

## TABLE OF CONTENTS

Response to Competitive Preference Priority 5 .....	1
A. Need for the Project and Quality of Project Design .....	1
Need for the Project .....	1
Quality of the Project Design .....	3
Description of the Intervention .....	5
The “Whole Teacher” Approach to PD .....	6
B. Strength of Research, Significance of Effect, and Magnitude of Effect .....	8
Development and Pilot-testing of the Proposed Program .....	8
Research on PD Effectiveness and Need to Support WT Development .....	9
C. Experience of the Eligible Applicant .....	10
D. Quality of the Project Evaluation .....	13
Formative Evaluation Measures .....	13
Summative Evaluation Questions .....	14
Sample and Timing of Outcome Assessments .....	15
Teacher Outcome Measures .....	15
Student Outcome Measures and School-level Outcome Measures .....	16
Power Analysis and Attrition .....	17
Data Analysis .....	17
E. Strategy and Capacity to Further Develop and Bring to Scale .....	18
F. Sustainability .....	20
G. Quality of the Management Plan and Personnel .....	21

## **Achieving High Standards for Pre-K—Grade 3 Mathematics: A Whole Teacher Approach to Professional Development**

Erikson Institute proposes a five-year initiative that addresses **Absolute Priority 3** and **Competitive Preference Priority 5** via an Investing in Innovation **Development** grant. The initiative will help Illinois's students reach or exceed state Learning Standards for Mathematics by designing and implementing an innovative professional development (PD) program for teachers who serve high needs children in prekindergarten through third grade (PK-3).

### **Response to Competitive Preference Priority 5**

Erikson's approach to mathematics PD for PK-3 teachers of high needs children is designed to improve early learning outcomes. By increasing knowledge of foundational mathematics and its relationship to the Illinois Learning Standards for Mathematics (ILSM) among PK-3 teachers, this initiative will lead to greater mathematical achievement for children throughout their school years (Blank, de las Alas, & Smith, 2008). In addition, teachers will benefit from an improved understanding of early mathematics learning trajectories and how these relate to ILSM, enhancing their ability to assess students and plan for instruction (National Research Council [NRC], 2009). Because collaboration and cross-grade articulation within schools can improve student outcomes for years to come, the intervention will include all PK-3 teachers in each of 8 elementary schools, creating an integrated approach to children's first 5 years of school-based math (Bogard & Takanishi, 2005; Kauerz, 2007; Reynolds, Magnuson & Ou, 2006).

### **A. Need for the Project and Quality of Project Design**

**Need for the Project.** The proposed project will address three significant problems confronting mathematics education in Illinois: (1) the mathematics achievement gap between low-income, minority students and their more advantaged peers; (2) the low level of competence

in math teaching of early childhood and early elementary teachers; and (3) the limited and ineffective in-service opportunities for early childhood and elementary teachers to develop mathematics competencies.

Mathematics knowledge is vital to the economic well-being of society and the practical life success of its members. Although the Illinois Learning Standards for Mathematics (ISBE, 2002) are based on research and incorporate recommendations of the National Council of Teachers of Mathematics (NCTM, 2000), NAEP results show that Illinois nonetheless has one of the five largest math achievement gaps in the U.S. (Kerachsky, 2009). This gap appears as early as kindergarten and widens during elementary school (Flanagan, McPhee, & Mulligan, 2009), indicating the importance of early intervention (NRC, 2009; Raudenbush, 2009). Although mathematics intervention during preschool can be effective (e.g., McCray & Chen, in press), gains fade out during primary school years if not supported by continued excellent and aligned instruction (Heckman & Masterov, 2004). Large-scale studies show that early mathematics achievement predicts not only later mathematics achievement but also later reading, suggesting the broad influence of early math across school subjects (Claessens, Duncan, & Engel, 2006).

Although benchmarks and performance standards have been added to the ILSM, research indicates that PK-3 teachers lack the content knowledge to make use of these pedagogical aids (Ginsburg, Lee, & Boyd, 2008, National Research Council, 2009). In Illinois, early childhood teacher certification for PK-3 is general; early childhood teachers typically acquire less math knowledge than teachers at higher grade levels in pre-service training. Because teachers tend to teach what they know (Darling-Hammond & Bransford, 2005; Sarama & DiBiase, 2004), this limited preparation leads to inadequate classroom practice. A recent study of Chicago early childhood classrooms found that 90% of teachers conducted literacy-related activities daily, but

only 21% carried out mathematics activities (Chicago Program Evaluation Project, 2008).

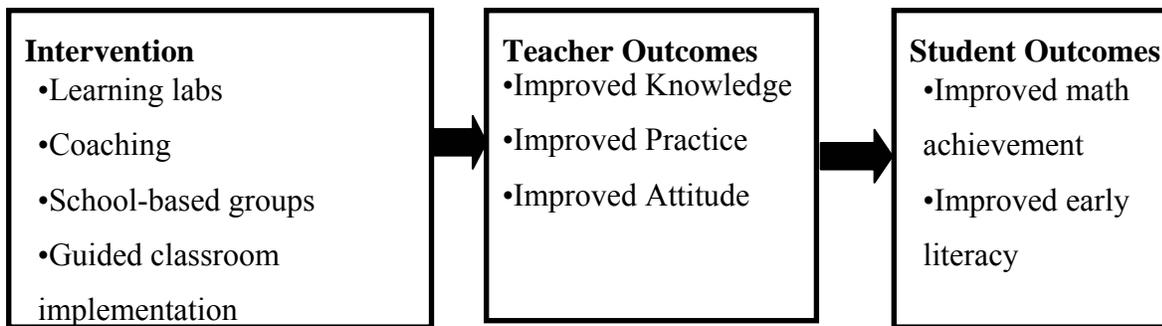
The PD in math available to early childhood teachers is very limited, and largely ineffective (NRC, 2009). Training related to learning standards mainly focuses on introducing the standards rather than helping teachers learn how to use them. Curriculum-specific training tends to be similarly shallow, emphasizing activities and neglecting deep conceptual understanding. Further, the dominant model of in-service PD is a one-day workshop; continuing support is rarely available for teacher implementation of new practices (Sarama & DiBiase, 2004). Lastly, PD effectiveness is limited by its lack of a conceptual framework that specifies dimensions of teacher change and guides program design (Chen & Chang, 2006a).

