EXPLORATION 3.19 The Scaffolding Algorithm

Many students have trouble with long division. Common problems include poor multiplication facts, not being able to remember the sequence, and misplacing the digits in the quotient. The standard algorithm can be unforgiving, as the example at the right shows. After repeated failure with the standard algorithm, many students simply give up; many of my students in this course have told me of bad experiences learning the division algorithm.

$$
\begin{array}{r}
69 \text{ R } 24 \\
8\overline{)576} \\
\underline{48} \\
96 \\
\underline{72} \\
24
\end{array}
$$

An alternative algorithm called the scaffolding algorithm has been helpful in giving students a sense of success, which builds their confidence. It also develops their ability to use guess–check–revise and reinforces their multiplication skills.

Here is how it might work with the problem 576 ÷ 8. The student is asked to estimate the quotient.

Let's say the student's first guess is 60. The student multiplies 60 × 8 to see how many 8s have been "used up" and how many are left to be dealt with. The 60 is placed at the top. (*Note:* The diagram for each step is below.)

The student is now asked the same question with the remaining 96. Let's say the student guesses 10. The 10 is placed above the 60 (that is, in the "answer" space), and the student takes away the 10 groups of 8, or 80.

We now have 16 to deal with. The student sees that 8 × 2 = 16 and places the 2 in the answer space. The student now adds 60 + 10 + 2 to get the answer.

At the far right is another example of this algorithm; note that the actual numbers in the answer space and the number of steps depend on the student's guess.

$$
\begin{array}{cccc}
 & & & 1 \\
 & & 2 & 6 \\
 & 10 & 10 & 20 \\
60 & 60 & 60 & 50 \\
8\overline{)576} & 8\overline{)576} & 8\overline{)576} & 64\overline{)4953} \\
\underline{480} & \underline{480} & \underline{480} & 3200 \\
96 & 96 & 96 & \overline{1753} \\
 & \underline{80} & \underline{80} & 1280 \\
 & 16 & 16 & \overline{473} \\
 & \underline{16} & \underline{16} & 384 \\
 & 0 & 0 & \overline{89} \\
 & & & \underline{64} \\
 & & & 25
\end{array}
$$

1. **a.** Do some more problems on your own until you feel confident using the scaffolding algorithm.

    b. Write directions for using this algorithm and give them to a friend. See whether the friend can divide on the basis of your directions. If he or she can, great. If not, have a conversation and find where the directions "went wrong." Keep revising the directions until your directions make sense to your friend. If possible, try the new directions on another friend.

    c. Now that you know how this algorithm works, try to explain the *why* of each step, as was done for the standard algorithm in the textbook.

    d. What advantages might this algorithm offer in teaching?