Fraction Operations, The Grid Method

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Introduction

The Grid Teaching System introduces the student to the concept of *common denominator*, using a hands-on experience. This system is suitable for teaching:

- **Fraction ordering.** As an example to ordering, the student has to determine which fraction is larger

  $^{3}/_{5}$ or $^{2}/_{3}$ and $^{3}/_{5}$ or $^{4}/_{7}$, etc.

- **Fraction Addition.** The text below describes in details how to direct the student to solve fraction addition problems.

- **Fraction subtraction.** When the student performed fraction ordering, he or she in effect performed fraction subtraction, for the student has determined which fraction is larger and by how much.

  $^{2}/_{5} - {}^{1}/_{6}$, $^{3}/_{7} - {}^{4}/_{9}$, $^{7}/_{9} - {}^{5}/_{11}$, etc.

  Note that, as is, without additional explanation and/or tools, this system is not suitable to teach subtraction when the results are negative fractions.

Ordering

It is easier to understand ordering (size comparison) than to understand addition. In other words, it is easier to deal with a question like

1. *Which number is larger 1/2 or 2/3?*

Then the question

2. *What do you get when you add 1/2 to 2/3?*

To answer question (a) you only need to compare two fraction of the same whole. To answer question (b) you have to possess the understanding of the concept of common denominator that is required for the operation. While the Grid Teaching System does not require any understanding of abstract concepts, such as common denominator, it requires only two steps to perform a size comparison and three steps to perform an addition.

So, what I suggest is to proceed gradually.

1. Introduce the kids to using graph paper as a tool to create fractions. To that end, in the first lesson they can learn only making a whole and then cutting it to different fractions along the grid line.

2. Instruct the kids to take the different fractions of the same whole and determine which is larger.

3. Instruct the kids to count the squares in the various fractions (of the same whole). Lead them to the realization that the more squares in a fraction the larger it is.

This process introduces them to the concept of common denominator without mentioning this abstract concept. Only after this lesson they can proceed to learn fraction addition.

Fraction Addition

Using a grid it is possible to teach fraction addition of all fractions such as:

$$½ + ¾,\ {}^{2}/_{3} + {}^{5}/_{6},\ {}^{7}/_{9} + {}^{5}/_{11},\ {}^{9}/_{7} + {}^{23}/_{18},\ \text{etc.}$$

The grid system for teaching fraction addition is a hands-on learning process, like some existing methods, such as the Montessori system of 12 pies (from a whole pie to, two halves all the way to 12 twelfths). However, unlike the existing methods, the gird method is not limited to a small set of fractions and does not require a specific set of tools.

All that is required is several sheets of grid paper, a pair of scissors and a pencil. If you have two color pencils of different colors the learning can be simpler. Finally, any straight edge tool, such as a ruler, is also helpful but not necessary.

Below is a step-by-step description of the system, using, for illustration, the following fraction-addition exercise:

$$ {}^{7}/_{9} + {}^{11}/_{13}$$

1. Draw three 9 x 13 rectangles on the grid paper.

Explanation. Create a rectangle having sides equal to each of the two denominators (families).

1.1. Mark one rectangle: “Whole Unit”.

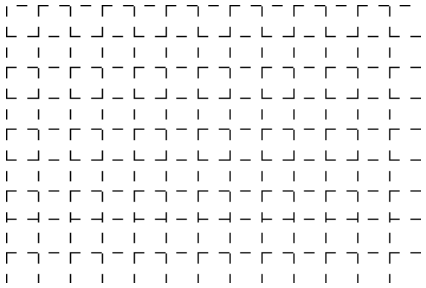

Figure 1. Whole Unit Rectangle

1.2. Using one color, draw parallel lines over the grid lines that are 9-square long, dividing the second grid into 13 equal parts. This grid shows that one whole unit is equal to $^{13}/_{13}$.

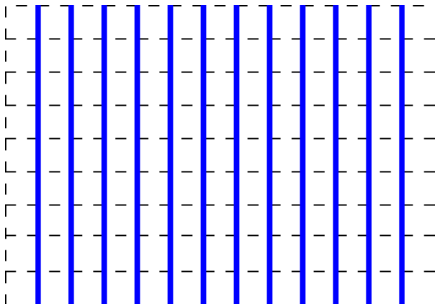

Figure 2. First Division

1.3. Using a different color, draw parallel lines over the grid lines that are 13-square long, dividing the last grid into 9 equal parts. This grid shows that one whole unit is equal to $^{9}/_{9}$.

