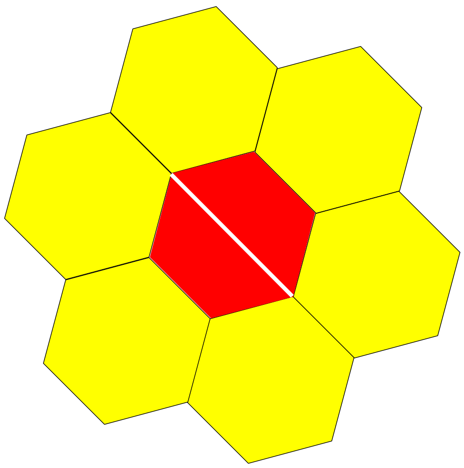
Race for a Pattern Block Flower (and back)



Let the **area** covered by the yellow hexagon = 1

How many of each of the other blocks does it take to cover the hexagon exactly?

Make a “pattern block sandwich” and summarize your findings:

In terms of area…

1 yellow hexagon = 6 green triangles

1 yellow hexagon = 3 blue rhombi (rhombuses?)

1 yellow hexagon = 2 red trapezoids

As fractions…

1 green triangle = $\frac{1}{6}$ of a hexagon

1 blue rhombus = $\frac{1}{3}$ of a hexagon

1 red trapezoid = $\frac{1}{2}$ of a hexagon

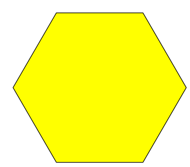
Put purely symbolically…

$$1 = \frac{6}{6} = \frac{3}{3} = \frac{2}{2}$$

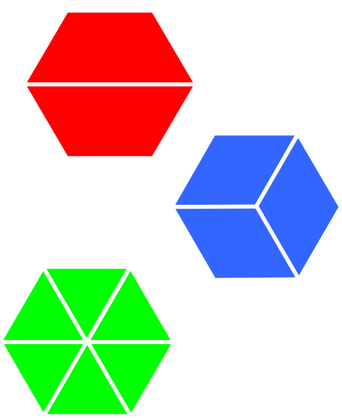
“Pattern block sandwich” (superposition)

Starting with a hexagon on the bottom as a bun, make a layer of each type of block that covers the same area as the hexagon. (If you prefer sandwiches open-face, just omit the hexagon on top.)

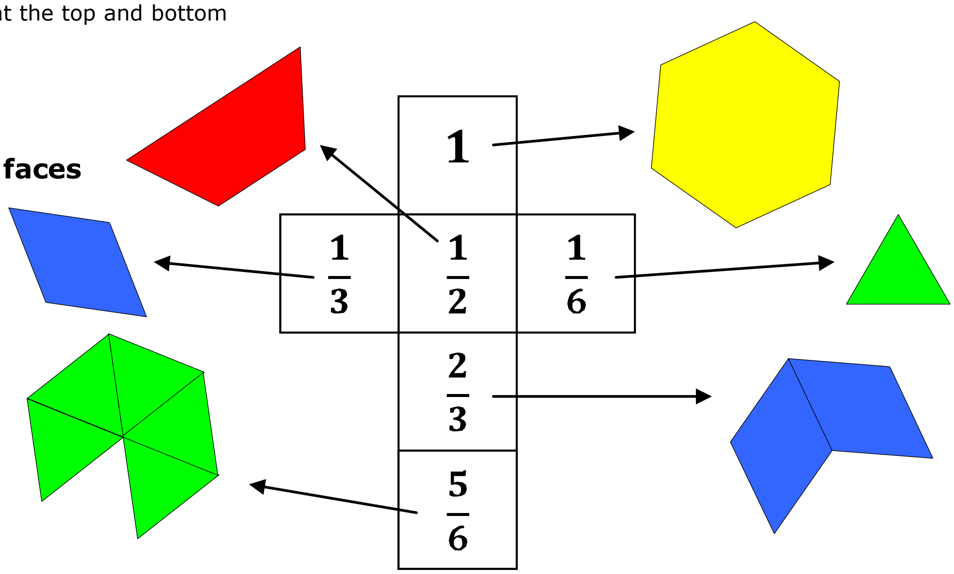
side view: pattern block sandwich with hexagons at the top and bottom



