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PROFESSIONAL DEVELOPMENT AND TEACHER LEARNING :

MAPPING THE TERRAIN

By Hilda Borko

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Abstract

Teacher professional development is essential to efforts to improve our schools. This article maps the terrain of research on this important topic. It first provides an overview of what we have learned as a field, about effective professional development programs and their impact on teacher learning. It then suggests some important directions and strategies for extending our knowledge into new territory of questions not yet explored.

Educational reform movements in the United States and around the world are setting ambitious goals for student learning. Many factors contribute to achieving these goals. However, the changes in classroom practices demanded by the reform visions ultimately rely on teachers (Fullan & Miles, 1992; Spillane, 1999). Changes of this magnitude will require a great deal of learning on the part of teachers and will be difficult to make without support and guidance (Ball & Cohen, 1999; Putnam & Borko, 1997; Wilson & Berne, 1999).

This realization has led educational scholars and policy makers to demand professional development opportunities for teachers – opportunities that will help them enhance their knowledge and develop new instructional practices. As one example, the No Child Left Behind (NCLB) Act of 2001 requires that states ensure the availability of "high quality" professional development for all teachers. NCLB does not, however, address questions such as what constitutes high quality professional development or how professional development should be made available to teachers. Similarly, "Teaching at Risk: A Call to Action," the report released recently by The Teaching Commission (2004), reminds us that teaching is "our nation's most valuable profession" (p.12), arguing forcefully that "helping our teachers to succeed and enabling our children to learn is an investment in human potential, one that is essential to guaranteeing America's future freedom and prosperity" (p.11). The Commission proposed a multifaceted approach to helping teachers succeed, one that includes high standards for teacher classroom performance and student achievement, and "ongoing and targeted professional development" to help teachers meet the demanding new standards. Again, little is said about the content and character of that professional development.

Despite recognition of its importance, the professional development currently available to teachers is woefully inadequate. Each year, schools, districts and the federal government spend millions, if not billions, of dollars on in-service seminars and other forms of professional development that are fragmented, intellectually superficial, and do not take into account what we know about how teachers learn (Ball & Cohen, 1999; Putnam & Borko, 1997). Sykes (1996) characterized the inadequacy of conventional professional development as "the most serious unsolved problem for policy and practice in American education today" (p. 465). The premise of this article is that it is a "serious unsolved problem" for educational research as well.

Indeed, while the field of research on teacher learning is relatively young, we have made a great deal of progress in the last 20 or so years. For example, we have evidence that professional development can lead to improvements in instructional practices and student learning. We are only beginning to learn, however, about exactly what and how teachers learn from professional development, or about the impact of teacher change on student outcomes (Desimone, Porter, Garet, Yoon, & Birman, 2002; Fishman, Marx, Best, & Tal, 2003; Garet, Porter, Desimone, Birman, & Yoon, 2001). We have a full research agenda ahead of us to gather the information necessary to guide professional development policy and practice.

This article, and the AERA presidential address on which it is based, are intended to move us along that path by mapping the terrain of research on teachers' professional development. Two major questions guide my analysis. The first focuses on the known terrain: What do we know about professional development programs and their impact on teacher learning? The second proposes a route into unexplored territory: What are important directions and strategies for extending our knowledge? My analysis presumes a situative perspective on knowing and

learning. I begin by briefly describing that perspective. I then move on to consider the two guiding questions.

A Situative Perspective on Teacher Learning and Professional Development

Several years ago, Ralph Putnam and I used a situative perspective to interpret existing research on teacher learning and identify several issues for future investigation (Putnam & Borko, 2000). In some sense, this article is an extension of that work. Again drawing on a situative perspective, I consider what researchers have learned about professional development programs and their impact on teacher learning, identifying areas in which additional research is needed and suggesting strategies for exploring those areas.

The term *situative* refers to a set of theoretical perspectives and lines of research with roots in various disciplines including anthropology, sociology and psychology. Situative theorists conceptualize learning as changes in participation in socially organized activities, and individuals' use of knowledge as an aspect of their participation in social practices (e.g., Greeno, 2003; Lave & Wenger, 1991). Several scholars have argued that learning has both individual and socio-cultural features, and have characterized the learning process as one of enculturation *and* construction (e.g., Cobb, 1994; Driver, et al., 1994). As Cobb explained, "learning should be viewed as both a process of active individual construction and a process of enculturation into the ... practices of wider society" (p. 13).

Research in a situative tradition allows for multiple conceptual perspectives and multiple units of analysis. These multiple perspectives provide powerful tools for understanding student learning in classroom settings. Using psychological conceptual frameworks and the individual as the

unit of analysis, researchers can study students' activities as individuals and their evolving knowledge and understanding. They can use sociocultural conceptual frameworks and the group as the unit of analysis to examine the social context of the classroom and patterns of participation in learning activities. Both perspectives are essential to understanding how students learn through participation in classroom practices. The appropriate unit of analysis in any particular situation depends on one's research purposes and questions (Bowers, Cobb, & McClain,1999; Cobb & Bowers, 1999; Greeno, 2003).

