Hanlonmath Newsletter

A newsletter for math teachers and administrators

What works is work!

Math – Unlike Other Subjects

One of the foremost reasons why so many students struggle in math is because it is so dependent upon prior knowledge – where sequencing, mastery and automaticity are important. That's just not the case in other subjects.

In history, it seems like sequencing should be important for better understanding, but that sequencing and mastery of certain periods of history have no or minimal impact on future studies. So, while we might think teaching students about World War I, World War II, the Korean Conflict, Viet Nam War, etc. in order might lead to increased student understanding, it has little impact on student success.
That is, students could have very little knowledge of World War I, but be quite knowledgable about World War II. In other words, prior knowledge will not impact their performance in a class. In fact, if students studied World War II before World War I, there would be negligible impact on their performance – sequencing does not impact student achievement.

The same would be true in science, students can be taught Earth Science, Biology, Chemistry, and Physics in almost any order without impacting their performance in the next class. And, mastery of physics will have minimal impact on how students might perform in chemistry or biology.

That's not the case in math, sequencing and mastery are important. Students will experience a great deal of difficulty and little success if they were taught division before subtraction. Trying to solve quadratic equations without knowing how to factor polynomials just sets students up for failure. So, not only is mastery and sequencing important as students move from year to year in math, it is also important going from one chapter to the next. Math is unlike other subjects.

If students do not know the trig identity $\cos^2 x + \sin^2 x = 1$, equation of a circle, distance formula and Pythagorean Theorem are all the same formula, just written differently because they are being used in different contexts, then that suggests they learning facts in isolation, are merely memorizing math facts with little or no understanding of math about how math is linked and built upon previous knowledge.

When adding using the standard algorithm, we ask students to add the hundreds

column to the hundreds, the tens to the tens, etc. In adding or subtracting polynomials, we ask students to use the same concepts but describe it by saying "combine like terms". Notice the notation AND language changes to describe the sum, but the math is the same. The same algorithms taught in basic operations in elementary school are used in algebra. Secondary teachers need to know that, that allows them to introduce new concepts & skills in a familiar language, which makes student more comfortable and makes math a lot easier to learn.

Look at these two addition problems.

$$\begin{aligned} 341 + 256 &= (3+2)100 + (4+5)10 + (1+6)1 \\ &= 5(100) + 9(10) + 7(1) \\ &= 597 \end{aligned}$$

$$\begin{aligned} (3x^2 + 4x + 1) + (2x^2 + 5x + 6) &= (3+2)x^2 + (4+5)x + 1 + 6 \\ &= 5x^2 + 9x + 7 \end{aligned}$$

The 341 corresponds to the $3x^2 + 4x + 1$, the 256 corresponds the $2x^2 + 5x + 6$.

Notice the coefficients of the sums - 597 corresponds to the $5x^2 + 9x + 7$. For students to succeed, they would have to have learned basic facts and algorithms first and mastered them to be able to simplify polynomials.

Now, let's look at the following two multiplication problems.

$$\begin{array}{r} 32 \\ \times\ 21 \\ \hline 32 \\ 64 \\ \hline 672 \end{array} \qquad\qquad \begin{array}{r} 3x + 2 \\ \times\ 2x + 1 \\ \hline 3x + 2 \\ 6x^2 + 4x \\ \hline 6x^2 + 7x + 2 \end{array}$$

The 32 corresponds to the $3x + 2$, the 21 corresponds the $2x + 1$. Both the two 2-digit numbers and the polynomials are multiplied using the same standard algorithm. The products have the same coefficients 672.

Knowing that math is linked, you would think all teachers would know the importance of sequencing and mastery. Secondary teachers are hampered in covering their assigned curriculum when elementary and middle school teachers don't demand and require mastery of basic facts and algorithms.

Practicing stinks, I get it. But without practice, as students advance in mathematics, they will end up confusing any difficulty they encounter with the new concept or skill being taught – not their deficiency in basic skills.

702.218 3875 bill@hanlonmath.com

I would remind teachers of math they should know what they are teaching is linked to what has been taught, and what will be taught in the next chapter or grade. Math teachers not understanding that makes math much more difficult for students to learn.

While teachers should shoulder much of the blame when they don't require mastery, those deficiencies often don't "show up" for a couple of years before they really begin to impact a student's ability to succeed in math and those teachers often don't know they are the cause of their students' future difficulties.

If a first-grade teacher does not cover a concept or skill or two and hold students accountable for mastery, it does adversely affect the second-grade teacher, but it won't doom a student to failure. However, if the second-grade teacher does not cover their assigned curriculum and or does not practice enough for students to have acquired automaticity with facts and procedures (mastery), a couple more holes are created in the student's background. By 4th and 5th grade, the number of holes increases and begin to connect, meaning it's harder to get across the finish line for students because the isolated holes that they had to navigate before have become ditches that cause them to go further out of their way to reach the finish line. By the time struggling students reach high school, the holes created in elementary school have given way to ditches by middle school and become canyons that make it almost impossible for students to get to the other side successfully in a time certain.

If we want to improve proficiency in math, we need to recognize that math needs to be treated differently than other subjects.

Bill Hanlon was the former Director of the Southern Nevada Regional Professional Development Program, is a noted speaker, an author, educator, consultant and coach for schools, and is a national presenter for organizations such as: AASA, ASCD, ALAS, NMSA, NASSP, NSBA, and NCTM.

He was the coordinator of Clark County School District's Math/Science Institute and was also responsible for K-12 math audits. He served as vice president of the Nevada State Board of Education, Regional Director of the National Association of State Boards of Education (NASBE) and as a member of the National Council for Accreditation of Teacher Education (NCATE) States Partnership Board. He also hosted a television series, "Algebra, *you can do it!"* on PBS in Las Vegas, NV.

Bill's books, "Building Success on Success" and "Teaching Struggling Students in Math" can be purchased through Bloomsbury Publishing.