**Quality of the Project Design.** We propose to design and deliver a comprehensive PD program in mathematics to PK-3 teachers based on our successful PD model. Our goal is to reduce and prevent the achievement gap in math by improving teachers' understanding of the mathematical ideas in the standards and showing teachers how to transform them into effective learning activities (see Figure 1). Specifically, the program's objectives are: (1) teachers will understand how concepts represented by the standards develop in children's thinking; (2) teachers will demonstrate increased skill in implementing instruction that addresses the standards; (3) teachers will report a greater sense of comfort and competence in mathematics and math teaching; (4) the performance of students from high-need schools on standardized assessments of mathematics achievement, including the Illinois Standards Achievement Test (ISAT), will significantly improve; and (5) children's school readiness, as evidenced by math and literacy assessments, will increase. The proposed program addresses these objectives through an approach to PD that is unique, both operationally and conceptually.

Operationally, the program includes four components: (1) **Learning labs:** Held at Erikson

Institute, these are interactive learning sessions in which PK-3 teachers gain understanding of the math content and processes in the ILSM; (2) **On-site coaching**: Between learning labs, teachers work with a math coach in their classrooms to plan and reflect on their teaching; (3) **School-based learning groups**: Teachers within- and across-grades meet semi-monthly to study the ILSM benchmarks and performance descriptors and integrate them into their math curriculum; and (4) **Guided classroom implementation**: Teachers practice “mathematizing” classroom experiences and implement structured *Research Lessons*, becoming skilled in using ILSM to plan learning and track children's progress. Table 1 describes scheduled implementation, and Appendix H contains examples of these components.

**Figure 1. Logic Model of Intervention**



These four program components have been developed and used with over 250 PK and K teachers in the Chicago Public Schools (CPS) since 2007; they constitute varied learning contexts that promote a range of social interaction and learning. In *learning labs*, teachers from all 8 schools meet together, forming connections across school cultures. *Coaching* focuses on the individual needs of teachers. Using classroom videos, *school-based learning groups* become communities of learners, in which co-construction of knowledge, shared learning, and collaboration are the norm (Raudenbush, 2009). They are also a venue for planning among teachers from the same grade and discussion of curriculum alignment between grades. Finally,

in *guided classroom implementation*, teachers apply their new knowledge and skills via *research lessons* in a real classroom context, refining and integrating what they have learned.

**Table 1. Intervention Schedule: Frequency at a Single School**

	<u>Year 1</u>		<u>Year 2</u>		<u>Year 3</u>		<u>Year 4</u>		<u>Year 5</u>	
	<u>PK-K</u>	<u>1-3</u>	<u>PK-K</u>	<u>1-3</u>	<u>PK-K</u>	<u>1-3</u>	<u>PK-K</u>	<u>1-3</u>	<u>PK-K</u>	<u>1-3</u>
Learning labs	8	0	4	8	0	4	0	0	0	0
Individual coaching	4 <sup>a</sup>	0	4 <sup>b</sup>	4 <sup>a</sup>	4 <sup>b</sup>	4 <sup>b</sup>	0	4 <sup>b</sup>	0	0
School-based groups	4 <sup>c</sup> /2 <sup>d</sup>	0	4 <sup>c</sup> /2 <sup>d</sup>							
Guided implementation	8 <sup>f</sup>	0	4 <sup>f</sup>	8 <sup>f</sup>	2 <sup>f</sup> /2 <sup>g</sup>	4 <sup>f</sup>	4 <sup>g</sup>	2 <sup>f</sup> /2 <sup>g</sup>	4 <sup>g</sup>	4 <sup>g</sup>

<sup>a</sup>on-site; <sup>b</sup>video-based; <sup>c</sup>within-grade; <sup>d</sup>across-grade; <sup>e</sup>school-wide; <sup>f</sup>project-plan; <sup>g</sup>grade-level plan.

**Description of the Intervention.** Approximately 80 PK-3 teachers and 3,680 students from 8 Chicago public elementary schools will participate over a 5-year period (letters of agreement in Appendix D). *Learning labs* will be delivered in two cohorts: Cohort A includes PK-K teachers and Cohort B includes teachers in Grades 1-3, reflecting the rapid development and significant cognitive shift that occurs between 5 and 7 years (Sameroff & Haith, 1996). Each cohort will participate in learning labs for 2 years, with a decrease in frequency during the second year.

Coaches play a central role in sustaining the PD at the school level by helping teachers become reflective about teaching and co-facilitating school-based meetings. Individualized coaching sessions are gradually replaced by video-based observation and group study in the grade-level meetings, so that teachers learn to provide feedback on each others' teaching and eventually take on this responsibility themselves. Each grade within a school will have 2 annual cross-grade level meetings—1 with teachers from the earlier grade and 1 with teachers from the

subsequent grade. Most schools already hold grade-level and cross grade-level meetings, but by focusing some of these on math and providing a slowly-diminishing stream of coach facilitation, they become mechanisms that sustain the project's work over time. To solidify alignment of ILSM across grades PK-3, two school-wide meetings will be held at each school in Year 5.

