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Focusing on the Whole Teacher in Early Math Teacher Professional Development

by Jie-Qi Chen & Jennifer McCray

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Abstract

In this paper, we introduce a conceptual framework for in-service professional development—the Whole Teacher approach, which attends simultaneously to the attitudes, knowledge, and practice of a teacher's professional growth. Putting the framework in operation, we describe a project designed to improve teachers' competence and increase children's performance in early mathematics. Utilizing a quasi-experimental design, pre- and post-measures with intervention and comparison groups were collected. The results indicated that significant growth in children's mathematical performance favored to the intervention group. The discussion focuses on the significance of the Whole Teacher approach to early math teacher professional development.

Focusing on the Whole Teacher in Early Math Teacher Professional Development

A large body of literature specifies what constitutes high quality in-service professional development (PD) (Borko, 2004; Darling-Hammond, et al., 2009; Desimone, 2009; Guskey, 2003; Wei, Darling-Hammond, & Adamson, 2010). Among the major factors noted are (a) the use of an on-going process instead of a one-shot, cursory workshop, (b) emphasizing collaborative participation rather than teachers working in isolation, (c) tailoring training to meet the specific needs of teachers as opposed to such general goals as improving teaching and learning, (d) providing hands-on opportunities to construct new knowledge instead of lectures that target knowledge transmission, and (e) connecting workshop-developed knowledge to classroom practice through coaching or follow-up sessions.

Augmenting to the effective PD strategies in the literature, this paper describes a conceptual framework for in-service PD, namely, the *Whole Teacher* approach (Chen & Chang, 2006a). As a conceptual framework, it provides an over-arching understanding of "what works" and "why it works" in addition to "how to ensure PD works". To articulate the *Whole Teacher* approach, we first define its three major components: attitudes, knowledge, and practice. We then describe a PD program aimed at improving the quality of early math education in urban school settings utilizing the approach. We further present outcome data that demonstrates its positive impact on children's math achievement. The paper concludes with a discussion of the significance of the study to the field of teacher professional development.

Theoretical Framework

The *Whole Teacher* approach attends simultaneously to the social/emotional, cognitive, and behavioral aspects of a teacher's growth. A significant departure from the traditional approach to PD that speaks primarily to teachers' acquisition of knowledge and skills, the *Whole Teacher* framework emphasizes promoting all aspects of a teacher's development, including her attitudes, knowledge, and practice (Chen & Chang, 2006a, 2006b; Chen & McCray, 2012).

Teacher attitudes about a content area or an instructional practice are rarely addressed in PD sessions despite of the fact that they are closely related to teachers' knowledge acquisition and classroom practice (Chen & Chang, 2006b; Pianta, et al., 2005; Vartuli, 2005, Wilkins, 2008). In the field of early mathematics, a large portion of early childhood teachers describe themselves as math phobic (Copley, 2010). Such attitudes toward mathematics leaves a strong imprint on children's minds (Beilock, Gunderson, Ramirez, & Levine, 2009). By explicitly addressing early childhood teachers' attitudes toward math, PD is more likely to affect positive changes in teaching (Clements & Sarama, 2009).

Knowledge is the primary focus of most PD programs. Early mathematics—the mathematics that precedes arithmetic and the use of symbol systems for describing mathematical operations—is not widely understood (Chen, McNamee, & McCray, 2011). Early childhood teachers are trained as generalists. It is unlikely that they can provide quality early math education without the understanding of foundational math concepts in relation to young children's development (Sarama & DiBiase, 2009).

An ultimate measure of PD effectiveness is the classroom teaching. As teachers apply knowledge and methods learned through PD programs, they inevitably encounter unexpected challenges that require adaptations to make the practices effective (Darling-Hammond, et al., 2009). When early childhood teachers are further asked to change practice and address a weak spot, such as math that they have long felt unconfident and under-prepared to teach, ongoing and individual support is vital (Copley, 2004).

