In Search of Evidence for the Effectiveness of Professional Development:
An Exploratory Study

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This study examines the evidence for the effectiveness of professional development using a sample of ten elementary school teachers. These teachers were part of a larger intervention study that investigated the impact of a teaching model, Dynamic Pedagogy on student mathematics achievement. Positive results were obtained from the analysis of three sources of data: a teacher questionnaire about their professional development experiences, a rubric that rated teachers' classroom practice and students' test scores. Results are discussed in terms of the design features of a professional development program that are conducive to improvement in teacher knowledge and their subsequent classroom practice.

There is growing recognition in the educational reform community that improving student learning and performance rests on the capacity of teachers to demonstrate subject matter knowledge in the classroom. One aspect of teacher knowledge that is of interest to policy makers and researchers alike, is *pedagogical content knowledge,* the knowledge teachers need to know about subject matter content and understanding of what makes the learning of a specific topic easy or difficult for students (Shulman, 1986).

The linkage of teacher pedagogical content knowledge to student academic performance is of particular relevance for those who worry about the seemingly intractable problem of lack of access of many African American and Latino students from low income backgrounds to high quality teaching (e.g., Cochran-Smith, 2003; Darling-Hammond, 2003).

The linking of improvement in teacher knowledge to improvement in student learning and achievement has led to renewed interest among researchers and policy makers in improving the quality of the evidence about teacher professional development for in-service teachers. For

example, a number of recent studies have been interested in describing the links between the design and implementation of professional development and improvement in teaching and learning outcomes (Birman, Desimone, Porter, & Garet, 2000; Borko, 2004; Garet, Porter, Desimone, Birman, & Yoon, 2001; Spillane & Thompson, 1997; Supovitz & Turner, 2002). Similarly, school and district leaders expect providers of professional development to demonstrate plausible evidence that their approaches and activities contribute to improved test scores in schools serving predominantly African American and Latino students from low-income backgrounds.

This article examines the influences of professional development activities on teacher knowledge, their classroom practices and student academic achievement. The teachers participated in a larger study that investigated the impact of a socio-cognitive model of teaching, *Dynamic Pedagogy* on the mathematics achievement of African American and Latino students from low- income backgrounds.

Conceptual Framework

What are the design features of an effective professional development program? Birman et al. (2000) identified three structural features: form, duration and participation and three core features: content focus, active learning and coherence as key factors supporting the effectiveness of professional development. Other studies (Garet, 2001; Loucks- Horsley, & Stiles, 2001; Richardson & Placier, 2001) came to similar conclusions about the kinds of professional development activities that are likely to be effective in improving teacher knowledge. This body of research was referenced for the design of the conceptual framework for the professional development component of the larger intervention study. *Content, Process* and *Context* were selected as key constructs for deepening teacher knowledge and skills. A discussion of each construct follows.

Content

Content describes the curriculum, teaching method or assessment of a given discipline, (e.g., mathematics). Studies have documented improvement in teacher knowledge when some aspect of content becomes the focus of professional development activities. Some studies found that the teaching strategies that teachers use in their classrooms are related to the type of knowledge acquired in a professional

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development workshop (Garet et al., 2001; Gess-Newsome, 1999; Kennedy, 1999).

A model of teaching called *Dynamic Pedagogy* (DP) was the content focus of the professional development activities. Investigation of the impact of the model was part of a larger intervention study that was conducted in a school district, serving predominantly African American students from low-income backgrounds. The essential principles of DP called for classroom teachers to follow a dynamic approach to teaching and learning transactions integrating curriculum, assessment and instruction (C-A- I) components. The *Curriculum* strand of the model described tasks that used different modalities for representing its content as well as aroused and sustained student interest (e.g., The teacher assigned a problem in a puzzle format for student to solve). The *Assessment* strand of the model described the types of probes or questions (declarative, procedural, conceptual, and metacognitive) for helping students to respond to curricula tasks (e.g., The teacher asked students to explain how they solved the problem). The *Instructional* strand of the model consisted of a menu of strategies (e.g., modeling, scaffolding, explaining, shared and independent practice) for helping students to respond to curricula tasks and assessment probes (e.g., The teacher gave hints/cues to help students explain how they solved the problem). The thinking processes (*memory, practical, creative,* and *analytical*) of Sternberg's (1997) theory of Successful Intelligence were the focus for teachers' work in the three strands of the DP model.