Research lessons are the mechanism through which guided classroom implementation occurs and tie the 4 program components together. They are planned activities for children that teach specific math ideas at each grade level and coordinate with existing curricula. In number and operations, for example, teachers implement a research lesson based on *The Gingerbread Man* that illustrates to students how numbers and symbols can describe how the amount in a collection changes as members are added and taken away (see Appendix H for additional research lesson descriptions). Introduced at the learning labs, research lessons provide a common teaching experience for all teachers and are analyzed at grade-level meetings and at coaching sessions. By making the classroom itself a learning site, we activate a powerful mechanism for changing teaching practice. Research lessons are provided to teachers by the project during their first 2 years, but grade-level groups eventually take responsibility for generating their own.

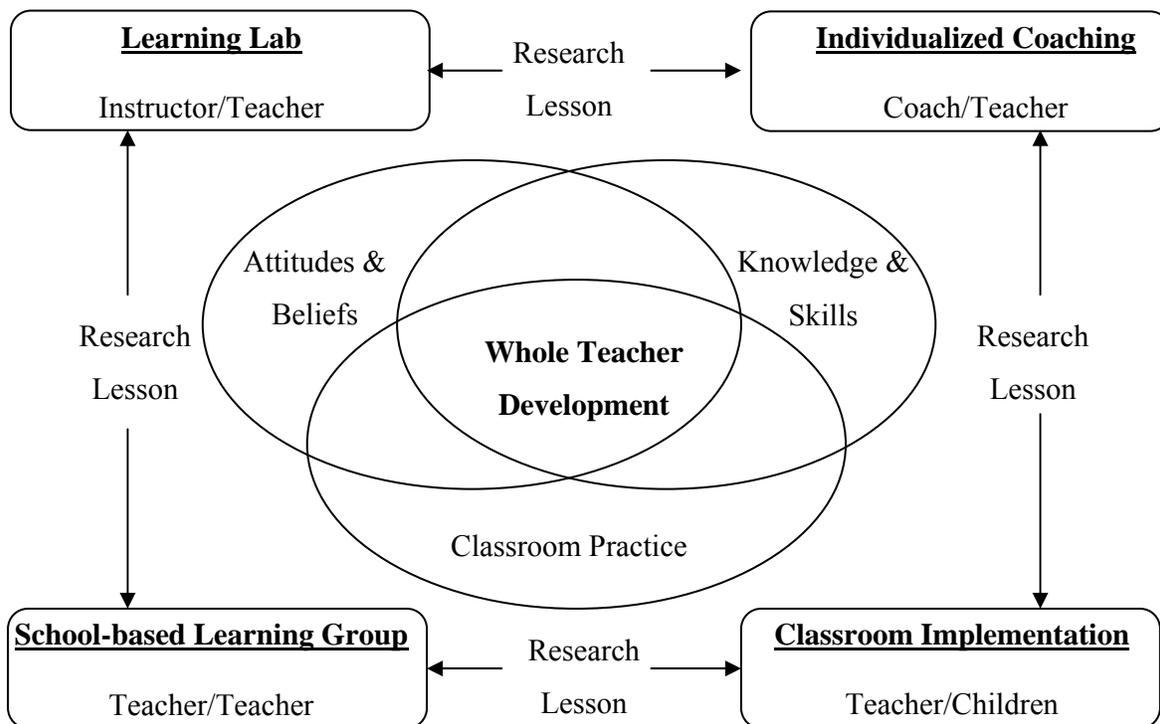
At each school site, the first year of intervention will involve only the PreK and K teachers; 1<sup>st</sup>-3<sup>rd</sup> grade teachers will begin during the second year. Not only will this first year be used for piloting adult learning opportunities and research lessons grades 1-3, it also gives schools time to change “from the ground up,” so that children entering first grade will have come from classrooms where their teachers experienced our math PD. As children matriculate, they will be better prepared for the enhanced mathematics education to come.

**The “Whole Teacher” Approach to PD.** Conceptually, the proposed Whole Teacher approach to PD is highly innovative. It is predicated on the idea that simultaneous development

of teacher *attitudes*, classroom *practice*, and content *knowledge* is the best way to engender teacher change (see Figure 2) (Chen & Chang, 2006a, 2006b). Attitudes are particularly important for math PD because many early childhood teachers doubt their math ability and thus avoid teaching it to children. By monitoring and supporting practice, the Whole Teacher approach encourages teachers to try out new methods and learn from their experimentation. Subject knowledge is crucial in mathematics, since addressing it with thoroughness is the only way to counteract the weak understanding held by many teachers of young children. To simultaneously promote teacher development of *attitudes*, *practice*, and *knowledge*, our PD is a multi-year process, emphasizing beyond-school, within-school, and individualized learning experiences. In each learning lab, instructors share a small amount of information to ensure that teachers fully understand the content and experience success as math learners. Between learning labs, coaches visit classrooms and provide individual support, helping each teacher identify teaching strengths and areas in need of improvement. Through guided classroom implementation, teachers gain confidence by observing children's pleasure and progress in math. Through grade-level groups, teachers develop a sense of belonging that affirms their value and increases their sense of efficacy, both key to positive attitudes and beliefs (Desimone, 2009). Cross-grade groups support alignment between grades while fostering school-wide commitment to mathematical excellence. The PD program also uses children's literature, a strategy that builds on early elementary teachers' familiarity with literacy activities, reducing math anxiety. Program content knowledge is derived from the ILSM, which are closely aligned with standards set by NCTM (2006) and the draft Common Core State Standards (NGA & CCSSO, 2010) which Illinois is on-line to adopt. Specifically, the PD focuses on Number Sense, Geometry, Estimation and Measurement, Algebra and Analytical Methods, and Data Analysis and

Probability. The content emphasis varies with grade level, taking its cue from both the standards and NCTM’s Curriculum Focal Points (2006)—recommendations for targeting specific mathematical content during particular school years. Interactive, hands-on study of ideas (see Appendix H) is followed by the modeling of a *research lesson*—an activity that teachers implement in their classroom between learning labs. Because on-site coaching often focuses on Research Lesson implementation, the Lesson connects the components of the PD and allows teachers to compare and contrast their instruction, encourages them to gain trust in their peers as a learning community, and expands their sense of what is possible.

