

Abstract Title Page

Title:

Implementation Fidelity: Implications for the Numbers Plus Curriculum

Author(s):

Lena Malofeeva, Ph.D., LLP, High/Scope Educational Research Foundation; Marijata C. Daniel-Echols, Ph.D., High/Scope Educational Research Foundation; Zongping Xiang, MA, High/Scope Educational Research Foundation; Ann S. Epstein, Ph.D., High/Scope Educational Research Foundation

Abstract Body
Limit 5 pages single spaced.

Background/context:

Description of prior research and/or its intellectual context and/or its policy context.

The Numbers Plus preschool mathematics curriculum supports instruction throughout the day, with a primary focus on small group time activities. It is organized according to the five content areas of the *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics: NCTM, 2000): number and operations, geometry, measurement, algebra, and data analysis. In keeping with recommendations in *Curriculum Focal Points for Prekindergarten Through Grade Eight Mathematics* (NCTM, 2006), Numbers Plus places more emphasis (close to 75% of its activities) on the first three content areas.

The purpose of the Numbers Plus project was to develop, implement, and test an early mathematics curriculum. As a part of that process, the pressing need to clearly define and measure implementation fidelity not just in this project but in general when evaluating interventions became apparent.

Fidelity of implementation (FOI) is defined as a degree to which a program is implemented as defined by program developers (Dane & Schneider, 1998). Knowing and assessing FOI has implications for internal and external validity. Understanding critical features of the intervention, determining what program components were or were not implemented, how their implementation is related to program effectiveness, and identifying conditions under which the implementation could be carried out at a high level are all linked to the importance of assessing FOI for understanding of the program, estimating its effectiveness, replication, and scale up efforts.

Dane and Schneider (1998) analyzed 162 studies indicating that only 39 of them reported some evidence of assessing FOI. They developed a useful framework by presenting five aspects of fidelity: 1) Adherence (program components are delivered as planned by program developers) 2) Exposure (frequency and dosage of implementation) 3) Quality of the delivery (how a teacher implements a program, e.g., enthusiasm, supervisor support) 4) Participants' responsiveness (students' responses to the intervention - e.g., the degree of their engagement, level of activity) and 5) Program differentiation (a manipulation check to make sure students in each condition receive only planned interventions). The authors recommended measuring all five aspects of fidelity.

Purpose/objective/research question/focus of study:

Description of what the research focused on and why.

The purpose of this paper is to propose a framework for conceptualizing and assessing fidelity of implementation (FOI) in the context of a cluster-randomized design study. A research-validated mathematics curriculum for preschool children called Numbers Plus is used as an example to describe the role of curriculum implementation fidelity in the evaluation of programs, curricula, initiatives, and professional development activities.

Setting:

Specific description of where the research took place.

This three-year project was implemented in two states – Michigan and Indiana.

Population/Participants/Subjects:

Description of participants in the study: who (or what) how many, key features (or characteristics).

A total of 17 partner programs participated in the project. They were a mix of Head Start, private child care, and faith-based programs (see Table 1). Data from the second year of the project came from a total of 37 preschool sites, including 149 teachers from 70 classrooms and 417 children (210 in the treatment group and 207 in the control group). Among the sites 51.4% were in urban areas, 25.7% suburban, and 22.9% were rural area sites.

Teachers' ages ranged from 21 to 67 years. Most teachers were Caucasian (about 71%) and female (98%). Study teachers reported having been teaching anywhere from 0 to 30 years ($M=11.23$). In addition, 57.1% of lead teachers in the treatment group and 64.7% of the lead teachers in the delayed treatment group had their highest degree in early childhood education or child development.

Intervention/Program/Practice:

Specific description of the intervention, including what it was, how it was administered, and its duration.

Numbers Plus teaching strategies draw on the five underlying principles of active, participatory learning (Hohmann, Weikart, & Epstein Educating Young Children Third Edition, 2008). The strategies include materials, manipulation, choice, child language and thought, and adult scaffolding. Together they describe a set of teaching practices that specify what teachers say and do, describe the types of learning opportunities teachers provide to children, and encourage teachers to use observation based information to identify children's developmental levels. The five strategies align with and support the five process standards identified by NCTM - problem-solving, reasoning, communicating, connecting, and representing.

A unique feature of Numbers Plus is that it sequences within rather than across activities. That is, instead of being introduced in a specific order (making it sometimes necessary to split children into ability groups), Numbers Plus activities assume that children of varying levels participate together in an activity and, with a few exceptions, no one activity must be mastered before another. To put this approach into practice, every activity provides teachers with examples of what children on a continuum of three levels (Earlier, Middle, and Later) may say and do. Correspondingly, for each level, the activity lists strategies teachers can use to support and extend children's learning.

In order to support this approach, the curriculum uses Key Developmental Indicators (KDIs) in each mathematical content area and topic. KDIs represent the important mathematical skills or concepts young children should acquire, or make substantial progress toward acquiring, by the end of preschool. Additionally, ten days of combined face-to-face and online, in-depth professional development was provided to teachers. The focus of that training was active learning, understanding math content, specific teaching strategies, and mastery of the small group time activity structure and process.