the hexagons are the buns of the sandwich



fraction die with six faces



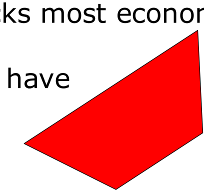
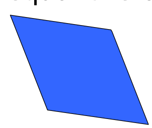
Materials: a set of pattern blocks with no orange squares or tan thin rhombi (rhombuses). The reason for this is that if you say the area of the orange square is 1, then the areas of the other shapes involve root 3.

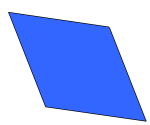
Players: Two players and a banker.

Overview: The game has two parts. In the first part, the players roll, build, and trade their way up to a flower. The first player to build a complete flower, six yellow hexagons with a pair of red trapezoids in the middle, wins. (Overage is okay: the winner doesn't have to hit it right on the nose.) Then it's time to race back down to nothing, taking the flower apart, trading it in, petal by petal, to return the quantity shown by each roll of the die back to the bank. The first player to get get back to zero wins. (Again, going back down, if a player doesn't have enough flower left to return what's rolled back to bank, that counts as a win and the game is over.)

Rules:

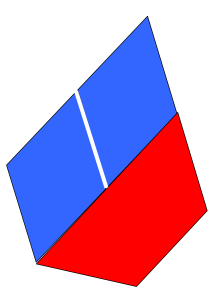
1. **Starting**: Roll the die; high roller starts.
2. **Always race up and down:** Just like in other race games, you race your way up to a complete pattern block flower, building and naming each amount that you roll (see above) as you add it to your collection. On the way back down to zero, you take away what you roll each time, trading as necessary, until you reach zero or have fewer blocks than what you need to take away what you rolled. (See Liping Ma on *composition* and *decomposition*.)
3. Trade in for a hexagon when you can. Similar to base ten race games, when the total area of your non-hexagon collection of pattern blocks is equal to or more than a yellow hexagon, you identify the fraction values of your pieces out loud (this is important practice!) and trade them for a yellow hexagon plus, whatever blocks most economically equal the overage.

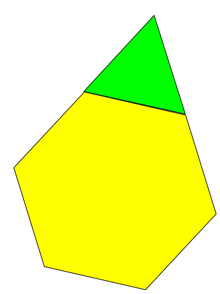
   Suppose, **for example**, you have  and 

   You roll $\frac{1}{3}$, so you get another blue rhombus 

   You realize you have more than a yellow hexagon, so you know you need to trade. (If you don't realize or know, the banker should tell you.)

   You put the collection together, touch the red trapezoid and say "one-half", the blue rhombi (rhombuses) and say "two-thirds"; then it's time to trade: you say "equals", then grab a yellow hexagon and a triangle, and cover the put them exactly on top of the old collection and say "one and one-sixth".





"two-thirds plus one-half" "equals" "one and one-sixth"

