Abstract Title Page

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Title: Sustainability of Fidelity of Implementation Over Time, in the Context of a Prekindergarten Mathematics Curriculum and Professional Development Scale-Up Intervention

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Abstract Body

Limit 4 pages single-spaced.

Background / Context:

Description of prior research and its intellectual context.

The theoretical framework supporting the scaling up of this research-based, learning trajectories-focused mathematics intervention is an interconnected network of influences at school, classroom and student levels (Clements & Sarama, 2004), with faithful implementation at the center of the model. Sustained and faithful continuation of the intervention is theorized as a teacher outcome. Learning trajectories are at the core of the components of this intervention, guiding the curriculum, the instruction, the formative assessment, and the professional development for all these. Coherence of research and connection to practice have been theorized as supportive of sustainability (Boerst et al., 2010; O'Connell, 2012). Learning trajectory-based instruction provides coherence, and offers an emerging theory of teaching (Sztajn, Confrey, Wilson, & Edgington, 2012). This emerging theory of teaching provided guidance in the analysis and interpretation of this sustainability data. Moreover, the extant study from which these data are drawn has documented significant positive change for children within the treatment condition relative to children within the control condition. These results have been published recently across multiple journals (Clements, Sarama, Wolfe, & Spitler, 2011).

Purpose / Objective / Research Question / Focus of Study:

Although there is growing interest in implementation fidelity, little research has been reported on the sustainability over time of faithful implementations of learning innovations (O'Connell, 2012). This study examined the sustainability of teachers' implementation fidelity to the components of a prekindergarten mathematics intervention two full years after external support ceased. Fidelity has been shown to decrease as time between interactions with developers increases (Datnow, 2005; Hargreaves, 2002). We hypothesized that an innovation based on coherent learning trajectories, wherein teachers increase their familiarity with mathematical goals, hypothesized developmental paths leading to the achievement of those goals, and activities designed to enable children to attain those goals, positively impacts teachers' sustained and faithful implementation of the innovation.

Setting:

This research draws from a large-scale up study of professional development across two diverse research settings. Teachers were from 42 randomly assigned public schools in two cities (one distal), serving primarily low-income, ethnically diverse students

Population / Participants / Subjects:

Participants were 106 (72 treatment) prekindergarten teachers. Data from 64 masters-level teachers (1 male) in 26 schools across both sites are included here. Students enrolled at randomly assigned schools who returned parental consents were eligible. Student participants were four-year-olds (51% Female) of mixed ethnicity (53% African American, 21% Hispanic, 19% White, 3.7% Asian Pacific, 1.8% Native American, and .6% Other). Most (82.33%) received free or reduced lunch, 13.5% had limited English proficiency, and 10% had an IEP.

Intervention / Program / Practice:
Teachers participated in 13 professional development (PD) sessions over two years, and interacted with peer coaches and project staff mentors as they implemented the curriculum. The focus in PD sessions was not on just curricular instruction but on changing the way teachers think about mathematics instruction by focusing on learning trajectories (author reference; author reference; Simon, 1995).

Research Design:

Using longitudinal growth modeling, we examined fidelity to the curriculum at three time points across the course of the study: fall 2006, spring 2007, and spring 2009. The first two time points reflect observations of teacher fidelity during the data collection time period of the study. The spring 2009 time point reflects a return to these prekindergarten classrooms two years past their involvement with the project.