Both delayed treatment control and experimental classrooms implemented the High/Scope curriculum in their classrooms as their overall curriculum model. During the school year,

experimental classrooms also implemented the Numbers Plus curriculum. The curriculum materials and activities primarily focused on content specific small group time activities. Follow-up ideas extend learning into other parts of the daily routine (such as meal times, during outside play, while children make plans and choices, at transitions, and so on) and in all areas of the classroom.

Research Design:

Description of research design (e.g., qualitative case study, quasi-experimental design, secondary analysis, analytic essay, randomized field trial).

The development and evaluation of this work has been a three year process. Year 1 consisted of curriculum development and a pilot testing. Years 2 and 3 have consisted of implementation and evaluation. Data collection was done within a cluster randomized three-level design with randomization occurring at the site level (stratified on the type of program (Head Start and non- Head Start) and the number of classrooms per site (1-2 classrooms versus 3-5 classrooms per site)).

Data Collection and Analysis:

Description of plan for collecting and analyzing data, including description of data.

Data has been collected from teacher reports, child assessments, parent reports, and classroom observations. Because a central concern of the work has been insuring high quality implementation, tools were developed to measure implementation fidelity.

The fidelity measures used in the study were based upon the curriculum theory and included multiple methods of assessment at multiple levels. The data on small-group time implementation was collected by administering the Mathematics Program Assessment, Part 2. The data on math throughout the day strategies was collected by using the Mathematics Program Assessment, Part 1. Activity Logs, teacher and director surveys, tracking training participation, and evaluating training were additional methods to assess the five aspects of fidelity.

The development of the composite fidelity indices as well as issues related to weighting, aggregating the indices, standardizing, and developing a normative framework will be broadly described. Some of the indices (i.e., achieved relative strength that is based on Hedges' g) created for the Numbers Plus study were modeled after the work done by Cordray and his colleagues (Cordray, Hulleman, and Lesnick, 2008) and some were specific to the evaluated curriculum. Multi-level modeling techniques also affect how FOI is measured: the need to balance the number of fidelity indices with sample size, correcting for clustering in the classrooms will be presented using the Numbers Plus data. Currently, each of the developed indices and different weighting schemes (i.e., when each component contributes equally as opposed to differential component weighting) are being explored to see how they function with multi-level data.

Currently, the fidelity indices are being tested in mediator models. We will present on the relationship between FOI (utilizing various types of indices) and teacher- (e.g., knowledge, beliefs about math instruction, frequency of classroom practices, confidence in teaching about math, and anxiety related to teaching mathematics) and child-level outcomes (e.g., TEMA-3, Woodcock-Johnson III Applied Problems subtest, Child Observation Record) when controlling for covariates.

Findings/Results:

Description of main findings with specific details.

We argue that using various measures of fidelity of implementation provides stronger validity evidence and identifies mechanisms of how implementation works. In addition, the results of the analyses on student and teacher characteristics predicting FOI will be shared.

Conclusions:

Description of conclusions and recommendations of author(s) based on findings and over study. (To support the theme of 2009 conference, authors are asked to describe how their conclusions and recommendations might inform one or more of the above noted decisions—curriculum, teaching and teaching quality, school organization, and education policy.)

FOI is an important concept in educational research, especially, studies implemented in schools. Well-designed studies assess FOI as a necessary step. It is, however, still true that there is little guidance on what aspects of fidelity to measure and how such assessment differs depending on the area of research, specific goals (development, efficacy, replication, or scale up), or a type of intervention used. This work will help researchers think critically about how to develop a framework of how to measure FOI and set guidelines that inform researchers, teachers, and policy makers about what curriculum or programs work for what students and under what conditions is proposed.

Appendixes
Not included in page count.

Appendix A. References

References are to be in APA format. (See APA style examples at the end of the document.)

Cordray, David S., Hulleman, Chris, & Lesnick, Joy. (2008). Assessing Intervention Fidelity in RCTs: Concepts and Methods. Presentation for the Institute for Education Sciences Research Conference. Washington, DC.

Dane, A.V., & Schneider, B.H. (1998). Program integrity in primary and early secondary prevention: Are implementation effects out of control? *Clinical Psychology Review, 18*, 23-45.

Hohmann, M., & Weikart, D. P. (2002). *Educating young children: Active learning practices for preschool and child care programs (2nd ed.)*. Ypsilanti, MI: High/Scope Press.

National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2006). *Curriculum focal points for prekindergarten through grade 8 mathematics: A quest for coherence*. Reston, VA: Author.

Appendix B. Tables and Figures
Not included in page count.

Table 1

Year 2 Percentage of Sites by Group Stratified by Type of Program and Number of Classrooms per Site

Types of Sites	Treatment	Delayed Treatment
Head Start	60	63.2
Non-Head Start	40	36.8
Smaller sites (1-2 classrooms per site)	65	68.4
Larger sites (3-5 classrooms per site)	35	31.6