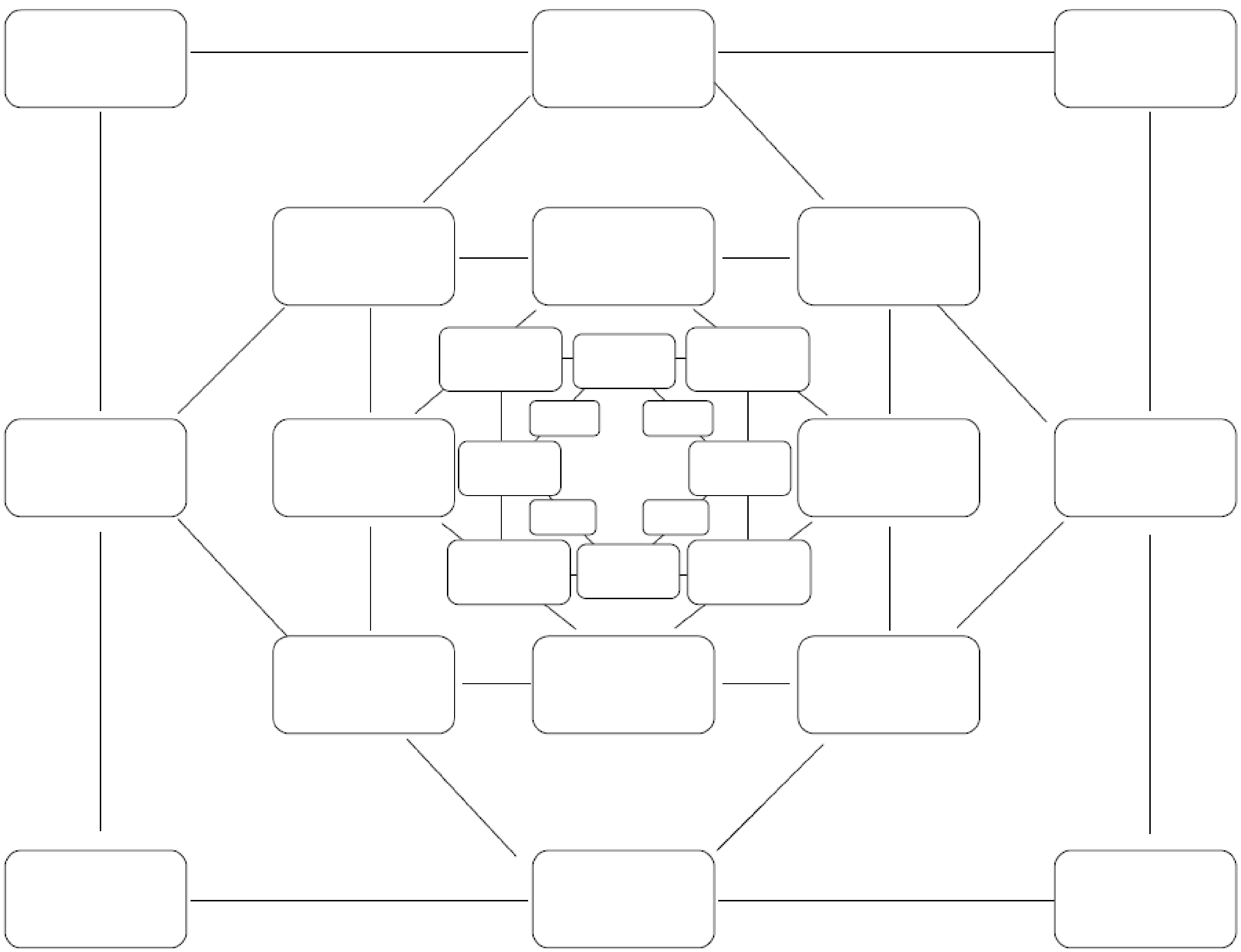
Extensions:

Diffies

As with other race games, diffies are a good way for kids to get practice on this by having them use dice (you might want to add a whole number die (0…3 or 0…5) to make some mixed numbers. Just get a number for each corner by rolling the die—or dice if you're going to make mixed numbers possible. Then calculate the difference (the distance between the two points on a number line) and put it in the middle. In the same way, calculate those differences and put them in the middle again. Unless you make a mistake in your calculations somewhere, your differences will ratchet down to zero in usually five to seven levels. Diffies are very similar to racing back down to zero: the big differences is that they're emphatically symbolic (although you can use actual pattern blocks to build each difference calculation) and they're usually done by individuals (although there's no reason why people couldn't work as partners.