From a situative perspective, teacher learning "is usefully understood as a process of increasing participation in the practice of teaching, and through this participation, a process of becoming knowledgeable in and about teaching" (Adler, 2000, p. 37). For teachers, learning occurs in many different aspects of practice, including their classrooms, their school communities, and professional development courses or workshops. It can occur in a brief hallway conversation with a colleague, or after school when counseling a troubled child. To understand teacher learning, we must study it within these multiple contexts, taking into account both the individual teacher-learners and the social systems in which they are participants. As in the case of student learning, situative perspectives provide a powerful research tool, enabling researchers to focus attention on individual teachers as learners and on their participation in professional learning communities (Putnam & Borko, 2000).

Mapping the Phases of Research on Teacher Professional Development

Using the multiple conceptual perspectives and multiple units of analysis of a situative perspective, I now turn to the questions that are the foci of this article: What do we know about

professional development programs and their impact on teacher learning? What are important directions and strategies for extending our knowledge?

In thinking about these questions, it is helpful to identify the key elements that make up any professional development system (see Figure 1): [i]

- the professional development program;
- the teachers, who are the learners in the system;
- the facilitator, who guides teachers as they construct new knowledge and practices; and
- the context in which the professional development occurs.

[Insert Figure 1 about here]

Educational scholars have studied these elements and the relationships among them in a variety of ways. I have organized programs of research into three phases, each building on the previous one. These phases represent one way in which research activities can progress toward the goal of providing high quality professional development for all teachers.

Phase 1 research activities focus on an individual professional development program at a single site. Researchers typically study the professional development program, teachers as learners, and the relationships between these two elements of the system. The facilitator and context remain unstudied. In **Phase 2**, researchers study a single professional development program enacted by more than one facilitator at more than one site, exploring the relationships among facilitators, the professional development program, and teachers as learners. In **Phase 3**, the research focus broadens to comparing multiple professional development programs, each enacted at multiple sites. Researchers study the relationships among all four elements of a professional development system: facilitator, professional development program, teachers as learners, and

context.

In the sections that follow, I examine the three phases in more depth. Rather than exhaustively reviewing the literature relevant to each phase, I draw upon research conducted on a small number of high quality professional development programs to illustrate major themes and patterns of findings. (For more comprehensive discussions of the research literature on teacher learning and professional development, see Borko & Putnam, 1996; Putnam & Borko, 1997; and Wilson & Berne, 1999).

Phase 1: Existence Proofs of Effective Professional Development

The goal of Phase 1 activities is to create an existence proof, that is, to provide evidence that a professional development program can have a positive impact on teacher learning (see Figure 2). Researchers study a single professional development program at a single site, as symbolized by "pd = 1." They explore the nature of the professional development program, teachers as learners, and the relationship between teachers' participation in professional development and their learning. Most of the professional development community's work to date has been in Phase 1. Thus, to map the terrain of research on professional development and teacher learning, much of my discussion focuses on this phase.

[Insert Figure 2 about here]

Phase 1 research provides evidence that high-quality professional development programs can help teachers deepen their knowledge and transform their teaching. Typically, the professional development programs studied in Phase 1 are relatively small, and the research on them is labor intensive. In most instances, the designers of the professional development programs are also

the researchers. Further, the participants are typically "motivated volunteers" – teachers who volunteered to participate and were motivated to try out new ideas (Fishman et al., 2003). The resulting existence proofs unquestionably are an important contribution to the field. As Shulman (1983) reminded us, they "evoke images of the possible ... not only documenting that it can be done, but also laying out at least one detailed example of how it was organized, developed, and pursued" (p. 495).

I use a situative lens to bring these images of the possible into focus, organizing my discussion around four themes. First, using the individual as the unit of analysis, I consider what Phase 1 research reveals about teachers and their learning. I next explore the processes and activities of professional development, using the group as the unit of analysis. Finally, I consider what we have learned about teacher learning and about research methodology by using conceptual frameworks and research tools that keep the individual and the group in focus simultaneously.

Individual Focus: Teacher Knowledge and Practices Can Change Through Intensive Professional Development Programs

Phase 1 research provides evidence that intensive professional development programs can help teachers to increase their knowledge and change their instructional practices. To explore what this research reveals about individual teacher change, I focus on three characteristics: subject matter knowledge for teaching, understanding of student thinking, and instructional practices – selected because of the emphasis they have received in recent professional development programs and research.

