Long Division

by

Trial Divisor

~The Cover-up Method~
&
Scaffolding

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The division algorithm is used throughout mathematics. It is used to divide polynomials, in synthetic division, and again in synthetic substitution when evaluating polynomials or solving higher degree equations using the Rational Root Theorem.

Too many students experience difficulty when first learning to divide by a multi-digit divisor. Most of the emphasis is placed on the procedure, but there are a number of issues that cause students difficulty that are often glossed over while teaching long division, those include: using simple, straight-forward examples that work, place value, trial divisors, and the format students are required to use when multiplying.

To address those issues, we will choose our numbers very carefully so we can concentrate on the procedure being taught – not getting caught up or distracted by the arithmetic, then repeatedly scaffold to the next tier and grade level.

To get students started, you might pose this question to students. If 4 kids had to split $136.00, how would they go about dividing that money if it was made up of one one-hundred dollar bill, three ten-dollar bills and six one-dollar bills?

You'd place one stipulation on them. They **cannot** use five, twenty, or fifty-dollar bills.

If they are like most kids, they would all want to start with the largest bill, the one-hundred dollar bill. They would quickly realize that they cannot split the single one-hundred dollar bill between them, they would have to make change.

To split the single one-hundred dollar bill between them, they would have to make change for the

One one-hundred dollar bill + three ten-dollar bills + six one-dollar bills

Changing the one hundred dollar bill into *ten* ten-dollar bills will result in having to split *thirteen* ten-dollar bills and *six* one-dollar bills.

13 ten –dollar bills + 6 one-dollar bills.

The four could split the *13* ten-dollar bills, each getting *3* ten-dollar bills, but there would be *one* ten-dollar bill left over.

That ten-dollar bill could be changed into ones, resulting in a total of *16* one dollar bills. The four could then split the ones, each getting 4 one-dollar bills.

Essentially, that's what we do when dividing. The biggest difference is we label the answer when describing it in words.

Each kid receives *3* ten-dollar bills and *4* one-dollar bills. In math, we use place value

$4\overline{)136}$ *cannot split 1 hundred four ways*

$4\overline{)\underbrace{13}6}$ *split 13 tens four ways*

Each person gets three tens. To show tens, the "3" must be written in the "tens" column.

$\begin{array}{r} 3 \\ 4\overline{)\underbrace{13}6} \end{array}$ *with 1 ten left, change that into 10 ones and combine with the 6 ones, now divide the 16 ones between the 4 kids.*

$$\begin{array}{r} 34 \\ 4\overline{)136} \\ \underline{12} \\ 16 \\ \underline{16} \\ 0 \end{array}$$

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Long Division by "Trial Divisor" – The Cover-up Method

When we use a trial divisor, we are essentially rounding the divisor to the nearest ten, hundred or thousand.

<u>Procedure</u>

1. To determine where to place the first number in the quotient, ask when the divisor is less than numbers in the dividend. Underline those numbers and place a small hash mark over that number in the dividend.

Ex. $32\overline{)\underline{204}9}$ ***Ask:***

Is	**32**	<	**2 ?**	**No**
Is	**32**	<	**20 ?**	**No**
Is	**32**	<	**204 ?**	**Yes, underline 204**

Now we know the first number in the quotient will go above the 4 (place a tick mark above the 4 as shown below, the second number in the answer will go above the 9. The answer will be a two-digit number.

$$32\overline{)\underline{20\overset{|}{4}}9}$$

2. Since we don't know the 32 table, we will cover up the last number in the divisor, the 2. And cover-up the last number **<u>underlined</u>** in the dividend, the 4.

$$3\cancel{2}\overline{)\underline{20\overset{|}{\cancel{4}}}9}$$

3. Now we will divide what's left, 3 into 20 and place that result over the ticked 4. In reality, what we are doing is finding how many 30s are in 204 tens.

$$\begin{array}{r} 6 \\ 32\overline{)\underline{20\overset{|}{4}}9} \end{array}$$

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4. Next we will multiply that divisor by the 6. (Remember to go straight down with the product.)

$$\begin{array}{r} 6 \\ 32\overline{)2049} \\ \underline{192} \end{array}$$

5. Subtract, then bring down the next number from the dividend, the 9.

$$\begin{array}{r} 6 \\ 32\overline{)2049} \\ \underline{192} \\ 129 \end{array}$$

6. Now we divide again by covering up the 2 again *and* the number you just brought down, the 9 and divide 12 by 3. Place that 4 above the 9 in the dividend.

$$\begin{array}{r} 64 \\ 3\cancel{2}\overline{)2049} \\ \underline{192} \\ 12\cancel{9} \end{array}$$

7. Multiply, then subtract. The difference will be the remainder.

$$\begin{array}{r} 64 \\ 32\overline{)2049} \\ \underline{192} \\ 129 \\ \underline{128} \\ 1 \end{array}$$

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Please notice on pages 7-10, the trial divisors will work using the cover-up method. That is meant to help students learn the procedure using what we refer to as the ***"success on success"*** model.

On page 11, students will divide by a three-digit divisor by covering up two numbers in the divisor and dividend. Again, using the same procedure, the trial divisor will work.

On page 12, the trial divisor will go into the underlined digits of the dividend evenly, **no remainder**. Generally, when that occurs, students will need to drop the quotient by 1. Otherwise they will use the trial divisor, get a number, multiply and find that number is too big, have to erase and start over because of regrouping.

By recognizing this pattern, students will hopefully see that recognition shortens their work and suggests before they simply accept using the trial divisor, they may want to do some mental math because of the need for "regrouping" when multiplying.

The last page of exercises page 13, the trial divisor will not work by just covering up. Students will find that they are sometimes better off rounding up to the nearest ten, then use that number as the trial divisor.

Teaching long division in increments, repeated scaffolding, like this eliminates some frustration students might otherwise experience by just jumping in and trying to learn the procedure, having to carry, and determining trial divisor.

When teaching long division, being neat is important and keeping the numbers in the correct column for place value is extremely important. By turning the papers sideways so the lines are vertical instead of horizontal, that will help students keep the numbers in the correct columns. Then, when teaching division of decimals, the chances of students placing the decimal in the wrong position diminishes greatly.

$21\overline{)135}$ $32\overline{)209}$

$51\overline{)228}$ $63\overline{)204}$

$73\overline{)168}$ $82\overline{)347}$

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$33\overline{)1058}$ $41\overline{)2379}$

$91\overline{)3078}$ $82\overline{)1879}$

$72\overline{)1685}$ $63\overline{)2008}$

$72\overline{)4586}$ $53\overline{)3267}$

$82\overline{)7568}$ $42\overline{)2789}$

$91\overline{)4024}$ $62\overline{)4554}$

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$32\overline{)2017}$ $21\overline{)7777}$

$51\overline{)34682}$ $42\overline{)21678}$

$62\overline{)1569}$ $73\overline{)3486}$

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$512\overline{)3367}$ $614\overline{)2687}$

$213\overline{)1368}$ $902\overline{)2089}$

$723\overline{)40587}$ $821\overline{)60589}$

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$58\overline{)2579}$

$69\overline{)3678}$

$45\overline{)1687}$

$36\overline{)9067}$

$27\overline{)4788}$

$76\overline{)4983}$

$46\overline{)2069}$

$29\overline{)1289}$

$98\overline{)2777}$

$56\overline{)2590}$

$89\overline{)7362}$

$66\overline{)3847}$

$28\overline{)3072}$

$47\overline{)3368}$

$57\overline{)4567}$

$78\overline{)57682}$

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