

What Do We Know About Teaching Basic Facts?

What have we learned from research about teaching the basic facts?

Research has clearly shown that drill and practice are not sufficient for all students to learn the basic facts. Many students never memorize the facts, often forget, sometimes guess, and rarely feel confident using their knowledge in new problem situations.

If teachers delay the drill, and instead, plan lessons to help children learn thinking strategies, that is, more efficient ways to figure these facts out,

- it actually helps students learn the facts,
- it takes less time for them to learn the facts,
- they remember the facts better,
- they have learned some of the thinking strategies that can be used with larger numbers for mental computation and estimation, and
- they have become more flexible in their thinking with numbers.

Initially, three research studies were influential for the importance of teaching these thinking strategies. Now many more studies are confirming the results of these studies that were conducted twenty to fifty years ago.

First, Brownell and Chazal found that drill does not help children change the way they are thinking to figure out facts. Drill only speeds up the way of thinking they already knew before the drill. In this study about the effects of premature drill, they also found that drill did not help many of the students learn the facts. If the students were counting to figure out a fact before the drill, they were still counting to figure it out after a month of drill. They were counting faster, but they often did not know the fact yet and they had not figured out a better or more efficient way to figure the fact out. (Brownell, William A., and Charlotte B. Chazal. "The Effects of Premature Drill in Third-Grade Arithmetic." *Journal of Educational Research* 29 (September 1935): 17-28.)

Second, Brownell also found that students, who had a way to figure out facts, were far more likely to be able to give an immediate response and be able to justify that response by the end of the year than were students who were guessing or giving rote responses without being able to explain how they could justify their response. (Brownell, William. "Rate Accuracy and Process in Learning." *Journal of Educational Psychology*, 35:321-337. September, 1944.)

Third, Rathmell found that students who could explain their thinking retained far more over summer vacation than did students who had memorized the same facts, but could not justify their answers. (Rathmell, Edward C. "Using Thinking Strategies to Learn Basic Facts." *Developing Computational Skills. The 1978 Yearbook of the National Council of Teachers of Mathematics*, Marilyn Suydam (editor). Reston, Va.: National Council of Teachers of Mathematics, 1978.)

These research studies indicate that having a way, to figure out the basic facts, helps students memorize them. Drill does not provide new ways of figuring out basic facts. Furthermore, students who understand efficient ways of figuring out basic facts are much less likely to forget over the summer. So, to help students with basic facts, we need to help them

learn efficient thinking strategies. Drill will not do that, so we need to teach them. Note that this does not mean that we need to tell them. It means that we need to structure problems to encourage them to use new methods of solution. Then we can have them verbalize their thinking and before long they are using a new way of thinking.

Since the 1970's, there have been many other studies done on basic facts. One by Carol Thornton and Paula Smith has convincing data to show the powerful effects of teaching thinking strategies to help students learn the basic facts. (Thornton, Carol A., and Paula J. Smith. "Action Research: Strategies for Learning Subtraction Facts." *Arithmetic Teacher* 35 (April 1988): 8-12.)

Another article by Isaacs and Carroll, which appeared in the journal *Teaching Children Mathematics*, provides a description of what we currently know about teaching basic facts and some of the issues that still need to be addressed. (Isaacs, Andy, and Bill Carroll. "Strategies for Basic Facts Instruction." *Teaching Children Mathematics*. 5 (May 1999): 508-515.)

What are the most effective classroom practices based on research results and classroom experiences?

Based on many years of classroom experiences, and on the results of research, a curriculum that includes the following has proven to be very effective.

- First, provide word problems with a variety of structures to help children understand the meaning of the operation. This helps children learn to directly model the operation and to understand when that operation can be used in everyday problem situations. By changing the context of these problems, students are provided the opportunity to make sense of a variety of representations, representations that match the variety of contexts.
- Second, provide experiences that involve solving problems with representations, experiences that promote new thinking strategies. This helps children learn efficient ways to solve the harder basic facts and mentally compute answers to problems with larger numbers.
- Third, only after students have made sense of a thinking strategy through the use of representations, provide students opportunities to practice that new thinking strategy as needed. Some students may not need much practice; others can benefit from it because that practice speeds up their ability to use the new thinking. Before long, the students are able to use the new thinking to solve fact problems very quickly. Furthermore, they are capable of solving many problems with larger numbers using the same thinking.