Process

The reform-based literature on teacher learning suggests that when teachers have opportunities for active engagement in professional development activities, they are likely to report increases in their knowledge and skills (Fishman & Krajcik, 2003; Spillane, 1999, 2004). Similarly, professional development experiences that allow teachers to discuss subject-specific topics or a particular innovation among their peers from the same school or district, promote its successful implementation (Bryk & Schneider, 2002; Garet et al., 2001).

In using the construct of active engagement and shared responsibility for learning, staff provided teachers with experiences

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to deepen their knowledge of elementary school mathematics topics (Number Sense, Equivalent Fractions, Measurement and Geometry) and to help them make adjustments in teaching that content to learners with different strengths and needs. Professional development staff played the role of "critical friends" in working with teachers from the same school and other schools within the district to develop DP lesson plans, give them feedback on implementing DP lesson plans in their classrooms, review and critique samples of student work from the DP lessons taught in their classrooms.

Context

The context describes conditions in the school or district that may or may not be compatible with the professional development activities provided or its implementation in classrooms. Context factors supportive of effective professional development include: strong alignment of professional development activities with the district's goals; support from the school leadership for a particular innovation discussed in professional development workshops; and shared philosophy of teaching and learning between the professional development providers and the school and district leaders.

The study was conducted in a school district that was committed to improving mathematics achievement of all its students, the majority of whom were from low-income backgrounds. The leadership of the school district was supportive of the study to improve teacher knowledge through the professional development activities provided about the DP model. To facilitate the efforts of teacher to implement the DP model in their classrooms, the district leadership and principals scheduled time for teachers and support staff to work collaboratively to develop and implement DP strategies acquired through professional development.

Method

The sources of data for the study were a questionnaire administered to teachers who participated in the DP professional development and the implementation of the DP model in their third grade classrooms, observation data of classroom practice of teachers who implemented the DP model and scores on a mathematics test administered to students who were enrolled in classes taught by teachers who participated in the professional development activities.

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Participants

Ten teachers self-selected for participation in the pilot year of the study, two teachers in each of five schools in the suburban district of New York during the 2003-2004 academic year. All teachers had certification and license in K-6 General Education with teaching experience ranging from 6-24 years of experience. A total of 136 students participated in the study (African American, 62%; Latino, 11.4%; White, 14%; Asian, 13%). Approximately 14 students were enrolled in classes of teachers who participated in the study. To establish baseline performance, end-of-year scores on the 2nd grade Terra Nova mathematics achievement test were obtained from students. After a year of enrollment in DP classes, end-of year scores on the 3rd grade Terra Nova mathematics test were obtained for these students to ascertain change, if any, in their mathematics performance.

Procedures

Over the course of a year, teachers attended a series of mandatory professional development seminars that had two goals: (1) to enable teachers to understand the DP model; and (2) to support their use of the DP strategies in their teaching before, during, and after classroom practice. To help teachers implement the DP model, multiple opportunities were provided for teacher learning - a three-day Summer Institute was held prior to the start of the study; two full-day and three after-school seminars each lasting approximately two and a half hours. In addition, project staff held debriefing sessions with each teacher after teaching a DP lesson.

Implementation of the Dynamic Pedagogy (DP) Model

Teachers were expected to implement the DP model by planning lessons, implementing and evaluating them using DP strategies. To do so, a three-stage structure (before, during and after classroom practice) was used to organize these areas of teachers' work. However, for this study, only the implementation of the DP model during and after classroom practice was examined.