To foster students' conceptual understanding, teachers must have rich and flexible **knowledge of**

the subjects they teach. They must understand the central facts and concepts of the discipline, how these ideas are connected, and the processes used to establish new knowledge and determine the validity of claims (Anderson, 1989; Ball, 1990; Borko & Putnam, 1996; McDiarmid, Ball, & Anderson, 1989). Professional development programs that include an explicit focus on subject matter can help teachers develop these powerful understandings. Experiences that engage teachers as learners in activities such as solving mathematical problems and conducting scientific experiments are particularly effective. The conceptual change science teaching project (Neale, Smith & Johnson, 1990; Smith & Neal, 1991) and SummerMath for Teachers (Schifter & Simon, 1992; Simon & Schifter, 1991) provide examples. Both projects featured intensive summer workshops in which subject matter learning was a central component, followed by ongoing support during the school year. The teachers who participated in these projects developed deeper understandings of the mathematical and scientific content they explored.

To guide **student thinking**, teachers must also understand how children's ideas about a subject develop, and the connections between their ideas and important ideas in the discipline (Schifter & Fosnot, 1993). Research on the conceptual change science teaching project and Cognitively Guided Instruction (CGI) project shows that professional development can help teachers construct these understandings. In addition to content knowledge, the science teaching project's summer institute focused on children's thinking. Through activities such as clinical interviews with students, teachers learned about children's conceptions and typical misconceptions about key scientific concepts and the role that these ideas play in learning. The 4-week CGI summer workshop also included a variety of opportunities for teachers to explore student thinking and plan ways to build on students' knowledge in their mathematics instruction. Teachers who

participated in the CGI workshop knew more than control-group teachers about the strategies that children use to solve problems, the kinds of problems they find difficult, and different ways to pose problems to students. Teachers in both projects reported an increased awareness of the role that children's thinking plays in the learning process, and the importance of listening carefully to students in order to build on their understandings and misconceptions (Carpenter, Fennema, Peterson, Chaing, & Loef, 1989; Smith & Neale, 1991).

A key reason for deepening teachers' knowledge of subject matter and student thinking is to improve classroom teaching. Research on CGI incorporated a more extensive focus on **instructional practices** than most Phase 1 studies, including observations in CGI and control classes during the year following the summer workshop and longitudinal follow-up studies with several subsets of teachers. CGI teachers attempted to incorporate ideas from the professional development workshops into their teaching. For example, they taught problem solving more frequently than non-CGI teachers. They also attempted to foster discussions of problem-solving strategies, listen to students talk about their thinking, and use students' responses to assess their understanding and match subsequent problems to their abilities. Students in CGI classrooms solved a wider variety of mathematics problems, used more problem solving strategies, and were more confident in their mathematical ability than students in control classrooms (Carpenter & Fennema, 1992; Fennema, Franke, Carpenter, & Carey, 1993; Fennema, Carpenter, Franke, Levi, Jacobs, & Empson, 1996; Franke, Carpenter, Levi, & Fennema., 2001).

Research using the individual teacher as the unit of analysis also indicates that meaningful learning is a slow and uncertain process for teachers, just as it is for students. Some teachers change more than others through participation in professional development programs (Fennema

et al., 1996; Franke, et al., 2001; Knapp & Peterson, 1995). Further, some elements of teachers' knowledge and practice are more easily changed than others. For example, it appears to be easier for teachers to incorporate strategies for eliciting students' thinking into their teaching than to use what they hear from students to make instructional decisions (Franke et al., 2001; Franke & Kazemi, 2001).

Group Focus: Strong Professional Communities Can Foster Teacher Learning

Phase 1 research also provides evidence that strong professional learning communities can foster teacher learning and instructional improvement. Researchers have extended our understanding of teacher learning by using sociocultural conceptual frameworks and the group as the unit of analysis to examine participation in the processes and activities of professional development. Within this broad arena, I focus on teacher learning communities because of their centrality in recent programs of professional development and research (Ball, 1994; Little, 2002; Wilson & Berne, 1999).

Research on teacher learning communities typically explores features of professional development programs such as the establishment and maintenance of communication norms and trust, as well as the collaborative interactions that occur when groups of teachers work together to examine and improve their practice. This research provides evidence "that strong professional development communities are important contributors to instructional improvement and school reform" (Little, 2002, p. 936). Studies of the Community of Teacher Learners and QUASAR (Quantitative Understanding: Amplifying Student Achievement and Reasoning) projects are illustrative.

The Community of Teacher Learners project (Wineburg & Grossman, 1998; Thomas, Wineburg, Grossman, Myhre, & Woolworth, 1998, Grossman, Wineburg, & Woolworth, 2001) brought together English and history teachers at one urban high school and university-based educators to read books, discuss teaching and learning, and design an interdisciplinary humanities curriculum. Initial analyses of the first 18 months of the project focused on the group's development toward community and the challenges involved in community formation. Based on these analyses, Grossman, Wineburg, and Woolworth (2001) identified several key components of community formation: development of a group identity and norms for interaction, formulation of a sense of communal responsibility for the regulation of norms and behavior, and willingness of community members to assume responsibility for colleagues' growth and development. While these analyses did not link changes in teachers' interactions with the quality of their teaching or their students' achievement, the researchers reported some anecdotal evidence that the teacher community had an effect on students.

