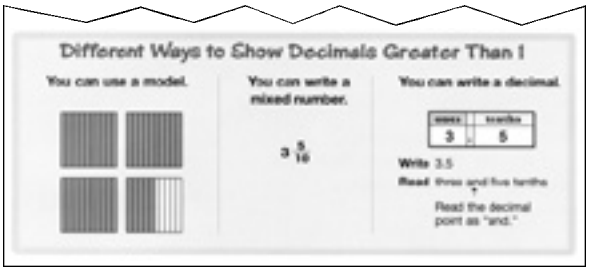
can look at something that visually represents a mathematical concept, they have greater accessibility to the language needed to describe it. Visual learning is exemplified. When students physically move manipulatives to show various relationships, their sense of touch is actively engaged. This enhances understanding and, in

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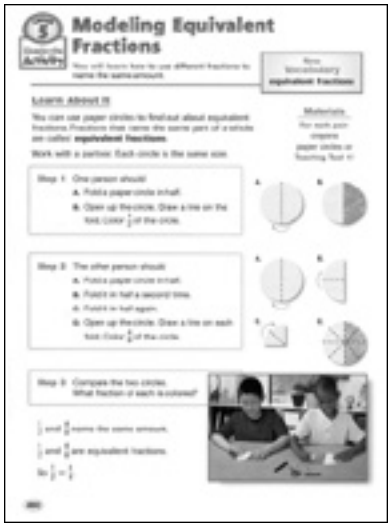
turn, promotes communication of ideas.

When small or large learning groups explore new ideas or explain understandings, they have something to talk about when they have manipulatives and models to work with. Discussions and learning become more focused. Multisensory experiences provide access to ideas and concepts, and offer multiple entry points in discussions and reasoning, ensuring that all students in the group are active participants.

Manipulatives and models also afford English language learners greater access to language and mathematical terminology. A physical representation of a mathematical idea or solution might provide an English language learner with greater confidence in his or her solution. Terms in a new language are easier to learn when used in the context of a model. Just as student dictionaries provide illustrations of nouns, manipulative representations of concepts and solutions provide illustrations of mathematical concepts and ideas.

Using mathematics manipulatives and models offers many benefits. Just as a picture can be worth a thousand words, manipulatives can provide visual representations of ideas, helping students to know and to understand mathematics. Manipulatives enhance the abilities of students at all levels to reason and communicate. Working with manipulatives deepens understanding of concepts and relationships, makes skills practice meaningful, and leads to retention and application of information in new problem-solving situations. In turn, the valuable time spent on manipulative- and model-based lessons has the sustained, long-term effect of building student confidence and deepening mathematics understanding. Indeed, it is time well spent!

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