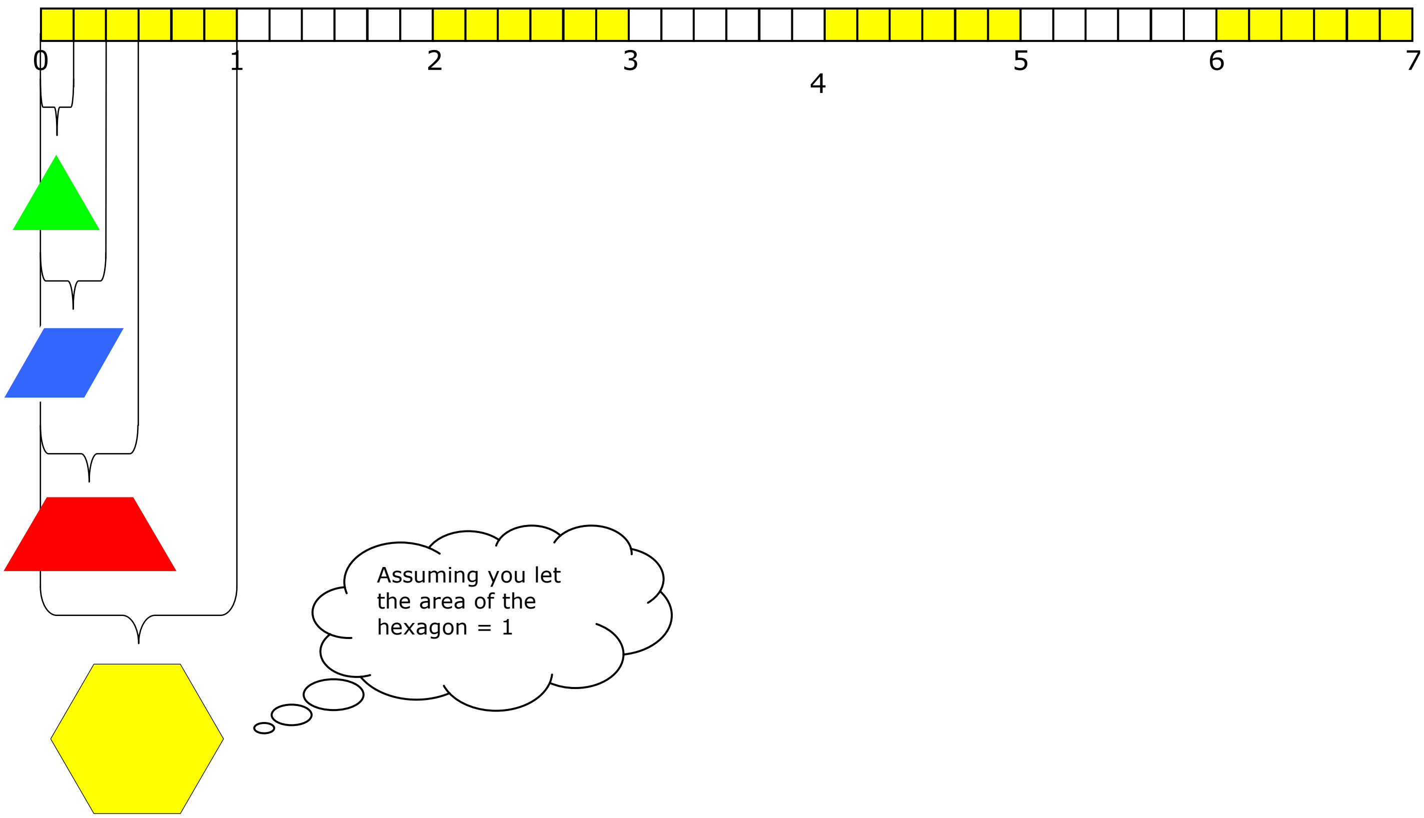
For virtual online diffies, see the National Library of Virtual Manipulatives' Diffy page: http://nlvm.usu.edu/en/nav/frames_asid_326_g_2_t_1.html

For blank downloadable diffies, see SOESD's math resources page http://www.soesd.k12.or.us/files/diffy_blank.pdf