The QUASAR project sought to improve mathematics instruction for students attending middle schools in economically disadvantaged neighborhoods by funding and studying six site-based professional development programs. At each QUASAR school, the mathematics teachers worked with resource partners (usually mathematics educators from a local university) to develop and implement innovative curricula and instructional practices. The QUASAR project staff who studied these programs concluded that professional learning communities were central to fostering teacher change and student learning. For example, at schools where strong communities evolved, teachers increased their use of cognitively challenging tasks and students' mathematical explanations. Students in these QUASAR schools grew in their ability to solve problems and

communicate mathematically (Lane & Silver, 1994; Smith, 1997; Stein, Silver, & Smith, 1998; Stein, Smith, & Silver, 1999). Grossman and colleagues' (2001) insights about teacher community suggest a conceptual explanation for these findings. They argued that we cannot expect teachers to create a community of learners among students if they do not have a parallel community to nourish their own growth. The logic of this claim makes sense, but as a research community we have yet to build an empirical base to support the claim or to shed light on the mechanisms by which this relationship works.

Research on these two projects also reveals that the development of teacher communities is difficult and time-consuming work (Grossman, et al., 2001; Stein, et al., 1999). Norms that promote supportive yet challenging conversations about teaching are one of the most important features of successful learning communities. Teachers generally welcome the opportunity to discuss ideas and materials related to their work, and conversations in professional development settings are easily fostered. Yet, discussions that support critical examination of teaching are relatively rare (Ball, 1994; Putnam & Borko, 1997; McLaughlin & Talbert, 2001;Wilson & Berne, 1999). Such conversations must occur, however, if teachers are to collectively explore ways of improving their teaching and support each other as they work to transform their practice. To foster such discussions, professional development leaders must help teachers to establish trust, develop communication norms that enable critical dialogue, and maintain a balance between respecting individual community members and critically analyzing issues in their teaching (Frykholm, 1998; Seago, 2004).

Dual Focus: Records of Practices Are Powerful Contexts for Teacher Learning

Phase 1 research that explores how teachers learn through participation in professional

development communities reveals that records of classroom practice are a powerful tool for facilitating teacher change. This research uses group-level and individual-level conceptual perspectives, considering both the learning activities of the professional development community and the knowledge and instructional practices of individual teachers.

A central tenet of situative perspectives is that the contexts and activities in which people learn become a fundamental part of what they learn (Greeno, Collins, & Resnick, 1996). This tenet suggests that teachers' own classrooms are powerful contexts for their learning (Ball & Cohen, 1999; Putnam & Borko, 2000). It does not imply, however, that professional development activities should occur only in K-12 classrooms. Indeed, a number of programs have successfully used artifacts such as instructional plans and assignments, videotapes of lessons, and samples of student work to bring teachers' classrooms into the professional development setting. Such records of practice enable teachers to examine each other's instructional strategies and student learning, and to discuss ideas for improvement (Ball & Cohen, 1999; Little, Gearhart, Curry, & Kafka, 2003). I draw upon two projects to illustrate the power of these approaches.

The first example is an extension of the CGI project, in which Franke and Kazemi worked with the faculty at an elementary school for two years, facilitating and studying several teacher workgroups. Like CGI, their approach to professional development focused on the development of children's mathematical thinking. However, drawing upon ideas from sociocultural theory, they created communities of practice in which teachers came together to share, challenge, and create ideas about the mathematical thinking represented in their students' work. Teachers in these workgroup communities posed the same mathematics problem to their classes, brought samples of student work on the problem to monthly workgroup meetings, and explored the

samples together in order to make sense of students' solution strategies and discuss ways to move their mathematical thinking forward.

One set of research questions focused on the development of the workgroup communities. Over the course of the first year, the teachers came to see themselves as a community of learners with a shared goal of improving the learning and teaching of mathematics. They became better at elaborating the details of students' mathematical reasoning and understanding their problem-solving strategies, and they began to develop instructional trajectories for helping students advance their mathematical thinking. Analyses focused on individual participants revealed that the teachers' classroom practices also changed. They came to see their classrooms as places for their own learning as well as students' learning. Through experimentation, they developed new ways to elicit and listen to their students' mathematical thinking, and they used the workgroups as a place to reflect on their experimentation (Franke & Kazemi, 2001; Franke, Kazemi, Shih, Biagetti, & Battey, in press; Kazemi & Franke, 2004).