**Figure 2. Program Components and Conceptual Framework**



**B. Strength of Research, Significance of Effect, and Magnitude of Effect**

**Development and Pilot-testing of the Proposed Program.** The proposed PD is based on a conceptual framework that focuses on the *Development of the Whole Teacher*. The framework was developed in 2001 as part of a PD to promote the integration of computer technology in

Head Start classrooms (Chen & Horsch, 2004). Participants significantly outperformed non-participants on measures of knowledge and skills (Chen & Chang, 2006a, 2006b).

Both the *Whole Teacher* approach and the four intervention components are in use in a PD program—the **Early Mathematics Education Project**—at Erikson Institute. Since 2007, 250 Head Start, PK, and K teachers, serving approximately 8,000 students annually at 131 CPS schools have participated. More than 85% of the students are low-income, nearly one-fourth are English Language Learners, and over 70% are African-American or Latino. During 2008-2009, we evaluated effects in preschool classrooms. The Applied Problems Subtest of the Woodcock Johnson-III showed that our PD produced almost 3 additional months of mathematics learning during a school year as compared to a matched contrast group ( $p < .008$ ; McCray & Chen, in press). While children in the PD group progressed in relation to national norms, children in the contrast group fell further behind. In short, Erikson’s *Whole Teacher* early math PD helped teachers narrow the math achievement gap before children entered elementary school.

Results from this evaluation are encouraging but not sufficient for high needs children to keep pace with their more-advantaged peers. Cumulative advances from PK-3 are required to meet state standards and ensure sustainable performance (Bogard & Takanishi, 2005). This proposal extends our successful model of mathematics PD to achieve that goal.

#### **Research on PD Effectiveness and Need to Support Whole Teacher Development.**

Research shows that when math PD focuses on standards and standards-based assessment it is more likely to be associated with improved teacher practices and higher student learning outcomes (Blank, de las Alas, & Smith, 2008; Cohen & Hill, 2000; Kennedy, 1998; Puma & Raphael, 2001; Whitehurst, 2002; Wiley & Yoon, 1995). Strong pedagogical content knowledge is also a prerequisite for teacher effectiveness (Ball, Thames & Phelps, 2008; Guskey, 2003),

indicating that a deeper understanding of both the content and the process of students' learning is a critical PD complement to the organizing principles of the standards.

Teacher attitudes and beliefs about a content area are rarely addressed in PD because they are considered subjective and difficult to change (Vartuli, 2005). Yet studies indicate that attitudes and beliefs are tied to teachers' development of knowledge and classroom practice (e.g., Pianta et al., 2005; Wilkins, 2008). Affecting teachers' thinking, motivation, and behavior, attitudes and beliefs mediate processes of skill development and classroom instruction (Pajares, 1996; Richardson, 1996). Further, during the early years of schooling, positive teacher attitudes are key to sustaining student excitement about math (NRC, 2009).

The purpose of teacher PD is to improve classroom practice. Though a direct, supported connection between PD sessions and classroom implementation is acknowledged as important by many educators, most PD programs fail to forge this link (Brenneman, Boyd, & Frede, 2009). To improve student performance, PD programs need to allow time for teachers to try new practices in their classrooms. As they apply new knowledge and skills, teachers find they require adaptation in their particular classroom (Blank, de las Alas, & Smith, 2008; Wilkins, 2008). The knowledge-construction and knowledge-internalization processes that follow connect teachers' new knowledge and skills to the real learning needs of children (Borko, 2004).

### **C. Experience of the Eligible Applicant**

**Erikson Institute** is an independently accredited institution of higher education focused on graduate studies of the early childhood years from birth to age eight. The Institute has a long history of successful collaborations with teachers and administrators in CPS and across Illinois—collaborations that significantly improved educational outcomes for young children by strengthening the practices of their teachers.

In 1987, Erikson Institute launched a **Schools Project** to provide PD for 9 CPS elementary schools over 12 years. Most of the approximately 7,000 students served annually were low-income, minority students. School partnerships extended from 4-11 years (Chen & Horsch, 2004). Through our efforts, 2 schools were taken off probation when scores in reading and math significantly increased, and another was recognized as a CPS exemplary school for higher student achievement than other neighborhood schools. All PK and K classrooms in the project earned accreditation from NAEYC. An independent evaluation by the University of Chicago concluded that the Schools Project helped all partner schools strengthen teaching teams and raised student performance (Chen & Horsch, 2004).

Erikson Institute launched another school-based partnership, the **New Schools Project (NSP)**, in 2004. Like its predecessor, the NSP advances the quality of PK-3 education in CPS schools through multi-level professional development for teachers and administrators. Currently, the NSP is partnered with 11 CPS elementary schools, including 4 turn-around schools. These partnerships impact more than 130 PK-3 teachers and approximately 2,000 children each year. From 2007-2009, the percentage of third graders meeting or exceeding state standards on the ISAT at NSP schools increased an average of 13.2% in reading and 3.7% in mathematics, exceeding comparable district averages (Fleming & Maxwell, in press).

Child learning outcomes have also been affected by other Erikson projects. From 2005-2009, Erikson collaborated with CPS on a federally funded **Early Reading First** grant in 10 Head Start classrooms, providing coaching and PD. On the PPVT-III, 3-year-olds advanced from 2 standard deviations (SDs) below the national norm to just below it (80.57 to 98.13). Four-year-olds moved from 1 SD below the national norm in the fall to slightly above it in the spring (92.29 to 100.94). Effect sizes for 3- and 4-year-olds were 1.35 and 0.75, respectively. Differences

between project and comparison groups were significant ( $n=226$ ;  $p<.001$ ) (CPS, 2010).