More Extensions

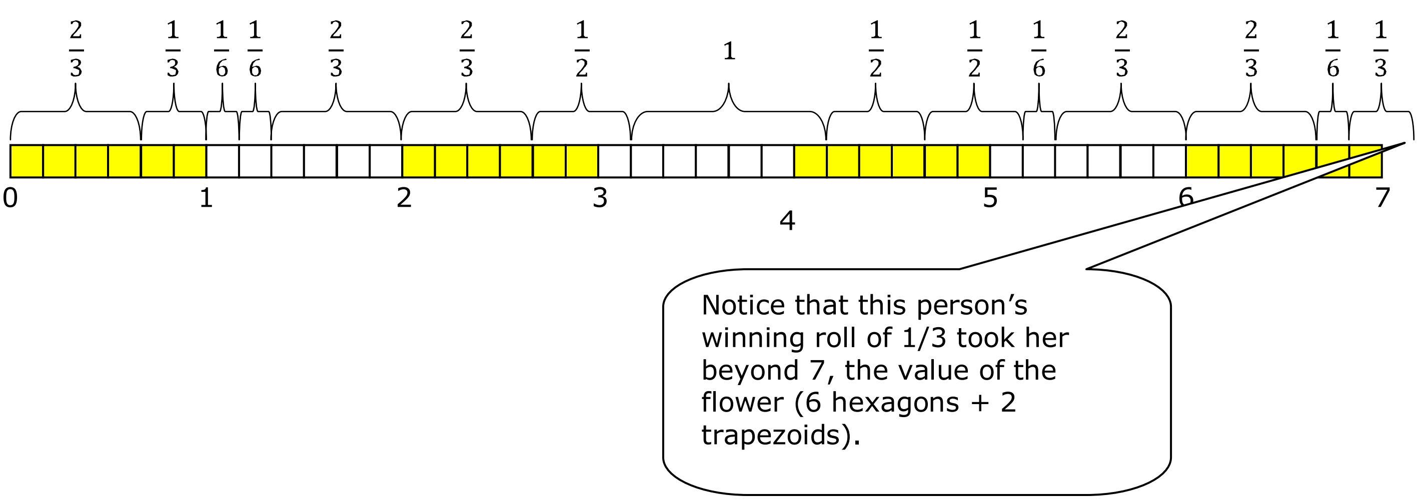
How would this look on a Number Line?



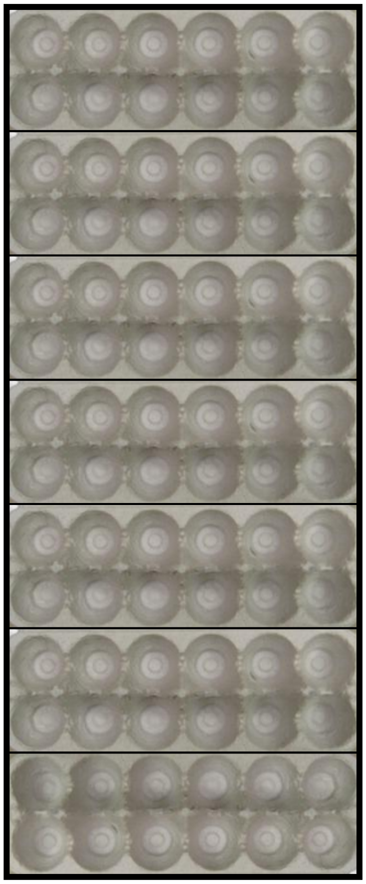
Students can use a number line to mark or locate their progress.

(This initially might be a good job for the banker.)

A game's progress might be plotted like this (for the winner):