The second example is one of my own research projects, a multi-year, multi-faceted project that we call STAAR – Supporting the Transition from Arithmetic to Algebraic Reasoning. One component of STAAR is a professional development program for middle school mathematics teachers, comprising an intensive 2-week summer institute and monthly workshops throughout the school year. Central goals for the summer institute included creating a professional learning community and increasing teachers' understanding of key algebra concepts. The instructors structured activities to establish trust and create an environment in which teachers would feel safe to explore unknown mathematical terrain and share their solution strategies. Pedagogical strategies for fostering algebraic reasoning received greater emphasis in workshops conducted

during the school year. In one series of activities, the teachers worked together on a mathematics problem and discussed how to use the problem in their own classrooms. They were then videotaped teaching the problem in one of their classes. In subsequent workshops, they viewed and discussed segments of the videotapes and collectively examined samples of student work (Borko, Frykholm et al., in press; Clark & Borko, 2004).

Analyses of data collected in the professional development workshops and teachers' classrooms are currently underway. Our initial analyses reveal changes in patterns of participation in the workshops over time, and suggest connections between teachers' experiences in the workshops and changes in their mathematical understanding and instructional practices. For example, teachers demonstrated greater knowledge of algebra concepts and skills on an assessment of mathematical knowledge at the end of the summer institute than on a parallel assessment administered prior to the institute. In daily written reflections and interviews at the end of the institute, several teachers commented that peer collaboration and mathematical conversations played a crucial role in their evolving understanding of algebra concepts. Moreover, they indicated that they planned to foster similar collaborations and conversations among students in their own classrooms. Videotaped lessons during the school year following the summer institute document numerous attempts by these teachers to incorporate group work and sharing of mathematical explanations and justifications into their instruction (Borko, Frykholm et al., in press; Clark & Borko, 2004).

Simultaneous Focus: The Value of a Multifocal Research Lens

Studies that focus on either the individual or the group as the unit of analysis can provide

valuable insights about teacher learning. However, these insights are limited in scope. To explore the connections among professional development activities and processes on the one hand, and individual teachers' knowledge and instructional practices on the other, researchers must use the multiple conceptual frameworks and units of analysis that situative perspectives provide, and must "coordinate them in a manner that leads to a fuller, deeper explanation of teacher development" (Stein, Silver, & Smith, 1998, p. 49).

Multifocal contact lenses: a metaphor.

As I have argued for the value of situative perspectives and used them to frame my research, I have been struck by how challenging it can be to explain these perspectives to others. On more than one occasion, I have struggled to articulate how researchers can keep both the individual and the community in focus. I confronted a similar problem several months ago, when attempting to explain to a friend how my multifocal contact lenses work. Turning to the World Wide Web for assistance, I found the following explanation:

> Multifocal or simultaneous vision contact lenses allow both distant and near objects to be in focus at the same time. The design places both distance and near prescriptions in the central visual area, on or close to the pupil. Your visual system learns to interpret the correct power choice, depending on how close or far you are looking. Thus, whether gazing at objects that are far away or close at hand, your eyes select the desired images and ignore the undesired ones. (Adapted from http://www.allaboutvision.com/ and http://www.contactlenscouncil.org/aging.htm)

Multifocal contact lenses provide a useful metaphor for considering situative perspectives on knowing and learning. Researchers use the "near vision prescription" of a psychological

conceptual framework to focus on the individual teacher. With this prescription, they collect and analyze data on questions such as how a teacher constructs new knowledge and instructional practices. They use the "distance vision prescription" of a sociocultural conceptual framework to focus on the professional development community – to collect and analyze data on norms of communication and patterns of participation in professional development activities. The ability to use multiple frameworks at the same time is a key strength of situative research perspectives. We can extend the metaphor by considering other characteristics of the human visual system. For example, there are several ways to array the distance and near prescriptions on multifocal lenses. The best design for an individual depends on characteristics of the person such as pupil size, eyelid position, and visual needs related to lifestyle and activities. Similarly, a researcher's choice of specific data collection and analysis tools, and relative emphasis to place on each, will depend on factors such as research questions and available resources (Cobb & Bowers, 1999).

A research example.

In my AERA presidential address, I presented and discussed three short video clips to illustrate how the STAAR research team is using multifocal lenses to trace teacher learning through participation in the professional development program. Here, I focus on one brief episode from each video clip. The specific instructional features I consider are questions and explanations. In one set of analyses, our research team is examining the kinds of questions teachers asked and the explanations they gave when they worked on mathematical tasks, examined student work, and critiqued each other's teaching. The first example, from a professional development session in January 2004, is illustrative. The teachers were working in pairs or small groups to solve the following problem:

A cube with edges of length two centimeters is built from centimeter cubes. If you paint the faces of this cube and then break it into centimeter cubes, how many cubes will have three faces painted? How many will have two faces painted? One face? How many will be unpainted? What if the edge length of the original cube is three cm? 50cm? n cm?