Importantly, the **Early Mathematics Education (EME)** project—the PD on which this proposal is based—significantly advanced CPS children’s mathematical performance. Described in Section B, the project has served over 250 early childhood teachers across 130 CPS schools since 2007. A majority of the schools enroll children from low-income, minority families. To evaluate program effects, we compared intervention and contrast groups on measures of math achievement, using the Applied Problems Subtest of the Woodcock Johnson-III. Hierarchical linear modeling indicated the PD increased children’s mathematics learning by almost 3 months during a single school year ( $n = 236$ ;  $p <.008$ ) (McCray & Chen, in press). For children who were below the national norm at Time 1 the effect was 5 months, suggesting the program is especially helpful to children who need help the most.

In sum, partnering with urban schools to improve young children's learning outcomes and strengthen the practice of early childhood teachers—that is, “closing the gap”—is a central mission of Erikson Institute. Over the last 40 years, our joint endeavors with CPS teachers to increase student achievement have succeeded and produced measurable outcomes.

**SRI International**, an official partner who will conduct the independent evaluation, is a nonprofit research and consulting corporation serving foundation, business, and government clients worldwide. Staff possess expertise ranging from early childhood education to cognitive science, effective pedagogy across the period from birth to age 5, the K-12 curriculum, assessment, teacher development, and school reform. The proposed staff from SRI’s Center for Education and Human Services’ Early Childhood Program has extensive expertise in experimental, quasi-experimental, and longitudinal studies and qualitative research.

SRI has a long tradition of work with school districts and schools to improve student

achievement, attainment, and retention (see Appendix H for additional materials). SRI collaborated with elementary schools and school districts across the country to implement and test an early intervention, First Step to Success, that uses behavior coaches to help children at risk for anti-social or aggressive behaviors get off to the best possible start in school. The Office of Special Education Programs (OSEP) funded SRI to develop a Model Demonstration Coordination Center (MDCC). The MDCC supports implementation of 9 individual model demonstration projects by identifying characteristics and best practices of effective interventions across a wide range of educational topics and reaches students from PK to high school.

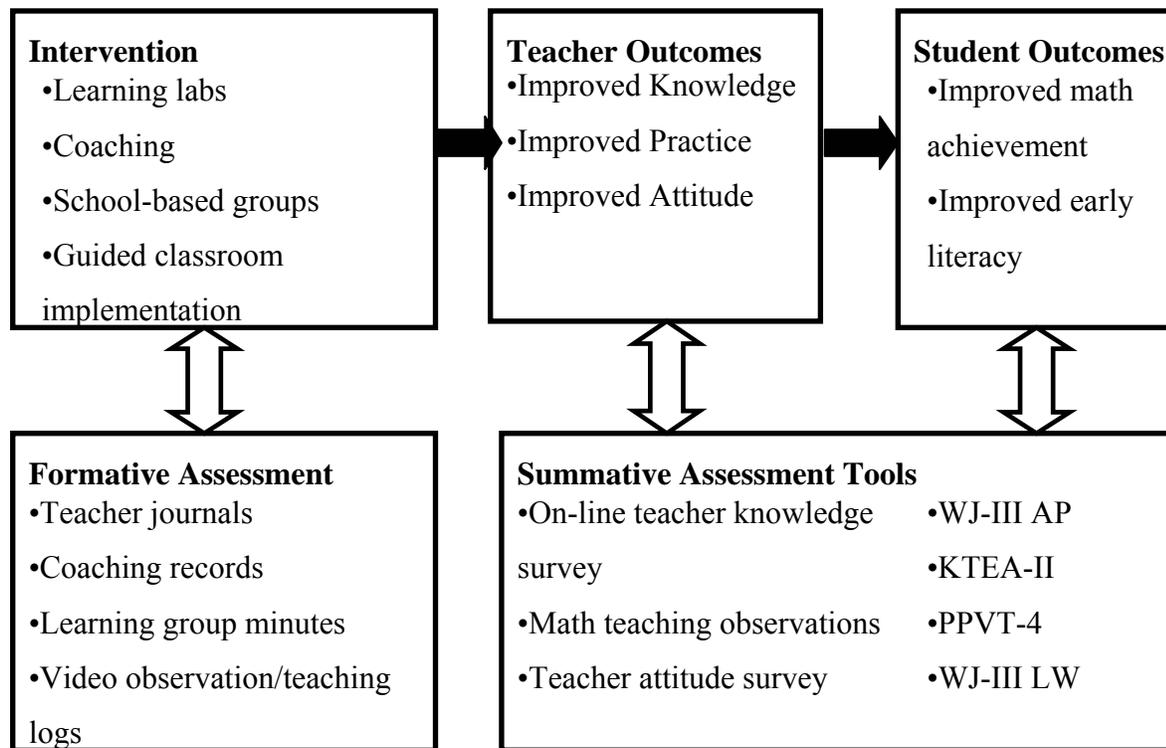
#### **D. Quality of the Project Evaluation**

Erikson Institute will collect formative evaluation data to ensure fidelity of program implementation and contribute to ongoing improvement of the intervention. SRI International will conduct an independent summative evaluation to examine teacher and student outcomes. See Figure 3 for the evaluation logic model.