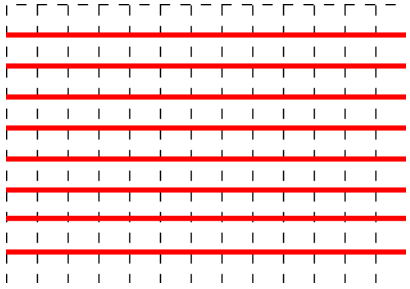

Figure 3. Second Division

2. **Cut 11 strips out of the $^{13}/_{13}$ grid** and discard the remainder of the grid.

Explanation. Now you have $^{11}/_{13}$ of the whole.

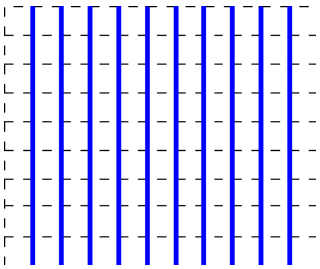

Figure 4. First fraction $^{11}/_{13} = {}^{99}/_{117}$

3. **Cut 7 strips out of the $^{9}/_{9}$ grid** and discard the remainder of the grid.

   Explanation. Now you have $^{7}/_{9}$ of the whole.

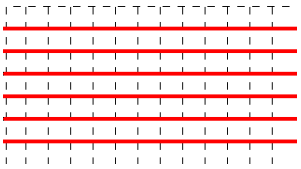

Figure 5. Second fraction $^{7}/_{9} = {}^{91}/_{117}$

4. Fit as many of the squares of both $^{7}/_{9}$ and $^{11}/_{13}$ as you can over the Whole-Unit grid. You may use the scissors to cut these fractions into *smaller* fractions so you can create the desired arrangement. Be careful to cut along the grid lines.

   Notice: Each individual square is $^{1}/_{117}$ (= $^{1}/_{(9x13)}$).

   4.1. If your arrangement or part of it is equal to the Whole-Unit grid, replace it with the Whole-Unit grid and discard these pieces of the fractions.

   4.2. Count the leftover squares from any of the fractions. In this example you should have 73 squares.

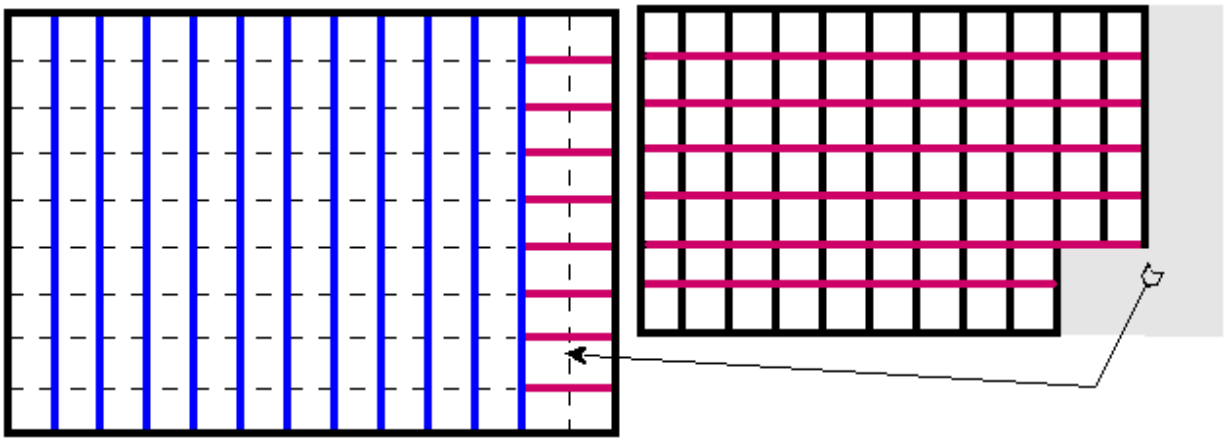

Figure 6. Perform the Addition Operation

$$^{99}/_{117}\ [=^{11}/_{13}] \quad + \quad ^{18}/_{117} \quad = \quad ^{91}/_{117}\ [=^{7}/_{9}] - {}^{18}/_{117} =$$

$$^{117}/_{117} \quad = \quad 1\,^{73}/_{117}$$

5. The answer of this fraction addition exercise is therefore: $1\,^{73}/_{117}$.

As an exercise, complete the $^{7}/_{9}$ grid to be equal to the Whole Unit with squares from the $^{11}/_{13}$. The result should be the same although graphically it will look differently.

Note. Colored lines are used in order to identify the source of the squares in the final assembly — the sum of the fractions. Colors appear as undistinguishable shades of gray when printed in black & white.