Method

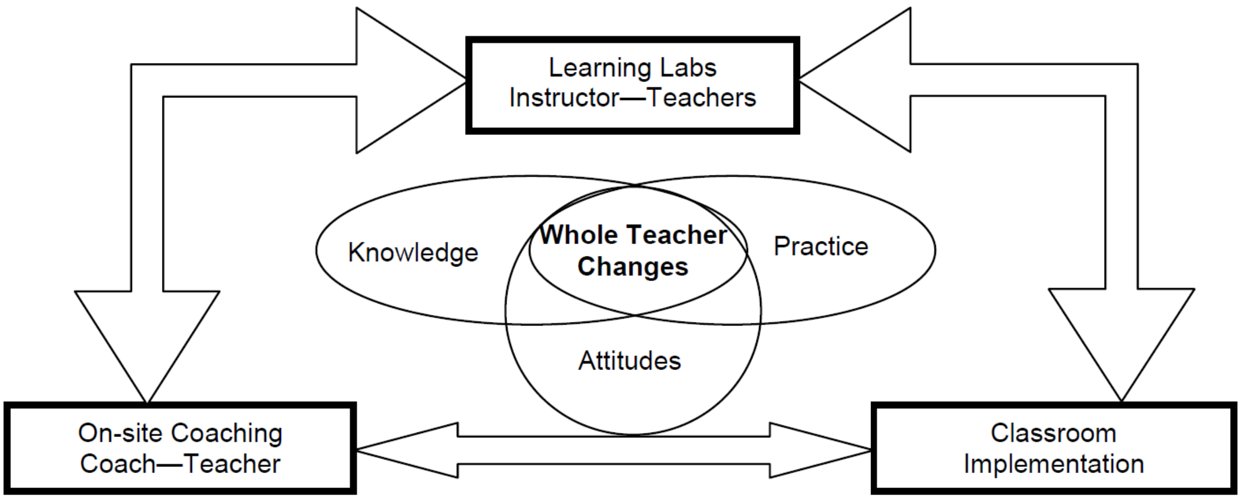
Participants

In partnership with Chicago Public Schools (CPS), Early Math Collaborative (EMC) at Erikson Institute has provided PD training in mathematics to approximately 80 Head Start, pre-kindergarten and kindergarten teachers each year for the last four years. These teachers came from 150 different schools, and they serve primarily low-income and minority children. A total of 154 three- to five-year-olds participated in the study. Of these children, 91 were randomly selected from 12 participating classrooms and served as the intervention group. An additional 63 children randomly selected from matched classrooms served as the comparison group.

Intervention

The EMC's PD program includes three components: (a) Learning labs—early math instructors lead these yearlong, interactive learning sessions focusing on teachers' understanding of foundational mathematics; (b) On-site coaching—between learning labs, teachers work with a math coach in their classrooms to plan and reflect on their teaching; and (c) Guided classroom implementation—teachers practice "mathematizing" classroom experiences under the guidance of coaches (see Figure 1).