Data Collection and Analysis:
The main data source for this sustainability study was a classroom observation measure, rather than teacher self-reports, which make up the main body of evidence of sustainability (O'Connell, 2012; Timperley, Wilson, Barrar & Fung, 2007). The Near Fidelity instrument was designed to evaluate whether or not, and to what degree, teachers were faithfully implementing the critical components of the curriculum, both on- and off-computer. The Near Fidelity instrument is comprised of multiple subsections. Observers rate agreement with curricula based statements on a 5 point scale (0 = neutral/not applicable***).*** An example of the Likert scale questions within each subscale, with potential answers varying from "Strongly Disagree" to "Strongly Agree" is: "The teacher facilitated children's responding: e.g., elicited many solution methods for one problem, encouraged elaboration of children's responses, waited for and listened attentively to individual children, responded to errors as learning opportunities." Project mentors collected data using this instrument, after participating in several training meetings and conducting interrater reliability visits over two years. Interrater reliability was 95%, arrived at through simultaneous classroom visits by rotating pairs of observers for 10% of all observations. Three time invariant covariates were selected for this analysis. The impact of site (dichotomous), years of experience teaching (range, 1-30+) and percentage of professional development attended. These three covariates seek to contextualize and account for both intercept and rate of growth differences across the three measured timepoints.
Findings / Results:

General Classroom. Within the General Classroom subscale, the intercepts are significantly different from one another across time points. Participant teachers continued to increase in the observed characteristics within the general classroom subscale. Neither sites nor percentage of PD attendance demonstrated significant impacts in initial levels. Teachers with more experience demonstrated lower intercept levels of GC across time compared to those of less experienced teachers. No significant differences in the rate of growth as a function of the included covariates were observed. This suggests a similar rate of growth across individual differences in site, years of experience, and percentage of PD attended (insert Table 1).
Whole Group. Overall, the intercepts are significantly different from one another across time points. At each measurement timepoint, treatment teachers exhibited observed growth in their enactment and management of whole group settings within the instruction of mathematics while

maintaining fidelity to the core teaching methods within the professional development. Although the overall rate of growth was not significant, the proximal site exhibited significantly slower growth than the distal site. Site, however, was not a significant predictor of intercept differences across time. Teachers with more experience had higher levels of initial Whole Group fidelity than teachers with less experience. Teachers with greater percentage of attendance in PD had lower initial WG levels of fidelity across time.

Small Group. Overall the intercepts are significantly different from one another across time points. Treatment teachers, again, demonstrate continued growth in their fidelity to the professional development program within the small group instructional setting in a pre-K mathematics lesson. Site has a significant impact on intercept differences such that teachers at the proximal site demonstrated significantly lower initial levels of Small Group (SG) across time relative to the distal site. Teachers with more experience demonstrated significantly lower initial levels of SG fidelity across time relative to teachers with less experience. Percentage of PD attended did not significantly impact initial levels of SG across time. The overall main effect for the slope was not significant, suggesting similar overall rates of growth across time points. Teachers with more experience demonstrated significantly higher rates of growth across time points relative to teachers with less experience. Site and percentage of PD attended were not significant predictors of growth in SG fidelity across time.

Computer. Overall, the initial level of computer fidelity was significantly different across time and demonstrated significant growth between measurement periods. None of the time invariant predictors (Site, Yr. Exp, and percentage of PD attended) had a significant impact on initial levels of computer fidelity. Rate of change across time was negatively impacted by percentage PD attendance – such that greater attendance was related to a slower rate of growth for Fidelity to the Computer component.

Conclusions:

Teachers exposed to the PD during the intervention continue to demonstrate high levels of fidelity to the underlying curriculum two years past exposure and without continued project support (insert Figure 1). The percentage of PD attendance, however, did not act as a significant predictor for initial levels within any of the measured subscales. Importantly, however, greater PD attendance was positively related to change in initial levels across time. PD attendance did seem to negatively impact rate of growth within the whole group subscale. This could be due to the focus on small group activities and instruction within the overall PD program, where individual movement along learning trajectories was supported by the teacher. In accordance, a trend ($p=.09$) toward a positive impact of PD attendance on small group fidelity was also found.

Site also demonstrated an inconsistent pattern across measured subscales. Initial levels are not significantly different except for fidelity to small group, for which Site 1 teachers are significantly lower. The rate of change is also not significantly different across subscales except for the WG subscale.