One exchange that stood out for us occurred as Ken and Pam [ii] were examining the cube they had built with edges of length 3 centimeters. After they agreed that it contained 8 cubes with 3 faces painted, Ken began to work on the next question, counting to himself as he pointed to each cube with 2 faces painted. After a short time, he said to Pam "there are 12 with 2 sides (painted)." Not keeping up with his thinking, Pam asked Ken to "prove it," and added, "Would you care to elaborate on that?" Ken pointed to the top, middle, and then bottom layers of the cube as he explained, "Each level has 4, so..." Pam counted the cubes in the top and middle layers that had 2 faces painted before agreeing with his answer. Our analyses indicate that questions that pushed the teachers to share their mathematical thinking – such as "Prove it" and "Would you care to elaborate on that?" – were much more common in January than in professional development sessions earlier in the school year.

Our research team observed and videotaped two or three lessons in each teacher's classroom approximately once a month, in order to analyze changes in their instructional practices. The second example is from a lesson on addition of fractions that we observed Ken teach in his sixth grade mathematics class in October 2003. The lesson was typical of Ken's teaching early in the year. Desks were arranged in rows facing toward the chalkboard at the front of the room. The class spent about 15 to 20 minutes going over the previous day's homework. Ken then

introduced the next assignment, and students worked on it independently for the remainder of the class session. Soon after class began, one student put his solution to a homework problem on the chalkboard as Ken and the rest of the students watched in silence. Once the student completed his work, Ken broke the silence by asking, "Thumbs up if you agree; thumbs down if you disagree." He looked around the room, observed that most students had their thumbs up, and commented, "All right. Pretty good." Ken then thanked the class and continued the activity, "George, why don't you come up and do letter C for us."

When we returned to Ken's class in February 2004, he was teaching a lesson using the Painted Cube Problem. The classroom was arranged differently. Desks were pushed together in clusters of four; three or four students were seated at each cluster. During the lesson, Ken worked with groups of students. In the example taken from this lesson, Ken was seated at one of the clusters, observing a group of three students as they worked together on the cube problem. He pointed to the cube with edges of length 4 centimeters that they had constructed and asked, "How many (cubes with one face painted) would that be?" After a brief exchange in which one student explained that she calculated 24 cubes (the correct answer) by multiplying 6 times 4, Ken pushed the group to think about a larger cube, "Do you suppose if you have 5 by 5 by 5... Imagine a bigger cube, are you still going to multiply by 6? Is that going to change the way that the paint falls on the cube in any way?" The same student responded, "Probably." Ken followed with another question, "How?" The student explained, "Because you're making the cube bigger, so the center cubes are going to increase." Ken continued to probe, "Increase how? How is it going to increase?" She answered, "More cubes are going to add to the center." Not satisfied that he understood the student's thinking, Ken decided on a different approach,

suggesting “Why don’t you go ahead and build that 5 by 5. You can add on to that one (the cube the group had been working with).”

Ken’s questions in the first example addressed only the correctness of answers. Students were not asked to explain their thinking or to show how they solved problems. In contrast, several questions in the second example were intended to help the student explain her problem solving strategies, and to help Ken understand her thinking. These are but two days during the school year, and we are all too aware of how capricious one day’s observation can be. It might be that by the February observation, Ken had simply learned how to teach the way we want him to when we visited, or that he taught differently on that one occasion because of the specific instructional task. Our research team is currently analyzing all of the data we have on the teacher participants, tracing potential changes in individual teachers’ instructional practices, and looking for confirming and disconfirming evidence that those changes are associated with the professional development experience. Such analyses require a multifocal research lens.

Phase 2: Well-Specified Professional Development Programs

Phase 2 research activities follow directly from Phase 1. The central goal of Phase 2 research is to determine whether a professional development program can be enacted with integrity (LeFevre, 2004) in different settings and by different professional development providers. Figure 3 provides a visual representation; “pd>1” represents the focus on multiple sites and facilitators. [iii]

[Insert Figure 3 about here]

A professional development program must be well defined and clearly specified before

researchers can investigate how it is enacted by multiple facilitators in multiple settings, and what resources are needed to ensure its effectiveness. Cohen, Raudenbush, and Ball (2003) made a similar argument for the importance of well-defined and clearly specified instructional systems. They identified several critical features of well-defined systems, including academic tasks and instructional materials, descriptions of teaching, and student outcome measures. Features of a well-defined professional development system are similar; they include activities and materials for teachers, descriptions of facilitator roles, and teacher outcome measures.