**Formative Evaluation Measures.** To monitor the fidelity of implementation of the 4 intervention components and learn more about how they lead to changes in teacher attitudes, knowledge, and instructional practices (Fixsen & Blasé, 2009), Erikson will collect data via the following processes: (1) Teacher journal entries that follow each learning lab and describe teachers' intended practices will be reviewed by instructors to refine lab content and by coaches to support individualized coaching; (2) Coaches' written reports of how and with what fidelity teachers implement the practices will be reviewed with instructors to enhance individualized support of teachers; (3) Coaches' grade-level meeting minutes will be reviewed with instructors to assess the development of learning communities; and (4) Teaching logs and videotaped observations will document teacher progress, support school-based learning group discussion,

engage teachers in coaching, and allow instructors to assess implementation in classrooms.

**Figure 3. Logic Model for Evaluation**



**Summative Evaluation Questions.** SRI will address four research questions: (1) What is the effect of the intervention on teachers’ mathematical attitudes and beliefs, pedagogical content knowledge, and classroom practices? (2) Are changes in teacher outcomes sustained over time? (3) Do students in the intervention group make greater gains in mathematics and general early literacy (i.e., vocabulary, and letter word) compared to students whose teachers have not received the PD? And (4) Are the effects on students’ academic achievement greater the longer the teacher has participated in the intervention?

Using a quasi-experimental design, SRI will collect pre- and post-tests of teacher-, student-, and school-level outcomes in both the intervention and matched-comparison schools. Schools will be matched on student demographics (e.g., percentage of students on free or reduced-price lunch status), patterns of ISAT test scores for the prior 5 years, and community characteristics.

**Sample and Timing of Outcome Assessments.** Table 2 shows the number of schools, teachers, and students in intervention (I) and comparison (C) schools and timing of assessments. The I group and matched C group will each consist of 80 PK-3 teachers from 8 CPS elementary schools (10 teachers per school, 2 teachers per grade level). All teachers in the I schools will participate in the summative evaluation all 5 years. Identical outcome data on teachers in the C schools will be collected in Year 2 of the project. Teacher outcomes will be collected in fall and spring in the first year the teacher participates and in the spring in subsequent years. The student sample will consist of 2,400 students across the 5 years. SRI will randomly select 10 students per class in each grade level in both I and C schools to be assessed in fall and spring. Comparison group students will be tested in Year 2 only. With the sample shown in Table 2, impacts of the intervention on student's achievement can be examined in Years 1, 2, and 3.

**Teacher Outcome Measures.** To assess mathematical attitudes and beliefs, teachers will complete a survey, pilot tested with over 300 CPS teachers. With an alpha of 0.93, 26 items are rated on a 10-point Likert scale, taking an average of 10 minutes to complete. A second survey measures teachers' pedagogical content knowledge (PCK) of math and ability to apply the ILSM to classrooms. Drawing on Ball's work (Ball, 1988, 1993) and the Standards themselves (ISBE, 2002), teachers review two 5-minute videos of mathematics teaching and answer questions about what math content is taught, what instructional strategies are used, and whether students understand the content. This measure takes about 30 minutes, and is coded on a 6-level rubric. Teachers' classroom practices will be measured using a classroom observation scale adapted from Clements and Sarama (2008). This 20-item observation rates mathematical teaching behaviors and student engagement on a 7-point Likert scale. For all 3 measures, SRI will collect pre- and post-data in the first year the teacher participates in the intervention and in spring in

subsequent years, with data collected in Year 2 for the comparison group.

**Student Outcome Measures.** To assess students’ **mathematics achievement**, 2 standardized tests will be used: the Woodcock-Johnson-III Applied Problems (WJ-AP) subtest (Woodcock, McGrew & Mather, 2001) and the Kaufman Test of Educational Achievement II (KTEA-II) Math Composite subtest (Kaufman & Kaufman, 2004). Two standardized tests of early literacy also will be administered: the Peabody Picture Vocabulary Test, 4th Edition (PPVT-4) (Dunn & Dunn, 2007) and the Woodcock-Johnson-III Letter Word (WJ-LW) subtest (Woodcock, McGrew & Mather, 2001).

**Table 2. Student and Teacher Samples in the Intervention (I) and Comparison (C) Groups**

<b>Teachers and students by grade level</b>	<b>Y1 I only</b>	<b>Y2 I/C</b>	<b>Y3 I only</b>	<b>Y4 I only</b>	<b>Y5 I only</b>	<b>Total for 5 years</b>
<b>Number of teachers</b>						
Pre-Kindergarten	16	16/16	16	16	16	
Kindergarten	16	16/16	16	16	16	
Sampled for each grade (1–3)	0	16/16	16	16	16	
<b>Total teacher sample</b>		<b>160</b>	<b>80</b>	<b>80</b>	<b>80</b>	<b>432</b>
<b>Cross-sectional student sample</b>						
Pre-Kindergarten	160	160/160	0	0	0	
Kindergarten	160	160/160	0	0	0	
Sampled for each grade (1–3)	0	160/160	160	0	0	
<b>Total student sample</b>	<b>320</b>	<b>1600</b>	<b>480</b>	<b>0</b>	<b>0</b>	<b>2400</b>

**School-level Outcome Measures.** SRI will track school-level third grade mathematics and reading scores for both I and C schools using the ISAT, a third grade norm- and criterion-

referenced test. The ISAT **math tests** cover the 5 content areas in the state standards (see above), and the ISAT **reading tests** assess vocabulary development, reading strategies, and reading comprehension. SRI will collect ISAT scores for the 5 years prior to the grant period (2004-05 through 2009-10) and the 5 years of the grant period (2010-11 through 2014-15).

**Power Analysis.** SRI conducted a power analysis showing the minimum detectable effect (MDE) for HLM analysis using the methodology in Schochet (2008). The MDE of the intervention on teacher outcomes in the first year of the intervention is 0.381. For student outcomes, the MDE of the intervention within a grade level is 0.453, and 0.350 across grade levels. Given prior studies of math intervention for young children (Clements & Sarama, 2008), we expect effect sizes between 0.3 and 0.5 and perhaps larger given the targeted nature of the intervention (see Hill, Rowan, & Ball, 2005 for a math intervention with slightly older children).

