retain, the greater the understanding we have of that idea. When we have the vocabulary to express the ideas, when we can articulate ways to use the idea, and when we can describe how ideas follow from earlier ideas, or even how they are similar or different from other ideas, then we gain confidence that we do in fact understand the concept. There are many ways to know an idea, but the greater the number of connections we have, the greater the level of understanding.

So, can you learn something but not understand it? In short, no. If understanding a new idea has to do with developing "connections," then so does learning. Insofar as only learning how to complete a task (e.g., carry out an algorithm or process) is at least some accomplishment, it is really difficult to argue that such learning is sufficient when the learner is incapable of applying the task to any situation other than the immediate one and sees no way to connect the learned process to any related or similar tasks. No, all learning requires connections, and the more connections attained, the more effective that learning becomes.

This conceptualization of understanding has important applications to our elementary mathematics classrooms. If we can accept that connections are key to understanding, then we must teach in such a way that students have many opportunities to develop such connections, and we must accept that these connections actually constitute the main goal of our teaching. We can encourage the development of connections through allowing structured exploration and experimentation with mathematical ideas integrating manipulatives, problem-solving experiences and writing activities in our daily instruction (among other activities). In other words, we help students learn mathematics by pointing them toward the key attributes of a wide variety of learning activities all of which are designed to encourage connections between ideas and the world around the student.

This conceptualization of understanding represents the underpinnings of this monograph. The purpose of this monograph is to provide a range of meaning-based activities for the primary mathematics classroom, focusing on manipulatives, problem solving and writing experiences. The activities are designed to help students develop connections between ideas, between ideas and the real world, between ideas and various models and manipulatives, and between ideas and their applications in problem-solving situations.

Manipulatives

Are Powerful Mathematical Models

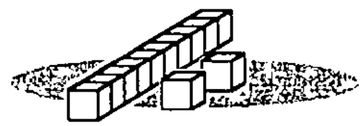
In the description of meaning given in the section above, it was argued that manipulatives can play an important role in the learning of mathematics. Manipulatives provide a concrete experience which is designed to help students actually see (and usually touch) a mathematical idea through the physical objects used to represent it.

But, why are seeing and touching mathematical ideas so important? The seeing and touching of these mathematical models often instil a sense of believability and confidence in the ideas which are encountered. We find it easier to accept and include as part of our cognitive structures things that we see and touch.

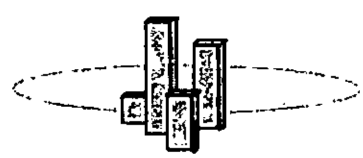
While manipulatives are important from the perspective of providing the means to visualize mathematical ideas, they are also useful from the perspective of problem solving. When students have models, they also have a mechanism for exploring ideas, visualizing problem situations, and guessing and checking to search for solutions or other means of solving given problems.

While manipulatives are extremely important from the perspective of encountering, exploring and developing new ideas, they do suffer from a variety of drawbacks. For example, teaching with manipulatives drastically increases management concerns within the classroom. Using manipulatives requires the teacher to do extra planning and organization prior to instruction and, with some grades and classes, increases the risk of off-task behavior. None of these represent significant reasons for not incorporating manipulatives.However, these limitations do make clear the need for monitoring student work during instruction and implementing management routines and structures for distributing and collecting the manipulatives.

One of the more pragmatic difficulties associated with manipulatives is their often prohibitive cost. Purchasing class sets of manipulatives can become extremely expensive, often impossible as a result of today's budgetary restrictions. Schools have implemented a variety of measures to counteract this difficulty, including purchasing class sets to be shared among several teachers, purchasing small group sets — useful when organizing the class around centre-based activities — and creating alternative manipulatives often made from common and available materials. Some suggestions for finding or making alternative manipulatives for those used in this book are given below.



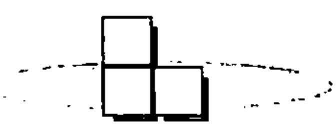
Base Ten Blocks can be created using popsicle sticks and beans. A single bean is the same as a single block, ten beans glued to a popsicle stick represents a long block and a raft built from a collection of ten sticks covered in 10 beans each would represent a flat block. For some activities, photocopied pictures of base ten blocks may be sufficient (see duplication masters at the end of the book).



Cuisenaire or Counting Rods can be cut from colored construction paper. Cut strips 1 cm wide ranging in length from 1 cm to 10 cm long. All strips of the same length should also be cut from the same color of paper.

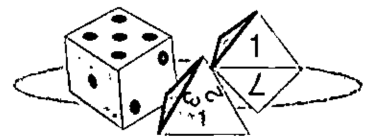
Pattern Blocks can also be cut from colored construction paper according to their various shapes: hexagons can be cut from yellow paper, trapezoids from red paper, etc. (see duplication masters at the end of the book).

Attribute Blocks can be cut from paper just like the other manipulatives above. To make a complete set of blocks, cut a large and small triangle, a large and small circle, a large and small rectangle, and other shapes from each of red, blue, yellow and green paper. The thickness of the shapes can also be varied by cutting them from paper or heavier cardboard.

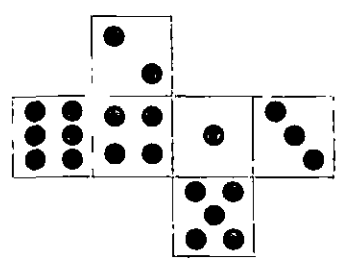


Color Tiles are also easily made by cutting one inch squares from colored paper. If thicker tiles are preferred, glue the construction paper to corrugated cardboard before cutting. Ceramic tiles are also readily available at minimal cost.

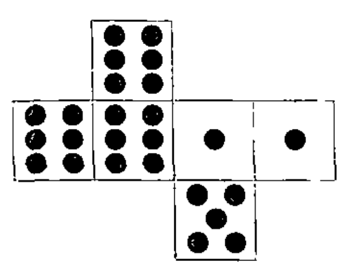
3-D Shapes are nice to have for tracing activities, but they can easily be made out of plasticine or clay, or cut from wood by a carpenter with moderate skill.



Dice are not particularly expensive unless purchased in quantity (check dollar or games stores). Most dice could be made from plasticine (even the four-sided dice) if necessary. These dice could also be easily made using paper nets as shown below. The paper versions are less durable, but are, however, easily adapted to create biased dice (replacing the values on any given side with new values).



(a regular die)



(a biased die)