Cohen and colleagues (2003) suggested that to design well-defined instructional systems, we need "excellent programs of development, field testing, and revision" (p. 136). Again, the situation for professional development is analogous. Major design activities in Phase 2 include refining a professional development program's tasks and materials for teachers (including the development of materials that are transportable across contexts), specifying the role of the facilitator, and developing resources and training for facilitators. A central purpose of Phase 2 research is to inform the development and refinement of program components. Thus, in a typical research program, researchers would study the enactment of a professional development program at multiple sites, with multiple facilitators, using multifocal lenses to explore similarities and differences in both the development of professional community and the learning of individual teachers.

My search through the literature did not yield any professional development programs for which there is adequate evidence that they can be enacted with integrity by multiple facilitators or in multiple settings. I did, however, identify a small number of projects that are working toward, or have achieved, widespread enactment. Three such projects are discussed here.

Curriculum-Based Professional Development

Developing Mathematical Ideas (DMI; Schifter, Bastable, & Russell, 1999 a,b,c) and VideoCases for Mathematics Professional Development (VCMPD; Seago, Mumme, & Branca, 2004) are similar in their approach to professional development. Both programs consist primarily of curricular materials designed for use in professional development seminars for teachers, and featuring multimedia cases as central components. The major goals of each program are to help teachers deepen their understanding of mathematics content, students' mathematical thinking, and instructional strategies; and develop norms and practices for learning about teaching. In DMI and VCMPD seminars, groups of teachers led by facilitators work together intensively over time, immersed in both subject matter and teaching practices.

From the outset, designers of DMI and VCMPD intended their programs to be published and disseminated for widespread use. To this end, both programs provide substantial preparation and support for facilitators, including resource materials such as a facilitator's guide with detailed suggestions for activities, readings, and agendas for seminar meetings; and a fictitious facilitator's reflective journal.

Research on both projects is limited, focusing almost exclusively on professional development conducted by the original design teams, with small numbers of teachers. Most studies addressed Phase 1 research questions and yielded insights similar to those reported in the previous section of this article. For example, detailed case studies conducted during development and pilot testing of the programs indicate that teachers who participated in the professional development seminars developed new norms for professional discourse, and deeper

understandings of the mathematics content they studied and the development of children's mathematical ideas (Cohen, 2004; Seago, 2004). For DMI participants, teaching practices changed more slowly than knowledge. Although all teachers fairly quickly adopted instructional strategies to support children's articulation of their mathematical ideas, their ability to use children's reasoning to guide instructional decisions developed more slowly (Cohen, 2004). Research on the effects of VCMPD on teaching practices is currently underway (Seago, 2004).

A small number of studies investigated the role of the facilitator during the design and pilot testing of DMI and VCMPD. These studies suggest that the facilitator is crucial to the success of the professional development program. Facilitators must be able to establish a community of learners in which inquiry is valued, and they must structure the learning experiences for that community. To do this, they must understand the goals of the program and how the resource materials can be used to achieve these goals (Remillard & Geist, 2002; Seago, 2004). Facilitators must be able to use the curriculum flexibly – reading the participants and the discourse, considering responses and possible consequences, and taking responsive action in order to balance the sometimes incompatible goals of the professional development program and the participants (Remillard & Geist, 2002).

LeFevre's (2004) longitudinal case study of VCMPD highlights the challenges involved in maintaining integrity when scaling up a curriculum-based professional development program. It is difficult enough to create a professional development curriculum for one's own use. As LeFevre warns, "It is challenging by another magnitude to design a curriculum for use by others" (p. 252). One central question addresses resource materials (e.g., VCMPD's video-based resources): How can these materials be designed to maximize the likelihood that teachers and

facilitators, in a range of contexts, will use them in the ways intended by the original design team? LeFevre's research indicates that communication is key. To maintain integrity, a program must effectively communicate the intended goals and uses of resources to prospective facilitators and provide support materials that will enable them to use the resources in the intended ways. LeFevre also notes the importance of extensive pilot testing, so that program designers can envisage the challenges and pitfalls that potential users might face and take these issues into account when revising both the professional development curriculum and support materials for facilitators.

Teachers Teaching Teachers

The National Writing Project (NWP; http://www.writingproject.org) has taken a very different approach to reaching large numbers of teachers. NWP's mission is to improve the teaching of writing and improve learning in the nation's schools. It follows a teachers-teaching-teachers model. Rather than developing extensive curricular materials for either teachers or facilitators, NWP focuses on situating teachers' learning in their own writing and classroom practices. Initiated in 1973 as the Bay Area Writing Project, NWP now includes 175 writing project sites and over 12,000 active teacher leaders. At each site, a university campus hosts a summer institute for teacher leaders, in which participants spend time demonstrating their classroom practices, studying theory and research about writing instruction, and immersing themselves in writing. During the following academic year, the teacher leaders give workshops for their colleagues, also hosted on the university campus. In 2002-2003, NWP leaders offered 6,482 programs for nearly 100,000 educators. The project also has an interactive online network in