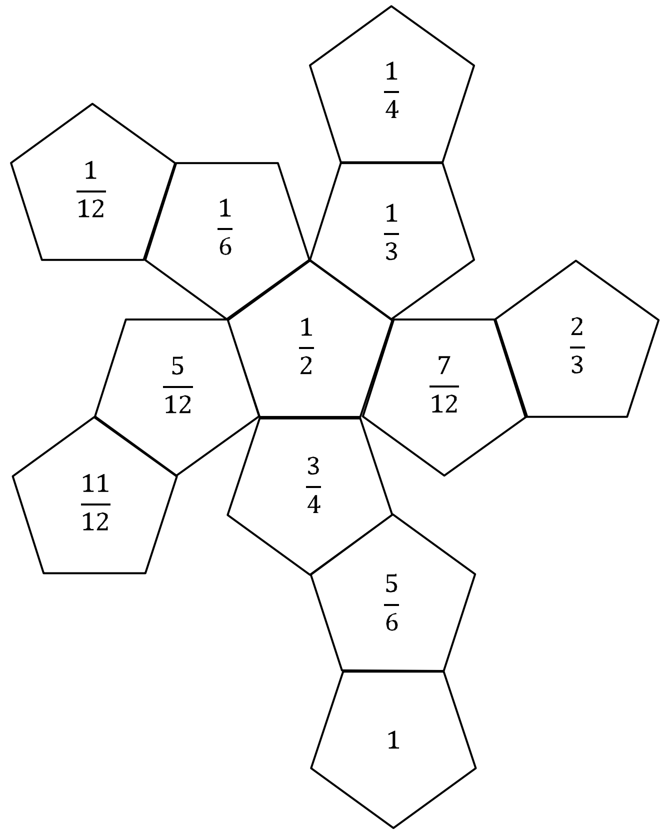
How would this look with egg cartons?



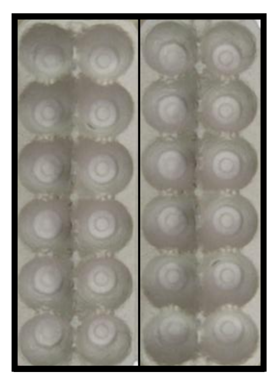
race for the equivalent of a pattern block flower

Egg cartons will handle wholes, halves, thirds, fourths, sixths, and twelfths, so the same die could be used with this other medium or another die could be used: a 12-sided blank, for example, could be filled with these eleven faces, plus either zero or 1 for the twelfth face:

1/12, 1/6, 1/4, 1/3, 5/12, 1/2, 7/12, 2/3, 3/4, 5/6, 11/12



If you define a whole to be the total number of hemispheres in 2 egg cartons, then you have eighths and twenty-fourths too!

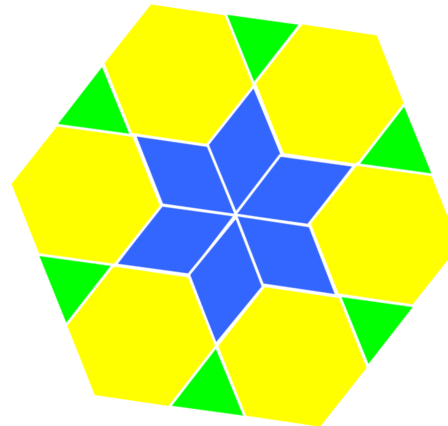


Find Common Denominators as you go

Have students build common denominators with pattern blocks or egg cartons or calculate them. But be careful not to slow down the game so much that the fun turns into tedium! (A good rule of thumb is that a game should take 7 (plus or minus 2) rolls to "win" going up and another 7 (plus or minus 2) rolls to "win" going down.

Still More Extensions

What about racing for other Pattern Block shapes?

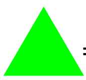


race for a pattern block mandala

Students can design their own goals for race games, determine the value of their design (what size block will be the unit area, what the total area is, accordingly).

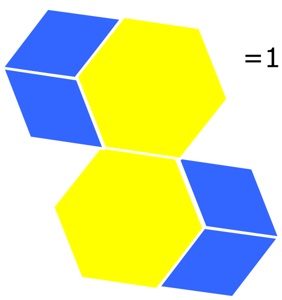
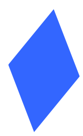
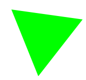
Let the area of another shape = 1

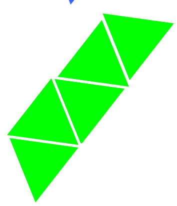
If the red trapezoid  =1,
then even numbers are all made up of hexagons

And  = $\frac{1}{3}$ and  = $\frac{2}{3}$

No halves, though! An important ingredient in this extension would be a blank die that you could mark appropriately. (See "Purchase Dice" below.)

