

Calculation Skills and the Use of Conceptually Advanced Solution Procedures

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Do conceptually advanced solution procedures develop through experience with calculation?

As children develop, marked individual differences sometimes are found in the use of concepts to solve problems. In this study we sought to determine whether children in Grades 2-4 differ in the use of the **mathematical principle of inversion** ($a + b - b$ must equal a), and whether this variation can be understood in terms of differences in calculation skills, conceptual knowledge, or attention

Calculation skills? Perhaps children who are good at addition and subtraction eventually notice that adding and subtracting the same number leaves the original quantity unchanged. On this basis they then infer the principle of inversion. Children who do not add and subtract well would have no such basis for inferring inversion.

Attention skills? Perhaps children require a certain level of attention skills to notice the inversion principle could be applied.

Conceptual skills? Perhaps the use of the inversion shortcut develops along with the development of other mathematical concepts, not necessarily related to inversion.

Figure 1: Inversion Task on Computer

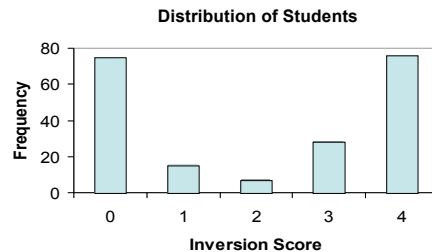


The cross-sectional study presented here focuses on a subset of tasks completed as a part of a larger longitudinal study. This group contained 111 girls and 90 boys in grades 2-4 in two Canadian cities.

Measures

Inversion Task - 14 standard & inversion trials.
 Calculation skill - WJ-R Calculation Subtest
 Conceptual skill - KeyMath Numeration subtest
 Attention skill - Children's Color Trails Test

Results

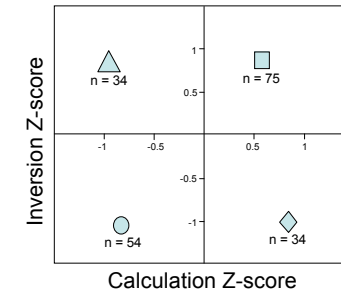


Inversion use was distributed bimodally such that children tended to either answer all or nearly all problems correctly or incorrectly.

We found 4 groups of children. Some children who use inversion have strong calculation skills, but many do not. In addition, many children who have strong calculation skills still do not use inversion.

Conceptual and attention skills did not predict a significant amount of the variance in inversion use.

Calculation Skills and Inversion Use Clusters



Multiple paths to inversion use

Some children appear to begin to apply inversion prior to extensive experience with addition and subtraction while other children continue to use procedural methods rather than the inversion shortcut even after developing high levels of calculation skills. **One possibility** may be that only low level calculation skills are pertinent in discovery of the shortcut. A **second possibility** is that at least some children are sensitive to inversion even prior to school and discovery of the shortcut is a process of mapping to their non-symbolic understanding. A **third possibility** is that many children are sensitive to the inversion shortcut, but an emphasis on syntactic approaches supersedes this understanding in early schooling.

Conceptually advanced solution procedures may develop through experience with calculation, but they may also develop through other routes.