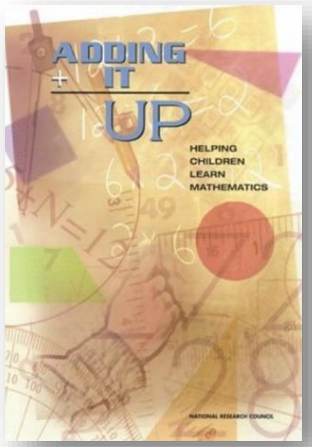
The Components of Mathematical Proficiency

Procedural Fluency



Procedural fluency refers to knowledge of procedures, knowledge of when and how to use them appropriately, and skill in performing them flexibly, accurately, and efficiently…In addition to providing tools for computing, some algorithms are important as concepts in their own right, which again illustrates the link between conceptual understanding and procedural fluency. Students need to see that procedures can be developed that will solve entire classes of problems, not just individual problems.

By studying algorithms as "general procedures," students can gain insight into the fact that mathematics is well structured (highly organized, filled with patterns, predictable) and that a carefully developed procedure can be a powerful tool for completing routine tasks. It is important for computational procedures to be efficient, to be used accurately, and to result in correct answers. Both accuracy and efficiency can be improved with practice, which can also help students maintain fluency. Students also need to be able to apply procedures flexibly… Procedural fluency and conceptual understanding are often seen as competing for attention in school mathematics. But pitting skill against understanding creates a false dichotomy. As we noted earlier, the two are interwoven.

Understanding makes learning skills easier, less susceptible to common errors, and less prone to forgetting. By the same token, a certain level of skill is required to learn many mathematical concepts with understanding, and using procedures can help strengthen and develop that understanding… When students practice procedures they do not understand, there is a danger they will practice incorrect procedures, thereby making it more difficult to learn correct ones… If students have been using incorrect procedures for several years, then instruction emphasizing understanding may be less effective. When children learn a new, correct procedure, they do not always drop the old one. Rather, they use either the old procedure or the new one depending on the situation. Only with time and practice do they stop using incorrect or inefficient methods.

Hence initial learning with understanding can make learning more efficient. When skills are learned without understanding, they are learned as isolated bits of knowledge. Learning new topics then becomes harder since there is no network of previously learned concepts and skills to link a new topic to. This practice leads to a compartmentalization of procedures

Extracts from: National Research Council (2001) Adding it up: *Helping children learn mathematics.* J. Kilpatrick, J. Swafford, and B. Findell (Eds.). Mathematics Learning Study Committee, Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.

that can become quite extreme, so that students believe that even slightly different problems require different procedures.

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