**Attrition.** The power analysis above accounts for 10% student attrition from fall to spring, based on available data (de la Torre & Gwynne, 2009). ISAT scores will include all 3<sup>rd</sup>-grade students who take the test in that particular year. Because SRI expects teacher turnover (teachers may leave a school or change grades), new teachers will be added to the I group.

**Data Analysis.** The magnitude of the intervention effects on teachers and students will be tested using Hierarchical Linear Modeling (HLM), adjusting for important covariates (e.g., pretest scores). HLM adjusts standard errors to account for the dependence among teachers within schools and among students within classrooms, thus avoiding overestimation of statistical significance of the effect size. For teacher outcomes, SRI will examine the overall effect of the intervention in each year, and change across years. For student outcomes, SRI will examine the overall effect of the intervention in each year and discover whether years of teacher participation in the intervention predict greater achievement gains (i.e., some teachers will enter I schools after

the first year). Trends in school-wide ISAT scores over the 10 year period will be graphed for each of the I and C schools; expected scores in each intervention year will be calculated based on linear extrapolation of scores in the baseline years and post-intervention scores compared with expected trends that preceded the intervention.

#### **E. Strategy and Capacity to Further Develop and Bring to Scale**

The proposed project will work with 80 PK-3 teachers in 8 Chicago public schools. These teachers serve approximately 2,400 students annually. For the 5-year period of the project, we estimate 4,512 unduplicated students will be served, some for 5 years.

The proposed PD is an extension of the existing EME Project at Erikson Institute. The project currently has a team of 11 staff members, including the Principal Investigator, Director, PD instructors, researchers, and school liaisons. This team will be the core staff in the proposed project, enabling us to start efficiently. The EME program has been met very positively by teachers, administrators, and funders. Evaluations indicate an extremely high degree of teacher satisfaction, evidenced by the fact that the program has had many more teachers apply than it has the capacity to serve. We have been the fortunate recipients of over \$1.6 million during the last four years from funders including the McCormick Foundation, CME Group Foundation, CPS, Motorola, and Exelon, suggesting the high degree of confidence private funders and our LEA have in our program. McCormick Foundation also provided \$273,000 to fund two international symposia on early mathematics education held at Erikson Institute this year and last. Over 200 researchers, teachers, administrators, and teacher educators from across the Midwest heard U.S. experts and speakers from Singapore, Russia, Australia, Finland, Japan, and the Netherlands discuss teaching mathematics to young children. CME Group has pledged \$1 million as a match for this Development grant.

We are very confident of having enough schools for the project. Erikson Institute currently has projects involving more than 40 CPS schools and has worked with more than 150 others. CPS, the project LEA, has made a full commitment, and 3 elementary schools—Prescott, Fulton, and Erie—have signed on to participate (see Appendix D). To participate as an additional school, an institution must demonstrate: (1) availability, as evidenced by no other major PD or research initiatives that involve PK-3 grades for the 5-year project period; (2) that a majority of students served are low-income or otherwise high need; and (3) that there are at least 2 classrooms at each grade level, PK-3, at project inception. To ensure access to teachers of all income levels, funds will be allocated to compensate them beyond normal work hours and provide a parking subsidy to attend learning labs. Erikson’s extended and ongoing relationship with CPS will make it easy to sustain the project over 5 years despite personnel or other changes at school sites.

Our focus on Illinois Standards for Mathematics rather than a particular math curriculum is a strength. Regardless of the curriculum chosen by a school, the proposed program helps teachers develop in-depth understanding of the foundational mathematics critical for its effective use, ensuring usefulness throughout Illinois or any other state which adopts the Common Core Standards. Mechanisms of dissemination include our quarterly newsletter, website, production of a trainer’s manual with accompanying classroom videotapes, summer institute to induct new teachers, presentations at national conferences, and publications. Upon project completion, we will shift our focus to training trainers, creating a model with significantly reduced costs.

The proposed project costs approximately \$1,330 per student, but at scale-up costs are reduced to \$462.43 (see Table 3). At scale-up, costs are eliminated for the Principal Investigator, Assistant Director, Doctoral Fellow, the independent evaluation, the assessment tools, some travel, books for contrast schools, some training supplies, video production, and publications.

Director, Instructor, and Coordinator time is reduced by 50% because development and dissemination are complete. Estimated costs are \$46,242,721.80 for 100,000 students, \$115,606,804.51 for 250,000 students, and \$231,213,609.01 for 500,000 students.

**F. Sustainability**

Our work will be sustained on four levels: school, classroom, project, and institution. At the **school level**, administrator and teacher commitment is a prerequisite. To build within-school capacity, the PD develops teachers and increases their opportunities to play more active roles, both within- and across-grades. This maintains teacher investment and provides structural support for continued development in teaching mathematics (Bryk et al., 2010).

**Table 3. Scale-up Cost Estimate**

<b>Budget Category</b>	<b>Item</b>	<b>Percent of Development Grant Amount</b>	<b>Dollar Amount</b>
Personnel & Benefits		55%	\$1,489,147.25
Travel	Teacher Parking	13.8%	\$6,000.00
Supplies	Books & Materials	83%	\$37,184.00
Other	Meetings	100%	\$17,480.00
Direct Cost	Direct Cost	33%	\$1,549,811.25
Indirect Cost	Indirect Cost @ 21%		\$325,460.36
Training Stipends	Learning Labs and Subs	100%	\$211,200.00
<b>TOTALS</b>	For 4,512 students		\$2,086,471.61
	Per single student		\$462.43

At the **classroom level**, positive attitudes will expand as teachers experience the rewards of

effective math teaching and appreciate their achievements in the PD program (Wilkins, 2008). Their growing reliance on the standards as a coherent resource will make them capable and flexible users of a variety of commercial curricula, better suiting them to teach in any situation and at any school and sustaining the attitudes, skills, and practices they develop during the PD.