Years of experience for the individual teacher demonstrated a varied pattern. Teachers with more experience had lower fidelity to the GC and SG components, consistent with prior research demonstrating that inexperienced teachers are more likely to sustain faithful implementation than experienced teachers (Gersten, Chard, & Baker, 2000; Stein et al., 2008), while experienced teachers may be more resistant to change (Coburn, 2004). Teachers with more experience demonstrated significantly faster rates of growth than their less experienced colleagues, and higher initial levels of fidelity to the whole group component. Overall, teachers with more experience may have gravitated toward and excelled at the whole group format as it most closely mirrors their prior experience in PreK mathematics instruction. Exposure and time with the curriculum, however, seemed to indicate a rapid growth in experienced teachers' fidelity to the SG component, perhaps indicating increasing understanding of the concepts and procedures of small group instruction.

The learning trajectory based instruction engaged in by the prekindergarten teachers in this study may have provided a coherent program of teaching and learning, and may have promoted the statistically significant levels of fidelity found in this study. Teachers taught the curriculum with increasing fidelity as time went by, while no longer supported by research project staff. They seemed to have internalized the program (Timperley, Wilson, Barrar, & Fung, 2007), and to have made sense of the curricular activities involved with whole group, small group, and other components, within an overall structure of learning trajectories that progressed toward a known mathematical goal. By engaging in the initial PD, and then, possibly becoming empowered by their own knowledge of the trajectories and the ways to support learners through the trajectories, they became progressively more faithful to the intended program, instead of drifting from it as time elapsed and support disappeared, as has been documented by other studies when external support is withdrawn (Datnow, 2005; Hargreaves, 2002).

The coherence of a model of PD, curriculum, instruction, and assessment based on learning trajectories (see Daro, Mosher, & Corcoran, 2011) may provide the conditions for promoting sustainability in teacher practices, and may be particularly beneficial in addressing the climate of low expectations in urban schools (Johnson & Fargo, 2010), as teachers increase their understanding of the capacities of all children to learn mathematics.

As teachers come to understand children's probable developmental paths and become adept at anticipating children's strategies and misconceptions, their teaching practices may become more grounded and solidified. As they monitor for students' multiple models, and probe for the ways in which students mathematical thinking fits the structure of the trajectory, their teaching practices may become reinforced as student reactions provide positive feedback for their practices (Guskey, 2002). Teachers who demonstrate sustained fidelity of implementation to a program that has demonstrated improved child achievement could have an impact on many more students than teachers who implement with fidelity only during treatment.

Appendices

Not included in page count.

Appendix A. References

References are to be in APA version 6 format.

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Appendix B. Tables and Figures

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Table 1. Descriptives and standardized estimates for Fixed and Random parameters for each best fitting modeled Fidelity subscale

	GC	WG	SG	CP
# of items	5	7	25	12
Total Possible	14	28	75	40
Reliability	α=.60-.66	α=.81-.83	α=.90-.95	α=.73-.84
Means				
Intercept	5.49 (.760)**	10.58 (1.48)**	4.69 (1.38)**	5.15 (1.34)**
Slope	5.38 (3.64)	.154 (1.04)	3.32 (2.32)	2.64 (.657)**
Random Effects				
Intercept				
Site	-.060 (.156)	.132 (.144)	-.436 (.194)*	-.234 (.204)
Yr. Exp	-.260 (.128)*	-.234 (.092)*	-.342 (.111)**	.019 (.212)
PD %	.277 (.212)	-.002 (.151)	.344 (.203)	.260 (.174)
Slope				
Site	-.746 (.550)	-.383 (.153)*	.148 (.394)	-.017 (.143)
Yr. Exp	.607 (.510)	.042 (.155)	.830 (.159)**	-.154 (212)
PD %	.387 (.808)	.112 (.226)	-.418 (.351)	-.241 (.122)*
Variances				
Intercept	.836 (.124)**	.940 (.050)**	.401 (.159)*	.857 (.117)**
Slope	--[a]	.829 (.175)**	--[a]	.922 (.076)
Model Fit				
χ^2 (df)	15.80 (6)	9.64 (4)	2.31 (6)	7.23 (5)[b]
RMSEA	.152 (.062-245)	.141 (.015-.257)	.000 (.000 -072)	.085 (.000-.211)
SRMR	.062	.116	.046	.074

