

Does Early Mathematics Intervention Change the Processes Underlying Children's Learning?

Tyler W. Watts, Douglas H. Clements, Julie Sarama, Christopher B. Wolfe, Mary Elaine Spitler, and Drew H. Bailey

Summary by: Wen Wen

What are “state-” and “trait-” math achievements in early education?

Interventions can boost early math skills, but the role of these early skills on later math achievement is unclear. Consider that students who demonstrate stronger early math skills tend to demonstrate stronger later math achievement, yet some interventions that improve early math skills do not improve later math achievement – that is, the early benefits fade substantially after 2 or 3 years.

To attempt to reconcile these findings, a “state-trait” model was estimated. In this model, the variance in repeated math measures was partitioned into two components: “state” and “trait” variability. “Trait math” captures the variation in math achievement that is stable over time (hypothesized to be influenced by several factors, e.g., conscientiousness, working memory capacity, poverty, etc.), although the design of the experiment did not allow for a strong direct test of these hypotheses. Trait math was modeled as a single-factor that accounted for the variance (i.e., between-individual variation) in mathematics achievement that was assumed to influence math achievement at each wave of measurement. In contrast, “state math” captures the effects of time-specific variations in children's math achievement, which influence subsequent math achievement, for example via the effects of earlier skills (e.g., counting and magnitude understanding) on later skills (e.g., addition, word problem solving).

Will intervention-related effects on early math skills fade over-time?

The authors evaluated whether an early math preschool curriculum had

larger effects on “trait” (i.e., stable) or “state” (i.e., time varying) components of math achievement. They found that all the effect of the math intervention was on “state” math rather than “trait” math, thus allowing for stability in associations of math achievement over time despite diminishing intervention impacts. This provides an explanation for why we often observe that early intervention effects “fade out” over the course of early childhood. In this setting, the authors found that although the intervention affected early math learning, it only affected the parts of math learning that was time sensitive, and it did not affect the stable factors that have persistent effects on children's achievement over time. Importantly, this study does not rule out the possibility of intervention impacts on trait-level variance, but it provides a framework for thinking about what kinds of interventions might be more likely to operate through this pathway.

How did the researchers do this study?

They employed data from the TRIAD (Technology-enhanced, Research-based, Instruction, Assessment, and professional Development) evaluation study, which evaluated the scale-up of the “Building Blocks preschool curriculum”. Forty-two schools in urban low-income areas of northeastern U.S. were enrolled and grouped into 8 different blocks according to their SAT scores. Within each block, the schools were randomly assigned to intervention or control group. Math achievement was measured in preschool, kindergarten, first grade, and fourth grade. The interactions among treatment, trait characters and state effects were analyzed using structural equation modeling with other covariates including language skills, free lunch status, and mother's education.

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