Before classroom practice

Two forms were provided for teachers to use in documenting their thoughts and plans for DP lessons. On the first form, *the preplanning template,* teachers recorded the curricula tasks, thinking processes,

and students' prior knowledge and skills in readiness for these tasks. The second form, *the lesson plan template,* teachers recorded the goals and objectives, materials/tools for the intended lesson, and the DP strategies to be used across three phases of a lesson. Lesson phases are temporal markers that serve to differentiate instructional episodes corresponding to the beginning, middle and end of a lesson. The concept of phases was borrowed from previous work (Armour-Thomas & Szczesiul, 1989; Artzt & Armour-Thomas, 2002) that suggested that teachers make different decisions about helping student to learn at the beginning (Initiation), middle (Development) and end (Closure) phases of a lesson.

During classroom practice

Teachers implemented the DP lesson plans for each of the target mathematics units of the project: Number Sense and Place Value, Equivalent Fractions, Geometry, and Measurement. More specifically, they used DP strategies across three phases of a lesson: In the Initiation Phase of the lesson, the teachers used *Dynamic Pedagogy* strategies to help children make connections with their prior knowledge and ascertain any misconceptions or procedural errors likely to pose obstacles to students' achievement of the lesson's goals and objectives. During the Development Phase, they used *Dynamic Pedagogy* strategies to monitor students' progress toward the goals and objectives of the lesson and helped them to construct new knowledge. Finally, for the Closure Phase, the teachers used *Dynamic Pedagogy* strategies to ascertain whether the goals and objectives were met and help children to consolidate and extend newly acquired learning to other contexts.

After classroom practice

Teachers used a *Teacher Self-Assessment Survey* to rate their own performance about using the *Dynamic Pedagogy* strategies across the three lesson phases.

Measures

Three measures were used to assess the effects of professional development. The first was a 42-item measure, the *Dynamic Pedagogy Questionnaire* that was administered to participating teachers at the end of the first year of the DP intervention study in 2004. The questionnaire consisted of items that elicited teachers' perceptions of the following: (1) the helpfulness of the experiences to understand the components of the DP model; (2) the frequency with which they used the DP strategies

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in their classrooms; (3) the impact of the use of DP strategies on their teaching; and (4) the impact of their use of DP strategies on students learning. The questionnaire was a six-point measure ranging from 6-strongly agree to 1-strongly disagree.

The second measure was a *Teacher-Student Interaction Rubric* that was used to rate the extent to which teachers used DP indicators in their verbal interactions with students in their classrooms. In arriving at a judgment of the quality of teacher-student interactions, three conditions were considered: (1) The number of students with whom the teacher engaged in discourse (e.g., modeling, asking questions; giving feedback on student responses; giving explanations of tasks to be completed alone or in small groups) over the duration of the lesson; (2) whether the teacher's use of DP indicators were in alignment with the purpose of the lesson; and (3) the number of students engaged in the activities of the lesson (e.g., responding to teacher's questions; asking questions of the teacher; demonstrating work on the blackboard; working on class assignments alone or in small groups). Using a coded table of the *Dynamic Pedagogy* indicators, two coders first reached consensus on a subset of transcripts and then coded remaining transcripts independently to establish interrater reliability of approximately 85% agreement. These results were then used as the basis for making summary judgments about teacher and student behaviors over the course of a lesson and to assign scores that ranged from 4 to 1. Score 4 = the teacher interacts with many children and use of DP indicators is strongly in alignment with the purpose of the lesson; score 3 = the teacher interacts with some children and his/her use of DP indicators is strongly in alignment with the purpose of the lesson; score 2 = the teacher interacts with many children but his/her use of DP indicators is moderately in alignment with the purpose of the lesson; score 1 = the teacher interacts with few children and his/her use of DP indicators is weakly in alignment with the purpose of the lesson.

The third measure comprised the 2nd and 3rd grade *Terra Nova Mathematics Tests* that were administered to students who were enrolled in the classes of teachers who participated in the DP professional development activities. The 2nd grade test was administered to students prior to the start of the DP study in the fall 2003. The 3rd grade test was administered to students at the end of the first year of the DP study in the spring 2004. Any change in student performance from pre-test to post-test was assumed to be due to the successful implementation

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of the DP model by teachers who participated in the professional development activities.

Results

Dynamic Pedagogy Questionnaire

Table 1 displays the mean and standard deviation of teachers' perceptions about the professional development experiences indicating that all the teachers had positive reactions about the professional development activities in which they participated.

