Individualized, iPad-based math instruction – Does an external, proximal measure reveal differences in students' rates of learning?

Background/Context:

Emerging educational technologies can provide instruction differentiated to student needs. As a supplement to core instruction, technology can simultaneously support (a) intervening with struggling students, (b) addressing skill gaps for students who are generally on-track, and (c) building fluency for students who have already mastered the target content. Rigorously measuring the effectiveness of these technologies is therefore challenging because they are both designed and implemented for different purposes with different students.

The sample size needed to identify effects above and beyond core instruction (especially for subgroups of students) is often prohibitive. Traditional pre/post designs that might be appropriate for studies of core curricula fall short because the content being delivered by the technology is also likely being delivered by the teacher during core instruction, because the technology use replaces some sort of classroom instruction (such that missing that instruction may put treatment students at a disadvantage), and because implementation and dosage may vary dramatically given that the technology is a supplement.

Purpose and hypotheses:

We continue to face these challenges in the context of our KinderTEK iPad math program. After years of development and small evaluations, we are currently conducting a federally-funded efficacy study comparing outcomes for students in kindergarten classes that use KinderTEK to those who engage in the school's regular math instruction and intervention. Anticipating that KinderTEK's effects (timing, scope, and even content) will differ for student subgroups, we designed our study to include a wide range of pre/post and interim measures. For example, we administer the KinderTEK Proximal Assessment (KPA) monthly.

The purpose of the proposed analyses is to explore whether math gains made by treatment students as measured by the KPA at different points through the school year differ from the gains of their control peers and from each other based on initial skill and implementation differences. Our hypotheses are:

-- (a) Early in the year, we expect moderate, positive effects for students who perform in the upper range at pretest. Treatment students with above-average initial skills will likely move quickly through activities early in KinderTEK's sequenced curriculum and reach new content early in the year. Mastering later, more advanced KinderTEK content will put them at an advantage when compared to their control peers who will likely not encounter that content through the core curriculum until later in the school year. Later in the year, we expect KinderTEK effects to be less prevalent for students with above-average initial skills as compared to control students who will learn the same content in the context of core instruction.

-- (b) By the end of the year, we expect robust, positive effects for treatment students who entered kindergarten with below average math skills and knowledge at pretest. Larger effects are expected for students with low initial skills who have used KinderTEK consistently throughout the year given that they've had the time to make meaningful progress through the KinderTEK curriculum. We expect to find effects on discrete skills that are taught early and are used throughout the KinderTEK program to a greater extent than skills that are only encountered at the end of the KinderTEK program.

-- (c) Students performing in the average range at pretest are expected to show the most consistent gains throughout the year as they have the foundational knowledge to move quickly through the earliest KinderTEK activities and will have the foundational skills need to support

their progress through the mid- and later activities. KinderTEK's individualized instruction and response opportunities are expected to expand students' learning of math above and beyond what their control peers experience. We expect to find differences on proximal measures for treatment students with average initial skills.

Research design:

This classroom randomized control trial is expected to involve 120 classrooms (distributed across three implementation years). The first two years of implementation are complete. Year 3 implementation will begin in November 2019. Treatment students use KinderTEK's sequenced mode, 15 minutes per day, 4-5 days per week, for 20 weeks (winter through spring) while control students engage in their regular math instruction and intervention. All students complete proximal and distal assessments at pretest, during implementation, and at posttest.

Setting & participants:

Our large-scale efficacy study is taking place in Oregon and Pennsylvania kindergarten general education classrooms. All students in participating classrooms are invited to participate. During the first two years, 58 classrooms and 1,149 students (582 treatment, 560 control) participated. Year 3 recruitment is still under way.

Intervention/program:

KinderTEK is an engaging, interactive iPad-based math program targeting kindergarten whole number concepts. The app is usable in even resource-strapped schools and offers four instructional modes and supports. Students with a range of learning and behavioral challenges engage in individualized and differentiated math instruction, assessment, practice and review, as well as rewards and progress monitoring of their own learning. Educators use the app or a robust data dashboard to manage classes; adjust settings (e.g., activating engagement supports, timers, progress views, and instructional modes); and view reports. KinderTEK's online resource library supports educators in implementation and data-based decision-making (particularly around K-Gr3 students at-risk for math learning disabilities).

Data collection and analysis:

Measures relevant to the proposed analyses include the MAP (NWEA) and the KinderTEK Proximal Assessment (KPA; Authors). The MAP is an online, adaptive math assessment administered at pretest and posttest. The KPA addresses the content in KinderTEK through 28 items and is administered at pretest, monthly, and at posttest. Using all data from years 1-2 and any year 3 data that is ready for analysis, we will explore differential rates of change on the monthly KPAs by condition, initial skill level (as measured by the MAP), and other factors. We will use a set of multilevel latent growth curve models to appropriately model the nested nature of the data and accommodate missing data.