McGraw Hill Wright Group

Everyday Mathematics

How Everyday Mathematics Uses Multiple Algorithms To Help Students Learn More Meaningful Math

Everyday Mathematics is a structured, rigorous and proven program that helps students learn mathematical reasoning and develop strong math skills. *Everyday Mathematics,* carefully developed and tested grade level by grade level, helps students understand how math works, see the meaning of math in daily life, and become life-long mathematical thinkers.

In 2000, The ARC Center, located at the Consortium for Mathematics and its Applications, studied the records of 78,000 students and found that the average standardized test scores were significantly higher for students in *Everyday Mathematics* schools than for students in comparison schools.

Recently, the What Works Clearinghouse (WWC) stated that a handful of rigorously conducted experiments demonstrated that *Everyday Mathematics* had "potentially positive effects" on achievement compared with more traditional math programs. All other elementary mathematics programs reviewed by WWC as of this writing have been found to have "no discernible effects on mathematics achievement."

Research has shown that students using *Everyday Mathematics* perform well on a wide range of computational tasks – they calculate accurately and quickly and generally score high on the computation sections of standardized tests. Likewise, students using *Everyday Mathematics* typically succeed in algebra at earlier grades and at higher rates than ever before, according to *Everyday Mathematics Student Achievement Studies, Volume 6*, at:

http://www.everydaymathsuccess.com/pdf/StudentAchievementStudy_vol6.pdf

For example, a large study in Washington State found that students using *Everyday Mathematics* outscored a matched-comparison sample of students not using *Everyday Mathematics* on the computation section of the Iowa Test of Basic Skills.

Everyday Mathematics reflects the desire of the National Council of Teachers of Mathematics (NCTM) to have students understand the reasons behind mathematical formulas and calculations. It is in line with NCTM standards and the recently released NCTM Curriculum Focal Points.

Understanding the Multiple Algorithm Approach

Everyday Mathematics encourages students to learn multiple algorithms for doing arithmetic operations. Students can choose the way that works best for them, allowing them to not only feel more successful but to actually understand the math better.

Everyday Mathematics materials identify one algorithm for each operation as a *focus* algorithm. The purpose of a focus algorithm is to provide children with at least one accessible and correct paper-and-pencil method and thereby set a common basis for classroom work.

Carefully Selected Focus Algorithms

Each focus algorithm in *Everyday Mathematics* is chosen for both efficiency and understandability. The highly efficient paper-and-pencil algorithms that have been traditional in the U.S. may no longer be the best algorithms for children in today's technologically demanding world. Today's elementary school children will be in the workforce well into the second half of the 21st century and the school mathematics curriculum should reflect the technological age in which they will live, work, and compete.

Noted mathematics scholar Liping Ma, in her influential book, *Knowing and Teaching Elementary Mathematics*, presents evidence that many U.S. teachers do not understand the traditional multiplication algorithm. Ma does not claim that teachers cannot carry out the algorithm – they can – but rather that they do not understand why it works, why one must shift over in the second step, what the carry marks really mean, and so on. If teachers do not understand the traditional multiplication algorithm, then it is not likely that their students will either.

Everyday Mathematics expects that students should know both how to solve a problem and why the method is valid. These are the objectives. In the following paragraphs, the authors of *Everyday Mathematics* describe how the program's multiplication algorithms meet these objectives.

Everyday Mathematics authors selected the partial products multiplication algorithm as the focus algorithm because it is easier to understand than the U.S. traditional multiplication algorithm.

Partial products multiplication requires students to solve problems such as 20×30. This builds skills that are useful for estimation – a skill more important than ever today, and one traditionally neglected in the school mathematics curriculum.

Partial products multiplication also prepares students for multiplying polynomials in algebra. Students' experience using partial products to solve problems such as 26×31 will prepare them to solve problems such as $(2x + 6) \times (3x + 1)$ in algebra.

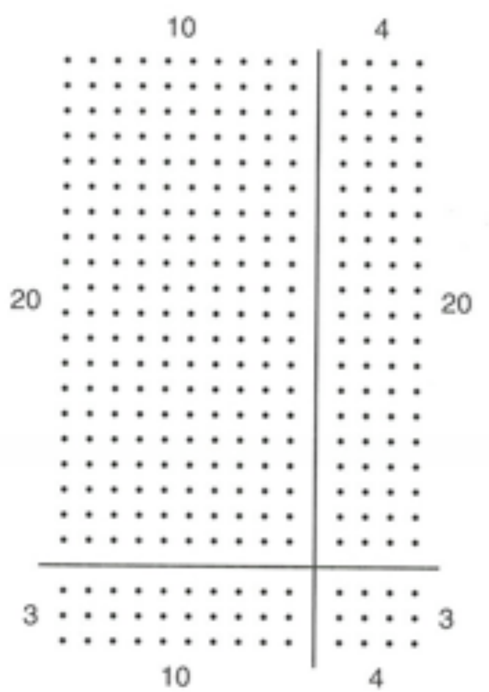
The partial products algorithm works as follows:

Think of each factor as a sum of ones, tens, hundreds, and so on. For example, think of 67×53, 67 as $60 + 7$ and 53 as $50 + 3$. Then multiply each part of one factor by each part of the other factor. Finally, add all the resulting partial products.

