Typical Development and Usual Teaching of Mathematical Skills

The information provided here is based on the following sources:

WISE Math Mission Statement ("Western Initiative for Strengthening Education in Math" founded by professors of mathematics in Manitoba and Saskatchewan);

Research by Professors Daniel Ansari and Ian Lyons, Numerical Cognition Laboratory, Department of Psychology, Brain and Mind Institute, Western University, London, Ontario

Research by Professor Lynn Fuchs, Department of Special Education, Vanderbilt University

Research from the Department of Psychiatry and Behavioral Science and the Symbolic Systems Program at Stanford University School of Medicine

Typical Development and Teaching of Mathematical Skills

1) Children are born with a number sense which allows them to identify which group of objects has same/less/more of them, e.g. number of dots on a page irrespective of how they are arranged. This "Approximate Number System", because it is applied to concrete objects, is referred to as the **"non-symbolic number representation".**

When a teacher uses **"manipulatives", "number lines"** or representations of numbers by drawing the corresponding number of **dots,** numerical questions are solved using the **non-symbolic (concrete) system.**

2) "In order to continue on to more formal mathematics, children first need to learn what number symbols (Arabic digits) mean and have an understanding of the magnitudes they represent (e.g. knowing that the Arabic digit 4 represents four discrete items)." (Matejko, Ansari, March 2016). This is the "**symbolic number representation**".

Mental computational skills e.g. ability to add/subtract two single digit numbers without resorting to "non-symbolic number representation" (counting fingers/dots) show that the child has acquired "symbolic number representation". The child "speaks numbers" understanding their corresponding quantities.

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Usually **children acquire symbolic number representation** for the purpose of solving numerical problems **at six years of age**, i.e. in Grade One. This process is best supported by the practice of adding two single digit numbers followed by subtractions using two single digit numbers

3) Standard algorithms for **addition, multiplication, subtraction, and division** must be included in math curricula...Students must practice math skills and arithmetic regularly to become proficient...calculator use in math classes should be minimized" (WISE Math).

This means that the child is working with the symbolic number system.

While the concrete (non-symbolic) teaching approach can be helpful when introducing numerical operations, they cannot be mastered until they can be completed in the symbolic system, i.e. writing numbers rather than counting fingers or dots.

Children need repetitive practice of writing additions, subtractions, multiplications and divisions using standard algorithms (24 + 37; 28 x 3; etc.) in order to become proficient. Ideally, when working with simple numbers e.g. 20 + 10, this can be combined with mental computation of the same numerical operation.

The numerical operations need to be taught in logical order, i.e. additions and subtractions must be mustered before introducing multiplications, which precede divisions. Fractions can be introduced with visual representations of a pizza cut into 1/2 = 2/4 etc. pieces.

4) Solving **mathematical word problems** requires mastery of the numerical operation(s) required to solve a given problem plus the word reading and reading comprehension and abstract reasoning necessary to read and understand the question.

Deficits in any of these areas may make the word problem incomprehensible. Sometimes they can be addressed, other times word problems cannot be taught.