17 The Value of Drill and Practice in Math: A Perspective

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The figure gliding over the skating rink at the Olympics, the zeal of Chinese acrobats, melodies flowing like rivulets from Pandit Ravi Shankar's sitar or Bismillah Khan's shehnai - all of these mesmerize you. All these people have something in common to have reached the pinnacle of success — talent and practice.

Having said that, should drill and practice be a part of the Mathematics teaching learning process?

Mathematics is about playing with numbers. The more familiar one is with numbers and what they represent, the easier it is, to see relationships that exist between them. Hence, it is important that children learn to count and are able to identify the number of things in a group either by counting or by patterns. In Mathematics is a type of understanding typically called number sense. It is generally agreed upon that it involves an awareness of number names, values, and relationships. Children with number sense recognize the relative differences in number quantity and how those differences can be represented. Number sense gives meaning both to an automatic Math fact and to a computational procedure. Gersten and Chard roughly compare the importance of number sense in computation to the need for phonemic awareness in reading (Gersten & Chard, 1999). Both are critical building blocks. The ability to recall basic Math facts fluently is necessary for students to attain higher-order Math skills. Garnett describes a typical hierarchy of procedures, or strategies, which rests upon number sense and leads eventually to automatic recall (Garnett, 1992). "The only way to learn Mathematics is to do Mathematics" said Paul Halmos.

"Cognitive psychologists have discovered that humans have fixed limits on attention and memory that can be used to solve problems. One way around these limits is to have certain components of a task become so routine and over-learned that they become automatic." Whitehurst, 2003)

What do all of above research findings imply for Mathematics?

It would be helpful if some of the sub-processes inproblem solving, particularly basic facts were developed to the point that they are done automatically. If a student constantly has to compute the answers to basic facts, less of that student's thinking capacity can be devoted to higher-level concepts than a student who can effortlessly recall the answers to basic facts. For example, if a child performing multiple-digit division consistently has to use his fingers to subtract or cannot recall multiplication facts during the division process, the attention and memory resources devoted to these procedures reduce the child's ability to monitor and attend to the larger division problem. The result is that the child often fails to grasp the concepts involved in multiple-digit division.

> *"It was in Class 8 that I had to teach Hero's formula - s(s-a)(s-b)(s-c).We made up a song "sun, sun meri aasha, sun meri bhasha, sun meri champa re "where sun stood for s, asha, bhasha and champa stood for a, b, c and meri stood for the subtraction sign. The class rocked."*

If this fluent retrieval does not develop then the development of higher-order Mathematics skills — such as multiple-digit addition, subtraction, long division, and fractions — may be severely impaired. Lack of Math fact retrieval can impede participation in Math class discussions, successful Mathematics problem solving, and even the development of everyday life skills. Besides all this it can create a lack of self-confidence in the child and also subject her to peer ridicule. Rapid Math-fact retrieval is an asset to perform well in Mathematics achievement tests. Studies in cognitive science also support continual practice, because it develops computational automaticity—it increases retrieval speed, reduces time required for recognition, and decreases interference (Klapp, Boches, Trabert, & Logan, 1991; Pirolli & Anderson, 1985; Thorndike, 1921).

Learning an algorithm is a matter of memorization and practice, but learning the purpose or rationale of an algorithm is not a matter of memorization or practice; it is a matter of understanding. Teaching an algorithm's steps effectively involves merely devising means of effective demonstration and practice. But teaching an algorithm's point or rationale effectively involves the more difficult task of cultivating students' understanding and reasoning. It requires insight and flexibility. Understanding and practical application are sometimes separate things in the sense that one may understand multiplication, but that is different from being able to multiply smoothly and quickly. Many people can multiply without understanding multiplication very well because they have been taught an algorithm for multiplication that they have practiced repetitively. Others have learned to understand multiplication conceptually but have not practiced multiplying actual numbers enough to be able to effectively multiply without a calculator. Both understanding and practice are important in many aspects of Math.

Related to learning theories, teachers apply at least four different approaches in Mathematics teaching:

- Skills Approach: a focus on procedural knowledge in Mathematics.
- Conceptual Approach: a focus on meaningful learning and understanding of facts, rules, formulas and procedures.
- Problem-Solving Approach: focus on development of Mathematical thinking.
- Investigative Approach: A focus on understanding meaningful memorization of facts, rules formulas, procedures and thinking necessary to contact Mathematical inquiry.

All the above approaches require practice of some manner or the other.

Drill can be interesting if the teacher has the ingenuity to repeat in various ways. The number 5 can be shown quantitatively as 5 pebbles/marbles. The concept can be drilled by clapping 5 times, by stomping 5 times, by playing a game which involves the children to group in fives. Here drill is different from writing 5 ten times.

It was in Class 8 that I had to teach Hero's formula--s(s-a)(s-b)(s-c).We made up a song "sun, sun meri aasha, sun meri bhasha, sun meri champa re "where sun stood for s, asha, bhasha and champa stood for a, b, c and meri stood for the subtraction sign. The class rocked. Children came out of their seats and danced. At the end of the class every child knew the formula.

When does drill and practice appear absurd or does not seem to have an effect on the learning?

Practicing something that one cannot even begin to do or understand seems absurd and fails. Practicing something that trial and error does not improve, is not going to lead to perfection. There are a number of reasons why a student may not be able to work a problem, and repeating to him things he does understand, or merely repeating things he heard the first time but does not understand, is generally not going to help him. Until the specific area of distress is not identified and clarified the students' needs may not be addressed.

When does drill and practice seem effective?

- Drill and practice have to be interesting and joyful to the learner.
- It will be effective only if there is clarity in what is being practiced.
- They must be systematically integrated into the teaching learning process.
- Technology is a valuable tool for repeated practice.

Can only drill and practice develop the learning process?

Several studies show that drill and practice must be coupled with periodic reviews to achieve tangible results. In one study Gay (1973) found that students who reviewed arithmetic rules on the first and seventh days after the original teaching presentation learned the rules better than students who reviewed the rules on the first and second days after the original teaching presentation. While most textbooks include review at the end of chapters, research has shown that review should be "systematically planned and incorporated into the instructional program."

Not having enough drill and practice often leads to the students to not master the topic in the specified class. There may be only a small gain and not the mastery of the concept *"…a phenomenon that everybody who teaches Mathematics has observed: the students always have to be taught what they should have learned in the preceding course. (We, the teachers, were of course exceptions; it is consequently hard for us to understand the deficiencies of our students). The average student does not really learn to add fractions in an arithmetic class; but by the time he has survived a course in algebra he can add numerical fractions. He does not learn algebra in the algebra course; he learns it in calculus, when he is forced to use it. He does not learn calculus in a calculus class either; but if he goes on to differential equations he may have a pretty good grasp of elementary calculus when he gets through. And so on throughout the hierarchy of courses. The most advanced course, naturally, is learned only by teaching it. This is not just because each previous teacher did such a rotten job. It is because there is not time for enough practice on each new topic; and even it there were, it would be insufferably dull".*

- Ralph P. Boas

Drill and Practice have to be an integral part of the Mathematics teaching learning process. The creative teacher would so weave it into the tapestry of Math learning that a beautiful design is created. The process of drill would not kill the joy of learning the subject but thrill the learner propelling him to seek more. Hence let us not drill and kill but drill and thrill!

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