Abstract Title Page

Title: Early Childhood Hands-On Science Efficacy Study

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Abstract Body

Background / Context:

ECHOS: Early Childhood Hands-On Science was developed at the Miami Science Museum as a comprehensive set of science lessons sequenced to lead children toward a deeper understanding of science content and the use of science process skills. Both ECHOS science lessons and integrated math, language and creative arts activities are designed to build upon children's existing knowledge base and to introduce new experiences that will become the foundation for the development of more complex science concepts that will be introduced later in their schooling.

The ECHOS Goal 3 Efficacy Study was funded by the Institute of Education Services (IES) to investigate the potential of the ECHOS model to increase teacher use of exemplary science-related instructional strategies that would impact children's science knowledge and use of science process skills.

Purpose / Objective / Research Question / Focus of Study:

The purpose of the research is to determine whether use of the *ECHOS* model will increase the amount and quality of science teaching and learning in preschool programs serving low-income children.

Setting:

ECHOS development and research is conducted in Head Start classrooms located in Miami-Dade County.

Population / Participants / Subjects:

Classrooms are comprised largely of African-American (55%) and Hispanic (35%) children, ages 3–5.

Intervention / Program / Practice:

ECHOS is based on the conviction that teachers of children at risk of school failure need to be both content sources and facilitators of learning who deliberately structure the environment and provide explicit instruction on basic science concepts. ECHOS professional development is focused on key science concepts and process skills introduced in the lessons to increase teachers' own science knowledge base and to build their confidence and skill in increasing children's ability to do science.

The ECHOS curriculum consists of nine units, each containing four guided week-long science lessons that are introduced in 20-minute segments to small groups of children. Each unit is supplemented with 12 integration cards (*i*-Cards); 108 for the entire program. The *i*-Cards provide open-ended explorations that reinforce the science concepts introduced in the lessons, and are designed to be delivered by teacher assistants, volunteers or parents in the domains of language and literacy, mathematics, and creative arts. Typical implementation consists of the

teacher working with a small group of 6–8 children on the ECHOS core science lesson, while the teacher assistant works with the rest of the class on *i-Card* activities. The units are sequenced to present increasingly more complex science process skills. The delivery of the 36 ECHOS lessons follows a project-designed learning sequence designed to provide teachers with a logical structure to deliver lessons that promote learning by thinking and doing.

ECHOS professional development is designed to provide teachers and assistants with the science content knowledge they need to feel comfortable in providing explicit instruction on the key science concepts that are introduced in the ECHOS science lessons and integration cards. PD is provided in small groups to model instructional strategies to be employed by the teaching teams.

Research Design:

In the 2011-2012 school year, 91 classrooms (45 ECHOS, 46 Control), with no prior experience implementing ECHOS, participated in the first of the two-year Goal 3 randomized, controlled trial examining the effectiveness of ECHOS. Baseline data were collected prior to randomization. Next, classrooms were randomly assigned to treatment group implementing ECHOS or to a business-as-usual control group. Approximately ten children from each classroom were randomly selected and stratified by age and gender, to be assessed on their science skills.

Data Collection and Analysis:

Teachers were observed using the project-developed Preschool Science Classroom Observation Tool (PreSCOT) at baseline, and again in the winter and spring of the school year. Approximately ten children from each classroom were assessed on their science skills using the Direct Assessment of Science (Greenfield, Dominguez, Fuccillo, Maier & Greenberg, 2009) in the fall, winter and spring of the school year.

To assess intervention fidelity, Museum staff observed teachers in the treatment group at the winter and spring of the academic year, using the ECHOS Fidelity Observation Tool. This ten-item instrument was designed to measure adherence to the ECHOS model (5 items) and quality of implementation (5 items), using a three-point rubric (0 = low, 1 = medium, 2 = high).

Findings / Results:

Analyses at the end of the first year show preliminary evidence for the effectiveness of ECHOS on the quality of teacher's science instruction and on children's science skills. A series of repeated-measures analysis of variance (ANOVA) revealed that ECHOS teachers significantly improved their scores in predicting, investigating, and evaluating across the year, while control group teachers did not (see Table 1). Multilevel models were analyzed to determine if ECHOS was associated with children's growth in science skills across the year. The results revealed that all children showed significant growth in science skills ($Slope_{\gamma} = 5.76$, $p < .001$); a trend indicated faster rates of growth for children in ECHOS classrooms ($ECHOS_{\gamma} = 0.49$, $p = .069$). Analyses conducted to determine if ECHOS predicted gains in science skills differently from fall to winter and from winter to spring showed that while ECHOS did not predict gains from fall to winter, a trend indicated that ECHOS predicted more gains in science skills from winter to spring compared to control classrooms (see Table 2). Analyses of fidelity observation data revealed a relatively high rate of fidelity to the model: at mid-year, fidelity observation scores averaged 8.5 for adherence and 7.9 for quality on a ten-point scale, and by the end of the year, scores had increased slightly to 8.8 for adherence and 8.6 for quality.

