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What works is work!

Linkage

As teachers teach mathematics, they should remain cognizant of the fact that the concepts and skills they teach will be used later as building blocks to introduce more abstract concepts. Middle-school teachers use concepts, skills and algorithms taught in elementary school, and high-school teachers continue to build on student knowledge gained in middle school. This process is referred to as "linkage" (connections), the introduction of new material through the use of skills and concepts that have previously been taught.

Therefore, as lessons are presented, teachers should link the new material to previously learned concepts or outside experiences. By introducing concepts through the utilization of linkages, teachers enable students to place new ideas into a context of past learning. Students are introduced to new or more abstract concepts *using familiar language*, thereby not being threatened. Teachers, on the other hand, have an opportunity to *review and reinforce* previously learned topics, topics and skills they often identify as deficiencies and reasons why they are not successful teaching their assigned curriculum. Teachers can then *compare and contrast* that information, and students see the idea used in a *different context*. Research suggests all the aforementioned leads to increased student achievement. Simply put, students are then more likely to understand and therefore absorb new material when linkage is being used.

The importance of linking concepts and skills to previously learned material and outside experiences can not be overstated. Many of our best students probably don't know the equation of a circle, the distance formula, Pythagorean Theorem, and trig identity $\cos^2 x + \sin^2 x = 1$ are all the same formula, just written differently because they are being used in different contexts. By not introducing these concepts through linking, teachers lose valuable instructional time by introducing these ideas as brand new and students don't see or understand the beauty behind mathematics.

Rather than just having students "flip & multiply" when dividing fractions, the division algorithm might be developed through repeated subtraction – just as was done in fourth grade with division of whole numbers. Solving equations should be connected to the Order of Operations. The standard multiplication algorithm that is taught in fourth grade is the same algorithm that is used in algebra to multiply polynomials. Invariably, student memory, over time, will diminish. At the RPDP, it is our belief that is not a question of "if" students will forget information, it's a matter of "when" they will forget it. An

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understanding of where theorems, formulas and algorithms (short cuts) originated will enable students to reconstruct concepts and solve problems over time.

Where possible, linkages should also be made between concepts within the course as well as to student experiences in "real life." Buying candy at a store can be linked to such mathematical concepts as ratios, proportions, slope, ordered pairs, graphing, and functions. Students quickly see that if one candy bar costs fifty cents, then two will cost a dollar. The connection is readily translated to the math they learn in the classroom. As a proportion, 1 candy bar is to $.50 **as** 2 candy bars is to $1.00; or written as ordered pairs, (1, .50), (2, 1.00). Linking makes math more relevant and it is very important for students trying to learn the language or students coming from poverty – by reviewing and reinforcing previously learned concepts and skills in a non-threatening manner.

The idea of slope is used quite often in our lives. However outside of school it goes by different names. People involved in home construction might talk about the pitch of a roof. If you were riding in your car, you might have seen a sign on the road indicating a grade of 6% up or down a hill or reading a graph and identifying a trend line All of those cases refer to what we call slope in mathematics.

Kids use slope on a regular basis without realizing it. Let's look at an example, a student buys a cold drink for $0.50, if two cold drinks were purchased, the student would have to pay $1.00.

I could describe that mathematically by using ordered pairs; (1, $0.50), (2, $1.00), (3, $1.50), and so on. The first element in the ordered pair represents the number of cold drinks, the second number represents the cost of those drinks. Easy enough, don't you think?

Now if I asked the student, how much more was charged for each additional cold drink, hopefully the student would answer $0.50. So the difference in cost from one cold drink to adding another is $0.50. The cost would *change* by $0.50 for each additional cold drink. The *change* in price for each additional cold drink is $0.50. Another way to say that is the *rate of change* is $.50. In math, we call the rate of change—slope.

In math, the rate of change is called the slope and is often described by the ratio $\frac{rise}{run}$.

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