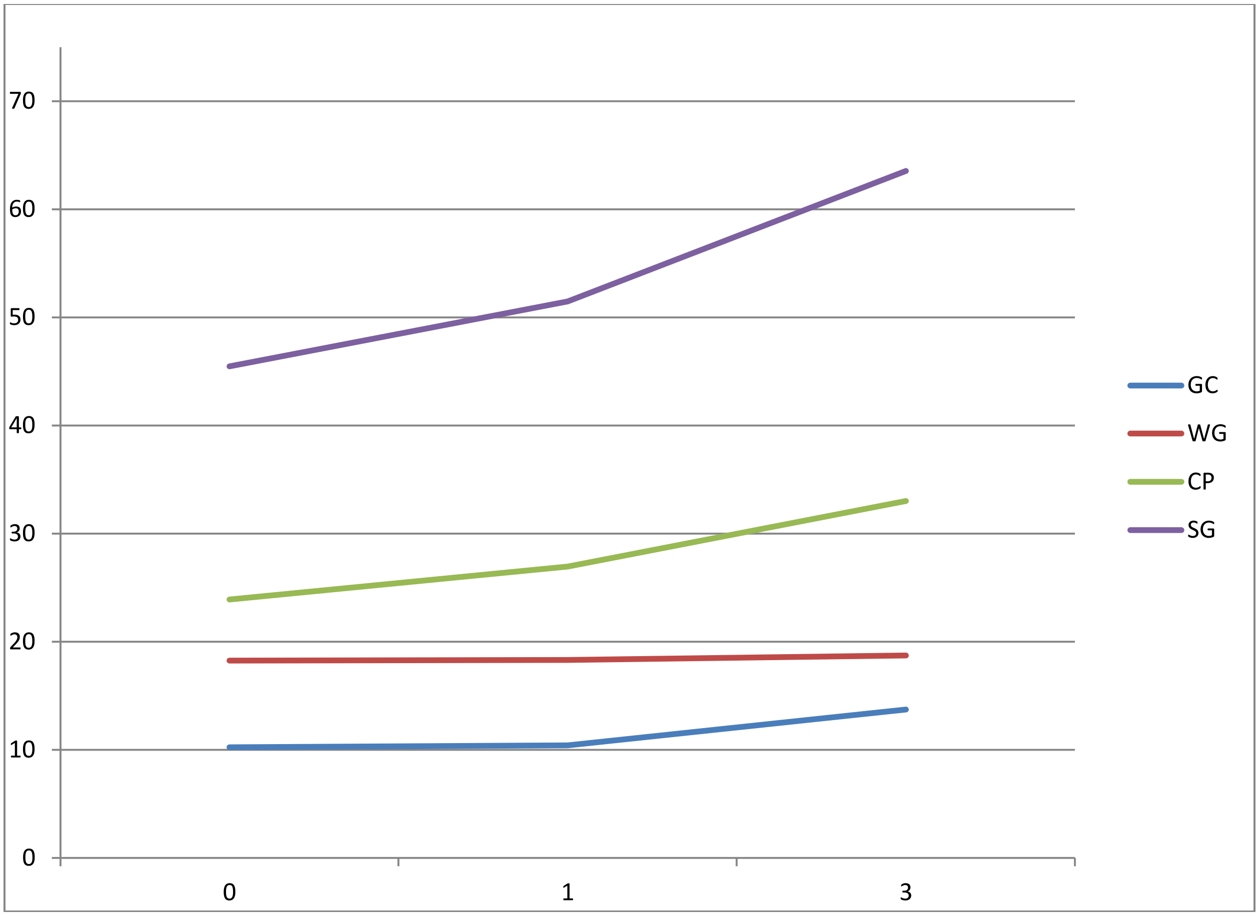

Figure 1. Fidelity of implementation is displayed over three time points for each subscale. Subscales were measured on separate scales. Scale information is in Table 1