Figure 1
PD Program Conceptual Framework and Components

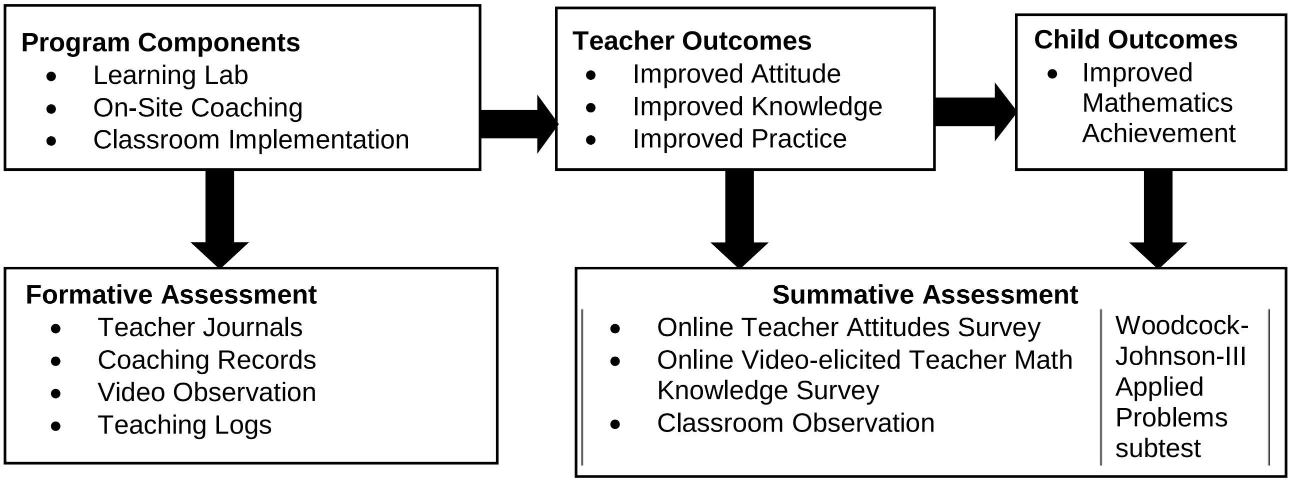


In response to the special needs of early childhood teachers, numerous strategies are used throughout the PD components, such as engaging in adult learning experience in mathematics investigation, using children's book as an entry point for math learning, introducing structured math research lessons for classroom implementation, and forming a community of learners for collaborative learning and reflective practice, to name a few. Central to all strategies is teachers' understanding of the Big Ideas in early mathematics and make use of them in classroom teaching. Big Ideas are "clusters of concepts and skills that are mathematically central and coherent, consistent with children's thinking, and generative of future learning" (Clements & Sarama, 2009). For example, attributes can be used to sort collections into sets is a Big Idea for algebraic thinking in early math. All measurement involves fair comparison is a Big Idea for measurement. An essential tool for mathematical understanding, teachers can use Big Ideas to organize the classroom environment, plan meaningful activities, engage in curriculum analysis, and articulate the underlying purpose of students' work (NRC, 2009).

Data Collection

The *Whole Teacher* framework guides our program evaluation. Figure 2 illustrates the logic model of the EMC PD program, which addresses two basic research questions of the program: To what extent does the EMC PD change teachers' attitudes, knowledge, and practice in early mathematics and how do these changes impact child outcomes? Utilizing a quasi-experimental design, pre- and post-measures with intervention and comparison groups have been collected.

Figure 2
Logic Model of Professional Development



Measures

For teacher change, three instruments are used: (a) a teacher survey of Attitudes, Beliefs, and Confidence in Early Math (ABC-EM); (b) an online survey of Pedagogical Content Knowledge in Early Math (PCK-EM) utilizing video stimuli, and (c) a classroom observation of High Impact Strategies in Early Math (HIS-EM). Together, the three tools are used to assess changes in teachers' attitudes, knowledge, and practice in early math[1]. For child learning outcome, children's mathematical abilities were measured using the Applied Problems subtest of the Woodcock-Johnson III (WJ-III) Tests of Achievement (Woodcock, McGrew, & Mather, 2001).

Data analysis

For purposes of report, scores on Applied Problems are converted to age estimates; that is, scores are converted to the average age in months of children in the normed sample with corresponding scores. Changes in WJ-III estimated age were calculated for each child. Two-level Hierarchical Linear Modeling (HLM) was used to determine how much of the variance among these changes could be attributed to teacher participation in the intervention. The HLM model is presented below

Level-1 Model

$$Y = \beta_0 + \beta_1(\text{T1 WJ Age Estimate}) + \beta_2(\text{Hispanic}) + r$$

[1] For more information about these tools, please visit earlymath.erikson.edu

Level-2 Model

$$\beta_0 = \gamma_{00} + \gamma_{01}\,(\text{Intervention}) + \mu_0$$
$$\beta_1 = \gamma_{10}$$
$$\beta_2 = \gamma_{20}$$

Results

Results showed that participation in the intervention significantly predicted changes in WJ-III age estimates (see Table 1). Compared to comparison classrooms, children in intervention classrooms showed an average of 3 months additional growth in WJ age estimate score over the intervention year ($p<.03$). The growth of children who began the school year behind national norms was closer to five additional months of learning. These results point to the positive impact of the program on children's learning and its particularly significant effects on the children most in need of help.

