Build It!

Concept Areas
Geometry and spatial reasoning in three dimensions, logic in a geometrical setting. Using vocabulary: cube, face, edge, side, touching, above, below, each, every.

For Each Group:
- Colored cubes. You can solve every problem in this family by using a subset of eleven cubes: two each of red, blue, yellow, green, and orange, and one purple.

Description
The group needs to build a small structure out of colored cubes. Each clue tells something about the structure, for example, “there is a red block below the green block,” or “the two orange blocks share an edge.” In some problems, students have to deduce what blocks they need from their clues. In one problem, each clue restricts its holder to touching only one color of block.

These problems are popular starters. They’re fun, and the first few are pretty easy without being trivial.

Purpose
We could go on for pages about the importance of geometry as part of mathematics learning at all levels. Let’s just make three points here:

- First, the clues use mathematical language and force problem-solvers to use words like “face” and “edge” to get their clues across to others. Furthermore, students get into good discussions about whether “below” means “below and next to.”

- Second, most geometry instruction is two-dimensional, yet we live in a 3D world. Learning to think in three dimensions is powerful and useful.

- Third, incorporating math language and 3D thinking will help those students who will need it the most—the students who don’t often play with toys that enhance spatial visualization.

Possible Debriefing Questions
How would you make these problems more difficult?

Did you use any words that had more than one meaning to the group?

Which was your favorite problem? Why?
Build It #1

There are six blocks in all.
One of the blocks is yellow.

Build It #1

The green block shares one face with each of the other five blocks.

Build It #1

The two red blocks do not touch each other.

Build It #1

The two blue blocks do not touch each other.

Build It #1

Each red block shares an edge with the yellow block.

Build It #1

Each blue block shares one edge with each of the red blocks.
Manipulatives

Students of all ages can use manipulatives to advantage. Counters such as blocks, beans, or pasta shells should be available at all times. Older students (and their teachers) sometimes feel that blocks are kid stuff and that Real Mathematicians only use paper and pencil. But we all benefit from concrete materials. They help even advanced mathematicians see relationships in both spatial and numerical problems. In groups, manipulatives give the students something to talk about, something everyone can see and work with, a tool around which to organize their thinking.

It's pretty clear how important concrete materials can be for a spatial problem; the problem about the M&Ms on the facing page is a good example of a numerical problem that benefits from using manipulatives. Note the labels at the bottom of the page. You cut those out, and put them in the envelope with the clue cards. With more advanced students, you could omit the labels, and see if they make their own.

With the labels on the table, students can move manipulatives to the labels to represent proposed solutions or parts of solutions. If you think there are three tan M&Ms, put three beans next to "tan." As the group comes to understand the relationships among numbers in the problem, everyone can check the proposed solutions as new clues are read. And they can try different solutions simply by moving manipulatives around from label to label.

The "guess and check" strategy becomes elegant and concrete with manipulatives. The numbers of beans represent the values of variables; the labels are their names. The pencil-and-paper, $x$ and $y$ abstract version of variables is not for fourth-graders, but those same children can learn the concept of a variable and use it to solve a problem. They can do algebra.
M & Ms in a Bag

I have the most of Browns—seventeen—and the least of Tan M&Ms.

How many M & M’s of each color do I have?

M & Ms in a Bag

I have as many Brown M&Ms as Yellow and Orange put together.

How many M & M’s of each color do I have?

M & Ms in a Bag

I have twice as many Green as Tan M&Ms and two more Yellow than Tan M&Ms.

How many M & M’s of each color do I have?

M & Ms in a Bag

I have the same number of green and orange M&Ms.

How many M & M’s of each color do I have?

M & Ms in a Bag

My Green and Tan M&Ms add up to 15.

How many M & M’s of each color do I have?

M & Ms in a Bag

I have 49 M&Ms in my bag and they are Brown, Green, Orange, Yellow and Tan.

How many M & M’s of each color do I have?

Green  Tan  Brown  Yellow  Orange
Spinner Sheet
Which Spinner #2

It is not possible to spin a sum of seven in two spins with this spinner.

The spinner is one of the spinners on the spinner sheet. Use your clue to help the group figure out which one!

Which Spinner #2

It is possible to get a ten with this spinner in two spins if you add the numbers.

The spinner is one of the spinners on the spinner sheet. Use your clue to help the group figure out which one!

Which Spinner #2

The chance of a spinner landing on a three in two spins with this spinner is zero. No chance at all.

The spinner is one of the spinners on the spinner sheet. Use your clue to help the group figure out which one!

Which Spinner #2

There are more ways to get a sum of five in two spins than a sum of one in two spins.

The spinner is one of the spinners on the spinner sheet. Use your clue to help the group figure out which one!

Which Spinner #2

In a hundred spins, the sum of the numbers you’ll get is about the same as for spinner A.

The spinner is one of the spinners on the spinner sheet. Use your clue to help the group figure out which one!

Which Spinner #2

There are four numbers on this spinner.

Which spinner is it?

The spinner is one of the spinners on the spinner sheet. Use your clue to help the group figure out which one!