

Knowledge of Fractions and Long Division Predicts Long-Term Math Success

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From factory workers to Wall Street bankers, a reasonable proficiency in math is a crucial requirement for most well-paying jobs in a modern economy. Yet, over the past 30 years, mathematics achievement of U.S. high school students has remained stagnant — and significantly behind many other countries, including China, Japan, Finland, the Netherlands and Canada.

A research team led by Carnegie Mellon University's Robert Siegler has identified a major source of the gap — U. S. students' inadequate knowledge of fractions and division. Although fractions and division are taught in elementary school, even many college students have poor knowledge of them. The research team found that fifth graders' understanding of fractions and division predicted high school students' knowledge of algebra and overall math achievement, even after statistically controlling for parents' education and income and for the children's own age, gender, I.Q., reading comprehension, working memory, and knowledge of whole number addition, subtraction and multiplication. Published in [Psychological Science](#), a journal of the [Association for Psychological Science](#), the findings demonstrate an immediate need to improve teaching and learning of fractions and division.

“We suspected that early knowledge in these areas was absolutely crucial to later learning of more advanced mathematics, but did not have any evidence until now,” said Siegler, the Teresa Heinz Professor of Cognitive Psychology at Carnegie Mellon. “The clear message is that we need to improve instruction in long division and fractions, which will require helping teachers to gain a deeper understanding of the concepts that underlie these mathematical operations. At present, many teachers lack this understanding. Because mastery of fractions, ratios and proportions is necessary in a high percentage of contemporary occupations, we need to start making these improvements now.”

The research, supported by grants from the U.S. Department of Education's Institute of Education Sciences and by the National Science Foundation's Developmental and Learning Science Group at the Social, Behavioral, and Economic Directorate, was conducted by a team of eight investigators: Siegler; U.C. Irvine's Greg J. Duncan; the University of Michigan's Pamela E. Davis-Kean, Maria Ines Susperreguy and Meichu Chen; the University of London's Kathryn Duckworth; the University of Chicago's Amy Claessens; and Vanderbilt University's Mimi Engel.

For the study, the team examined two nationally representative data sets, one from the U.S. and one from the United Kingdom. The U.S. set included 599 children who were tested in 1997 as 10-12 year-olds and again in 2002 as 15-17-year-olds. The set from the U.K. included 3,677 children who were tested in 1980 as 10-year-olds and in 1986 as 16-year-olds. The importance of fractions and division for long-term mathematics learning was evident in both data sets, despite the data being collected in two different countries almost 20 years apart.

“This research is a good demonstration of what collaborations between psychologists, economists,

public policy analysts and education scientists can create,” said Davis-Kean, associate professor of psychology at Michigan. “Instead of relying on results from a single study, this study replicates findings across two national data sets in two different countries, which strengthens our confidence in the results.”

Rob Ochsendorf, program officer for special education research at the U.S. Department of Education’s Institute for Special Education Research added, “This study is critical for providing empirical and general confirmation of the crucial role of division and fractions proficiency for long-term success in mathematics for all students. The results provide important cues to educators and researchers regarding the skills that are ripe for intervention in order to improve overall mathematics achievement in the U.S.”

For more information, watch this short video of Siegler discussing the study and its implications:
<http://youtu.be/7YSj0mmjwBM>.