At the **project level**, we will sustain our PD by expanding our website and providing a quarterly newsletter to foster information exchange among schools and teachers. We also will produce 3 dissemination products: a trainer’s manual; classroom videotapes for use with the manual; and journal articles. Finally, we will shift focus to training trainers to support scale up of the PD program to serve teachers and school districts beyond CPS.

Another major resource for sustaining the program is the support of **Erikson Institute**. As a graduate school in child development, the Institute engages in teaching, applied research, and community service. The proposed project is consistent with each of these priorities. Further, we propose to use what we learn to develop an early mathematics endorsement program for teachers of PK-3 as part of Erikson’s Teacher Education Program. The president of the Institute is donating his time to chair the Technical Advisory Council for the proposed project.

### **G. Quality of the Management Plan and Personnel**

The Project Team includes the Principal Investigator, Project Director, Assistant Director, Project Coordinator, four Instructors, Coaching Supervisor, and four coaches. Coaches’ time requirements will shift over the 5-year period, peaking during years 2 and 3 when both cohorts are receiving individual coaching (see Table 4 for a timeline). Each learning lab will be led by two instructors and attended by two coaches—school groups will be kept together within labs to allow collaboration and coaching access. Learning labs will be held after regular school hours; teachers will be paid to attend. Substitute teaching will be provided so teachers can have

**Table 4. Timeline for Single School Intervention**

		<u>Year 1</u>	<u>Year 2</u>	<u>Year 3</u>	<u>Year 4</u>	<u>Year 5</u>
Months: Oct-Sep		ONDJFMAMJJAS	ONDJFMAMJJAS	ONDJFMAMJJAS	ONDJFMAMJJAS	ONDJFMAMJJAS
<u>Pre-K &amp; K</u>	Learning labs	● ● ● ● ● ● ● ●	● ● ● ●	-----	-----	-----
	Coaching	● ● ● ●	● ● ● ●	● ● ● ●	-----	-----
	Within-grade	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●
<u>1st-3rd</u>	Learning labs	-----	● ● ● ● ● ● ● ●	● ● ● ●	-----	-----
	Coaching	-----	● ● ● ●	● ● ● ●	● ● ● ●	-----
	Within-grade	-----	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●
<u>All Grades</u>	Cross-grade	● ●	● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ●	● ● ● ●
	School-wide					● ●

individualized coaching during the school day. Within- and cross-grade level meetings will be held during regular work hours. Videotaping services and children's books will be provided.

Coaches will meet with the coaching supervisor and receive individual supervision once per week. Instructors will meet with the Project Director, Assistant Director, Principal Investigator, and Coaching Supervisor weekly to prepare learning labs and provide project oversight, with additional meetings in year 1 to develop curriculum for grades 1-3, and in years 4 and 5 to create "train the trainer" materials and disseminate findings. Short-term performance measures will receive particular attention during summer. The Technical Advisory Group will meet with the Project Director, Principal Investigator, Evaluation Director, and Senior Evaluation Consultant once annually to review feedback from SRI International. The Project Director, Evaluation Director, and Instructors will hold an Annual Administrative Meeting for school principals.

**Jie-Qi Chen, Ph.D.**, professor at Erikson Institute, will serve as **Principal Investigator**. Dr. Chen has taught various grade levels in China and the United States and has contributed to successful teacher PD initiatives in Boston and CPS for more than 20 years. She has received many honors and awards, including the 2009 NAECTE Outstanding Teacher Educator's Award.

**Jennifer McCray, Ph.D.** will serve as **Director** of the project. Dr. McCray directs the EME Project at Erikson and manages a million dollar budget. Her expertise includes mathematics teaching and learning, teacher professional development, cognition, and classroom assessment. Funded by the U.S. Dept. of HHS, her dissertation on PCK for preschool mathematics won awards from AERA and the National Association of Early Childhood Teacher Educators.

**Annie Georges, Ph.D.**, of SRI International, will serve as the **Evaluation Director**. Dr. Georges has a background in education policy analysis, with expertise in statistics, including multilevel regression (HLM) and fixed effects models. Dr. Georges has successfully managed

many large-scale early education projects funded by NSF, Department of HHS, and foundations.

**Donna Spiker, Ph.D.**, Manager of SRI's Early Childhood Program, will serve as **Senior Evaluation Consultant**. Dr. Spiker is a nationally known developmental psychologist with over 30 years experience in applied developmental research and school-readiness interventions. Her expertise in the use of quantitative and qualitative methods includes longitudinal studies, randomized trials, quasi-experimental designs, and case studies. Dr. Spiker has played a leadership role in dozens of large projects across the country and is already working closely with Erikson on 2 other major studies.

**Samuel Meisels, Ed.D.**, President of Erikson Institute and a nationally known expert in early education, child assessment, and early learning standards, will head the Technical Advisory Group. Members of the group include Dr. Doug Clements, Distinguished Professor of Learning and Instruction at SUNY (Buffalo), Ms. Angela Andrews, nationally known mathematics teacher educator, Dr. Kristiina Kumpulainen, Director of Information and Evaluation Services at the Finnish National Board of Education, and Kay Volk, Central Area Officer for CPS.

**Instructors** and **Coaches** for the project will be recruited from the EME team, which has extensive experience in mathematics curriculum, PK-3 education, and professional development. The **Assistant Director for Research** will have advanced skills in data management and analysis. The **Coaching Supervisor, Dr. Christine Maxwell**, is a former elementary school teacher and principal who supervises Erikson's New Schools Project (see Section C.).