Table 1
Ratings of the Dynamic Pedagogy Questionnaire

Components of the Questionnaire	M	SD
Helpfulness of DP Professional Development	5.24	.56
Frequency of use of DP strategies in teaching	4.66	.87
Impact of DP on teaching	5.29	.56
Impact of DP on student learning	5.35	.45

Teacher-student interaction rubric

Table 2 displays differences in the performance of teachers who implemented the DP model in the classroom. Of the 10 teachers who participated in the professional development activities, 4 of them received a rubric score of 4 indicating that they met all the criteria for using DP strategies in the classroom; 5 teachers received a score of 3 indicating that they met some of the criteria for using DP strategies in the classroom; and 1 teacher received a score of 2 indicating that she met few criteria for using DP strategies in the classroom.

Table 2
Ratings of the Teacher-student interaction rubric

Rubric Score	n	Percentage
4	4	40
3	5	50
2	1	10
1	0	0

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Performance on the 2nd and 3rd grade Mathematics Achievement Tests

As Table 3 demonstrates, students in classes taught by teachers who participated in the *Dynamic Pedagogy* professional development showed gains on a standardized measure of mathematics achievement. A disaggregation of the data as displayed in Table 4, shows a similar pattern of positive change on the standardized mathematics test.

Table 3
Performance on Terra Nova Mathematics Achievement Test

Grade	M	SD	Change
2	557.00	34.74	
3	627.45	40.27	
			70.45

Table 4
Achievement Data of Students in DP Teachers' Classes

	Average Math Scores on Mathematics Achievement Test						
	2nd Grade			3rd Grade			
Teacher	n	M	SD	n	M	SD	Gain
A	15	541.25	35.33	15	659.56	32.77	118.31
B	17	589.00	32.27	17	651.60	39.24	62.60
C	14	569.60	39.19	14	609.73	38.13	40.13
D	16	548.14	25.36	16	617.43	26.51	69.29
E	13	555.85	42.19	13	630.75	29.94	74.90
F	16	567.13	30.25	16	635.25	31.58	68.12
G	9	513.00	35.60	9	611.25	37.30	98.25
H	11	557.09	29.79	11	622.00	26.40	64.91
I	14	557.21	30.04	14	613.57	39.44	56.36
J	11	556.45	28.40	11	620.36	38.35	63.91

Discussion and Conclusion

The results of this exploratory study suggest some evidence for the effectiveness of professional development. The results are consistent with other studies that documented teachers' positive reactions about the professional development experiences in which they have participated (Birman et al., 2001; Kennedy, 1999). The results are also consistent with some large-scale studies that have indicated how professional

development can influence teacher classroom practice (e.g., Garet et al., 2001; Penuel & Means, 2004; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). Where this present study departs from previous studies is the finding, though preliminary, that links student academic achievement to professional development. This is an important finding for it suggests that improvement in student academic performance, not just teachers' self-reported judgments about professional development activities themselves, are important indicators of the effectiveness of professional development as other researchers have suggested (Borko, 2004; Fishman, Marx, Best, & Tal, 2003).

Limitations

Despite the encouraging findings, the results should be interpreted with caution. First, the study did not use a random-assignment design and therefore cannot answer with certainty the impact of professional development on teacher practice and student academic achievement. Secondly, the small sample size and the self-selection of teachers in the study limit the generalizability of the findings.

Implications for education

Given recent concern for improving teacher quality and student performance on standardized tests, school and district leaders are looking for approaches to professional development that address improvement in teacher knowledge, classroom practice and student learning. Taken together, the findings from this study suggest that these outcomes are likely if teachers are provided with opportunities for professional development that have a strong focus on content, active participatory learning with peers, and a supportive context at the district and schools in which they work.

Future research

The findings from this exploratory study provide some useful data for what makes professional development effective. Future studies may want to use more sophisticated statistical techniques to analyze the links between the design and conduct of professional development and change in teacher knowledge, classroom practice and student achievement. To minimize threats to internal validity, future studies may also want to use random assignment of teachers and schools to professional development conditions.

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