Table 1

Results of HLM on WJ III Age Estimates (in months), Controlling for Pre-test Scores and Ethnicity, and Using Participation as a Predictor

Final Estimates of Fixed Effects	Coefficient	*SE*	*T*	*df*	*p*
For Intercept 1, β_0					
Intercept 2, γ_{00}	21.7635	3.1903	6.822	18	0.000
Participation, γ_{01}	3.0609	1.309	2.337	18	0.031
For Pre-Test WJ-III, β_1					
Intercept 2, γ_{10}	-0.3184	0.0686	-4.642	147	0.000
For Ethnicity, β_2					
Intercept 2, γ_{20}	-1.5718	0.9160	-1.716	147	0.088

Discussion

Many factors contributed to the success of our early math PD program. Our clearly defined conceptual framework provides a basis for us to set goals, select instructional strategies, and evaluate outcomes. In the Whole Teacher approach attitudes, knowledge, and practices play equally important roles in teacher professional development. The focus on multiple dimensions offers teachers multiple pathways to learning. For some teachers, attitudes will be the most important first step; for example, overcoming fear of failing in teaching mathematics. For others, classroom practice will be the key, as when children's excitement and interest in learning mathematics affects teachers' attitudes. Knowledge, too, can play a pivotal role, as an "aha" moment in a PD session makes a teacher feel competent enough to try something new. Accessing multiple learning pathways allows PD to build on teachers' motivations and respond to their needs, rather than requiring that all teachers follow the same course of learning.

For early childhood teachers, there is one additional benefit to the explicit adoption of the Whole Teacher framework for PD. It is readily understood and meaningful to early childhood teachers because it resembles a widely accepted principle in early education; namely, the importance of addressing the development of the "whole child" (Copple & Bredekamp, 2009). Familiarity with the whole child concept helps teachers reorient how they see themselves and welcome and integrate shifts in their attitudes, knowledge, and practices that will make them effective early math teachers.

Guskey (1995) succinctly states the value and necessity of PD: "Never before in the history of education has there been greater recognition of the importance of professional development. Every modern proposal to reform, restructure, or transform schools emphasizes professional development as a primary vehicle in efforts to bring about needed change" (p.1). Effective PD updates teachers' content knowledge, exposes them to new teaching strategies, sustains their teaching effectiveness, and prompts continuous growth (Desimone, 2009; Hawley & Valli, 2001). For PD to deliver on its promise in education, the field needs not only evidence-based effective strategies, but also conceptual frameworks that are grounded in theories of teacher change and help explain and predict what works in teacher professional development.

The *Whole Teacher* framework is one such attempt. Our experience speaks of its promising future. The framework is based on the premise that teacher attitudes, knowledge, and practices interact and influence each other. It promotes PD strategies that build on the interrelationships and offers teachers multiple ways of learning, doing, and succeeding. Our work focuses primarily on math education during early childhood years; we believe, however, that the framework applies for other content areas across the age range. Funded by the Department of Education, we now are engaged in a multi-year study of PD in math education with teachers of pre-kindergarten through grade 3 in eight CPS public schools. The longitudinal data of teacher change in attitudes, knowledge, and practice as well as child outcomes will provide more empirical evidence to test the power of the Whole Teacher approach to teacher professional development.

Limitations

Although the *Whole Teacher* approach has been tested with early childhood teachers in the field of learning computer technology (Chen & Chang, 2006), the conceptual framework has not been empirically tested with regard to the relationship of teachers' attitudes, knowledge, and practice in the field of early mathematics. Without knowing such relationship, we fall short of understanding the mediating process between the intervention input and children's outcome presented above. The Early Math Collaborative at Erikson is in the process of collecting data on teachers' attitudes, knowledge, and practice in early mathematics teaching. We are on the lookout for the empirical testimony of the power of the *Whole Teacher* approach.

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