	67
	× 53
50 × 60	3000
50 × 7	350
3 × 60	180
3 × 7	+ 21
	3551

To use the partial-products algorithm efficiently, children must be adept at multiplying multiples of 10, 100, and 1,000, such as 60×50 in the example above. These skills also help children to make ballpark estimates of products and quotients.

The partial-products algorithm can be demonstrated visually using arrays. The diagram below shows how a 23-by-14 array represents all of the partial products in 23×14.



$$\begin{aligned} 23 \times 14 &= (20 + 3) \times (10 + 4) \\ &= (20 \times 10) + (20 \times 4) + (3 \times 10) + (3 \times 4) \\ &= 200 + 80 + 30 + 12 \\ &= 322 \end{aligned}$$

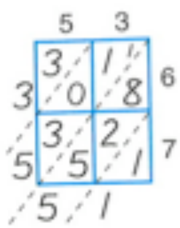
NOTE: The partial-products algorithm uses the Distributive Property of Multiplication over Addition repeatedly.

First, $20 \times (10 + 4) = (20 \times 10) + (20 \times 4)$
Second, $3 \times (10 + 4) = (3 \times 10) + (3 \times 4)$

Students are also taught how to use an alternative multiplication algorithm called *lattice multiplication*. Although this is not a focus algorithm it is included because it is a favorite of students and because it is fast, easy, and works every time.

The lattice method is very efficient and powerful. The authors have found that with practice, it is more efficient than standard long multiplication for problems involving more than two digits in each factor. And problems that are too large for long multiplication or for most calculators can be solved using lattice multiplication.

The lattice multiplication algorithm works as follows.



67 × 53 = 3,551 by lattice multiplication

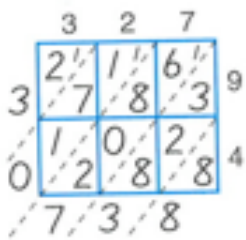
NOTE: In 1478, in Treviso, Italy, lattice multiplication appeared in what is said to be the first printed arithmetic book. Amazingly, it was in use long before that, with historians tracing it to Hindu origins in India before A.D. 1100.

To multiply 67 by 53:

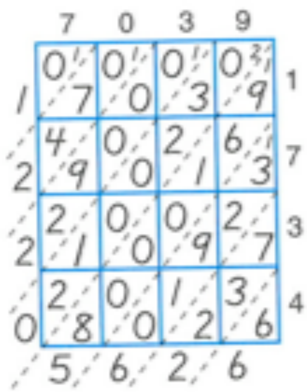
1. Draw a 2-by-2 lattice as noted above.
2. Write one factor along the top of the lattice and the other along the right, one digit for each row or column.

3. Multiply each digit in one factor by each digit in the other factor. Write the products in the cells where the corresponding rows and columns meet. Write the tens digit of these products above the diagonal and the ones digit below the diagonal.
4. Starting at the bottom-right corner, add the numbers inside the lattice along each diagonal. Write these sums along the bottom and left lattice. If the sum on a diagonal exceeds 9, carry the tens digit to the next diagonal to the left.

Multiplying larger numbers requires a larger lattice.

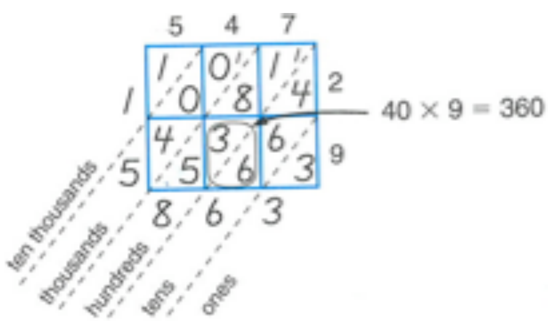


94 × 327 = 30,738



1,734 × 7,039 = 12,205,626

To understand why lattice multiplication works, note that the diagonals in the lattice correspond to place-value columns. The far right-hand diagonal is the one place, the next diagonal to the left is the tens place, and so on.



Advantages of the Everyday Mathematics Approach to Algorithms

Using multiple algorithms, *Everyday Mathematics* has many benefits:

- Students who invent their own methods learn that their intuitive methods are valid and that math makes sense.
- It promotes conceptual understanding. When students build on their own procedures, new knowledge is integrated into a meaningful network so that it is understood and retained more easily.

- It encourages proficiency with mental math. Students develop a broad repertoire of computational methods and the flexibility to choose whichever is most appropriate.
- Students are more motivated.
- Students understand that problems can be solved in more than one way, which develops computational proficiency, flexibility, and creativity.

Watch Success Multiply!

The approach of teaching multiple algorithms in *Everyday Mathematics* is based on decades of research and was refined during extensive field-testing. It has been proven to work. The program meets standards set by the National Council of Teachers of Mathematics in *Principles & Standards for School Mathematics*, and more than 3 million students across the country learn with *Everyday Mathematics.*

To learn more about *Everyday Mathematics*, visit www.WrightGroup.com or call 1-800-382-7670.