The influence of teacher beliefs on fidelity and efficacy of a technology-based curricular system

Philip Sirinides
University of Pennsylvania

Background

In recent years, mathematics education has experienced significant shifts in what is expected of students, as reflected by new standards, curriculum materials, and assessments. In addition, building on research on teaching and learning, the field has developed ambitious views of math instruction that focus on building students' conceptual understanding along with procedural fluency, engaging students in discussion and problem solving, and utilizing technological innovations to enhance student engagement and opportunities to make sense of mathematics. Supporting teachers in making these shifts in ways that lead to positive impacts on student learning has been a persistent challenge for mathematics education research and policy.

Purpose

This paper examines one example of an intervention that was developed to address this challenge by integrating conceptually rich curriculum materials, technology-based dynamic representations of math concepts, and teacher professional development aimed at supporting teachers' use of new curricula and technology. A recent independent evaluation in two large school districts found inadequate fidelity of implementation and no discernable effect on student performance, as measured by end-of-year state test scores. However, it did have mixed positive effects on mediating factors, specifically teacher beliefs and classroom practices that support opportunities for student collaboration. There was significant impact on teacher comfort and confidence in using technology, beliefs about student struggle, and teacher reports of practices that support student collaboration. There was no impact on teacher beliefs about teaching for incremental mastery or student scores on the end-of-year state achievement scores.

Given these evaluation findings, new questions emerged and are explored here in depth about how this program's design was being adapted in classroom enactment between teachers and students, the explanations teachers had for making adaptations, and how teachers were understanding both student struggle and teaching for incremental mastery. The primary research question is: What are the associations of teacher beliefs and student achievement in math?

Setting

The two Florida districts that participated in the i3 implementation during the 2015-16 school year were selected as the sites in part because they offered an opportunity to assess program impacts with diverse, high-need populations. The student population in district A comprised 32% Hispanic and 28% African American students, with 59% of students eligible for free or reduced-price lunch; the student population in District B comprised 39% African American and 32% Hispanic students, with 61% eligible for free or reduced-price lunch.

Participants

Across the 30 schools assigned to treatment, 342 classroom teachers were trained to implement the program. A total of 725 teachers participated in the i3 study in either the treatment or control group. The analytic sample is comprised of 45,235 middle school students from the 60 schools in both districts.

Intervention

SunBay Digital Mathematics (SunBay) is designed to improve students' engagement with and understanding of core math concepts and shift instructional approaches to position students as active problem solvers and meaning makers. The units are designed to be taught in place of the regular math program over a two-week period, and focus on core concepts in middle-school math: ratios and proportional relationships; expressions and equations; and functions and geometry. There are four core elements of the program model: 1) Multiple representations that provide different points of access to, or ways of understanding, complex mathematical concepts; 2) A technology-based experience that serves as a focal point for classroom dialogue and shared insights; 3) A narrative framework that allows students to access their intuitive knowledge of familiar situations (e.g. mixing paint or playing sports); and 4) A hands-on and engaging approach to learning that harnesses middle-school students' natural curiosity and excitement.

Research Design

The independent evaluation included a cluster-randomized controlled trial and a mixed-methods implementation study. Schools were randomly assigned to either treatment or control condition within two blocking variables, district and Title I status. All study schools remained in their assigned condition throughout the duration of the study. All teachers and students of regular and advanced math in grades 6 and 7 and regular math in grade 8 were involved in the study as part of either the treatment group or the control.

Data Collection and Analysis

Data were collected through surveys, state test scores, interviews, observations, and artifacts. The three teacher belief scales include 1) teachers' comfort and confidence using technology for instruction (CCTI), as measured by our own scale; 2) their tolerance for and understanding of the importance of student struggle as a part of the learning process, as measured by the TASSP scale (Clark et al, 2014); and 3) their recognition of mathematics learning as a process of building deep conceptual understandings, rather than incrementally mastering specific skills, as measured by the TMIM scale (Clark et al, 2014). The three classroom measures of opportunities for student collaboration 1) lesson structure and the role of teachers as facilitators; 2) classroom arrangement for student collaboration; and 3) student technology use for learning through exploration. Each measure was analyzed separately in a model predicting student achievement in math by substituting the treatment indicator for the respective scale and using the same three-level HLM specification with identical covariates as the main impact model for the RCT (pretest and fixed effect for grade and blocking variables).

Findings/Results

The five measures which showed significant and positive impact in the RCT, did not have significant associations with math scores. The one measure (teaching for incremental mastery) which the RCT did not find significant effect, was significantly negatively associated with student math achievement (the direct is as expected). To explore these findings qualitatively, interview and observation data were analyzed. Many teachers had entrenched beliefs about what it meant to teach and learn mathematics that were in direct conflict with the theories behind SunBay. A majority of teacher view reflect the "symbols-first" approach that the intervention intentionally tries to disrupt. The survey data confirms that many teachers implemented SunBay incompletely and/or in ways that did not reflect the curriculum designer's intent. Thirty-eight percent of teachers responding to the survey indicated that they deviated from the program model half of the time or more. Interviews with teachers suggest that modifications to the curriculum ranged from small adjustments--omitting a lesson component now and then to save time, for instance--to large enough adjustments to render the program nearly unrecognizable. For some teachers, however, trying out new ways of teaching math led to learning that was transformative in conceptualizing their role as a teacher.

Conclusions

This paper begins with an overview of the design and results of the independent evaluation of SunBay in terms of fidelity of implementation, impact on student learning, and impact on mediating factors. Taking a deeper look can help explain the lack of impact on student learning provide and valuable insight to future interventions and evaluations. The results have implications for both the design of evaluations and improving implementation and impact of technology-based content interventions.