Conclusions:

These positive preliminary results from a first year of the randomized controlled trial, and relatively high rates of teacher fidelity, indicate that ECHOS has demonstrated its potential to impact teacher practice and student outcomes. Full conclusions will be reported upon completion of the study.

Appendices

Not included in page count.

Appendix A. References

Greenfield, D.B., Dominguez, X., Fuccillo, J., Maier, M. & Greenberg, A. (2009, June). *Development and initial validation of an IRT-based direct assessment of preschool science readiness. Poster presented at the Institute of Education Sciences Research Conference,* Washington, DC.

Appendix B. Tables and Figures

Table 1. Differences in Quality of Science Teaching over Time between ECHOS and Control

PreSCOT	Baseline	Winter	Spring	Group x Time
Wondering				
ECHOS	1.20 *(0.62)*	1.43 *(0.53)*	1.43 *(0.55)*	*F (1,84)* = 1.13, *p* = .32
Control	1.24 *(0.63)*	1.30 *(0.56)*	1.25 *(0.54)*	
Describing				
ECHOS	.98 *(0.41)*	0.82 *(0.43)*	0.85 *(0.42)*	*F (1,84)* = 0.68, *p* = .51
Control	.87 *(0.51)*	0.80 *(0.43)*	0.69 *(0.41)*	
Observing				
ECHOS	0.66 *(0.35)*	0.55 *(0.36)*	0.40 *(0.32)*	*F (1,84)* = 2.52, *p* = .084
Control	0.61 *(0.36)*	0.44 *(0.30)*	0.50 *(0.30)*	
Predicting				
ECHOS	0.62 *(0.79)*	0.24 *(0.58)*	0.62 *(0.76)**	*F (1,84)* = 4.54, *p* = .012*
Control	0.73 *(0.85)*	0.52 *(0.73)*	0.30 *(0.63)*	
Investigating				
ECHOS	0.68 *(0.66)*	0.74 *(0.54)*	0.90 *(0.55)**	*F (1,84)* = 4.11, *p* = .018*
Control	0.86 *(0.68)*	0.67 *(0.55)*	0.61 *(0.43)*	
Evaluating				
ECHOS	0.57 *(0.77)*	1.26 *(0.77)*	1.02 *(0.90)**	*F (1,84)* = 3.54, *p* = .031*
Control	0.75 *(0.84)*	0.93 *(0.85)*	0.64 *(0.75)*	
Total Score				
ECHOS	0.80 *(0.39)*	0.78 *(0.28)*	0.76 *(0.33)* †	*F (1,84)* = 0.84, *p* = .44
Control	0.80 *(0.37)*	0.70 *(0.28)*	0.65 *(0.25)*	

*Not*e. Independent samples T-tests were conducted to determine significant differences in scores across group in the spring, and repeated measures ANOVAs were conducted to examine significant differences in scores across group over time. Science teaching scores represent raw scores (Range = 0-2).
***$p < .001$, **$p < .01$, *$p < .05$, †$p < .07$

Table 2. Associations between ECHOS Curriculum and Gains in Science from Winter to Spring

Fixed Effects	Science	
Parameter	Estimate (SE)	*p*-value
Intercept (γ_{000})	19.05*** (0.97)	< .001
ECHOS (γ_{001})	3.71† (1.93)	.057
Age (γ_{010})	0.19 (0.12)	.142
Sex (γ_{020})	1.37 (1.64)	.404
Hispanic (γ_{030})	2.54 (2.78)	.362
Other (γ_{040})	3.96 (7.23)	.586
Dual Language Learner (γ_{050})	3.31 (2.45)	.176

Note. The outcome is the change in children's science scores from winter to spring. Age is children's age in months. Gender (Female, = 1), Ethnicity and Language are dummy-coded with Black/African American and English Language as the reference groups.

***$p < .001$, **$p < .01$, *$p < .05$, $^{\dagger}p < .07$