Make new combinations of shapes = 1

If  =1, then you have tenths  and twentieths  and fifths 

—even fourths! 

Track Progress by Recording Each Transaction

A crucial difference here is that the recorder finds a common denominator each time. Progress could also be recorded on a number line rather than in a table.

Has	Rolls	Ends up with
0	$\frac{1}{3}$	$\frac{1}{3}$
$\frac{1}{3}$	$\frac{1}{2}$	$\frac{5}{6}$
$\frac{5}{6}$	$\frac{5}{6}$	$1\frac{2}{3}$
$1\frac{2}{3}$	$\frac{1}{2}$	$2\frac{1}{6}$

And so on…

Notice that the "Ends up with" amount gets brought forward to the new line.

Resources:

More on Race Games:
"Race Games Overview"
www.soesd.k12.or.us/files/race_games.pdf

"Race Games: Getting the Feel of Addition and Subtraction"
www.soesd.k12.or.us/files/race_games4add-subtract.pdf

Print:
Let's Pattern Block It by Peggy McLean, Lee Jenkins and J. McLaughlin $13.95
www.activityresources.com/store/catalog/Lets-Pattern-Block-It-p-144.html
"This book leads children to understand geometry and number concepts through sequenced problem solving activities. Included are activities involving copying designs, counting, equivalence, geometric cover tasks, addition, inequalities, pattern, sequence, time, symmetry, area, perimeter, and fractions—all using pattern blocks. Elementary and middle school students will find the activities challenging and fun."

Virtual Manipulatives:

Pattern Blocks (National Library of Virtual Manipulatives)
http://nlvm.usu.edu/en/nav/frames_asid_169_g_1_t_2.html

Pattern Blocks: Exploring Fractions with Shapes
www.arcytech.org/java/patterns/patterns_j.shtml

Fraction Shapes and Drawing Fun Fractions
http://math.rice.edu/~lanius/Patterns/ and http://math.rice.edu/~lanius/Patterns/draw.html

Do-it-Yourself:

Printable Pattern Blocks www.aug.edu/~lcrawford/Tools/pattern_blocks.pdf
Hand Made Manipulatives http://mason.gmu.edu/~mmankus/Handson/manipulatives.htm

Purchase Pattern Blocks:

Math Learning Center www.mathlearningcenter.org
ETA/Cuisenaire www.etacuisenaire.com
Activity Resources www.activityresources.com
Enasco www.enasco.com
largest selection of all 53 items: www.enasco.com/Search?&q=pattern%20blocks&page=4

Purchase Dice:

For best selection overall, see www.gamestation.net. Also available from Math Learning Center, ETA/Cuisenaire, Enasco, or Activity Resources. You may want to consider these dice:

ETA/Cuisenaire: www.etacuisenaire.com/search/searchdisplay?type=keyword&query=dice

Enasco: www.enasco.com/Search?catalog=&q=dice&x=0&y=0

6-sided fractions (1, 1/2, 1/3, 1/6, 2/3, 5/6)
www.gamestation.net/16mm-Opaque-Math-Dice-Fractions-112/M/B001EQXAT2.htm

6-sided blank www.gamestation.net/16mm-Squareedged-Opaque-Blank-White-6sided/M/B0018TDN8S.htm

8-sided blank www.gamestation.net/8sided-Jumbo-White-Blank-Dice/M/B0018TDNC4.htm

12-sided blank www.gamestation.net/12sided-Jumbo-White-Blank-Dice/M/B0018TFJN0.htm

2-operator (+ and -) www.gamestation.net/16mm-d6-Opaque-Math-Operator-Dice/M/B001EQV8PK.htm

4-operator www.gamestation.net/16mm-Opaque-Math-Operator-Dice-4/M/B001EQYS1Q.htm

Math Learning Center's collection: www.mathlearningcenter.org/store/product-1055985.htm

Larry Francis, SOESD Computer Information Services
larry_francis@soesd.k12.or.us and 541-858-6748