which teachers, writing project site directors, and staff can share tools, resources, and strategies. Research on the National Writing Project also differs from the research conducted on Developing Mathematical Ideas and VideoCases for Mathematics Professional Development. Most studies have been program evaluations. Rather than conducting case studies of NWP summer institutes or workshops, evaluation teams relied primarily on surveys and interviews to gather self-report data from teachers. Teachers have reported that NWP helped them to develop a valuable professional network, change their philosophies about teaching writing, and increase both the time spent on writing instruction and use of exemplary teaching practices. Some analyses of student writing samples have also been conducted, with a majority of students' work showing improvements in organization, coherence, and use of writing conventions. Limited information is available about the content and activities in the institutes and workshops, or the instructional practices of participating teachers (Academy for Educational Development, 2002; Dickey et al., 2003; St. John, Hirabayashi, & Stokes, 2004).

NWP, DMI, and VCMPD have made impressive progress toward providing high quality professional development for large numbers of teachers. At the same time, none has produced a well-specified professional development program with evidence that it can be enacted with integrity at multiple sites. Additional research is needed to inform this development work. The nature of integrity differs across the programs, focusing on intended use of curricular materials in the case of DMI and VCMPD, and on a conception of writing instruction for NWP. Thus, specific research questions will also differ. Recommendations for such research, as well as other Phase 2 design and research activities, are provided in the final section.

Phase 3: Multiple Effective Professional Development Programs

Phase 3 research activities build upon Phase 2. The central goal of Phase 3 research is to provide comparative information about the implementation, effects, and resource requirements of well-defined professional development programs. Thus, research tasks include gathering and analyzing data from multiple professional development programs, as they are enacted by multiple facilitators at multiple sites. Figure 4 presents a visual representation of these tasks. The upper case PD in "PD>1" symbolizes the focus on multiple programs, each enacted at multiple sites. The term "multi-multifocal lens" is meant to capture the idea that Phase 3 researchers consider multiple professional development programs, using near-vision and distance-vision prescriptions to study each program.

[Insert Figure 4 about here]

The information provided by Phase 3 research is essential to policy decisions about resource allocation. Yet, to my knowledge, no Phase 3 research programs have been conducted, and none are currently underway. Thus, my task here is quite different than it was for Phases 1 and 2. Rather than discussing what we have learned from existing programs of professional development and research, I offer suggestions for a Phase 3 research agenda.

A Phase 3 Research Agenda

Cohen and colleagues (2003) argued persuasively for the importance of experimental or quasi-experimental studies when well-defined instructional systems exist. From a statistical perspective, field studies in which schools or classrooms are assigned randomly to treatments are the best way to produce causal conclusions about the relationships among educational resources, instructional practices, and student learning. Quasi-experimental designs are a preferred choice

when random assignment is not feasible or not desirable. For example, a well-controlled quasi-experiment that compares schools with good implementation of different educational interventions may have greater external validity and produce more useful results than a randomized experiment in which assignment to interventions is externally mandated. In-depth case studies conducted in conjunction with large-scale field studies can provide important insights about the processes and mechanisms by which the causes produce their effects (Shavelson & Towne, 2002).

The Study of Instructional Improvement (SII) is an example of this type of multi-method quasi-experimental field study. Conducted by a research team led by Cohen, Ball, and Rowan, this longitudinal study is investigating the design, implementation, and effects on student achievement of three of the most widely-adopted comprehensive school reform programs in the United States: Accelerated Schools, America's Choice, and Success for All. The research program has three components: case studies of the three interventions, a longitudinal survey-based study of 120 schools (30 schools implementing each of the three interventions, plus 30 matched control schools), and detailed case studies of 12 schools (3 schools implementing each intervention, plus 3 matched control schools). The main purposes of the research are to gain a deeper understanding of the processes of school improvement; to investigate the conditions under which school improvement efforts improve instructional capacity, classroom teaching, and student learning; and to examine how state and local policies assist or detract from school improvement initiatives. With its multiple purposes, multiple sites, and multiple research methods, this project fits my characterization of research that uses a multi-multifocal lens (Cohen, Raudenbush & Ball, 2003; Camburn, Rowan, & Taylor, 2003).

Should we be conducting similar studies in the area of professional development? My answer to this question is a qualified yes. A longitudinal field study of multiple professional development programs could address important issues such as: how each intervention operates in diverse settings, program fidelity across sites, impact on teacher and student learning, resources required for enactment, and policies that support enactment. Like any large-scale field study (whether experimental or quasi-experimental), it will require tremendous resources. Thus, although such studies have the potential to provide information of great value to the educational community, they are appropriate only when well-defined interventions with demonstrated effectiveness already exist. In the area of professional development, a small number of programs – such as Developing Mathematical Ideas, VideoCases for Mathematics Professional Development, and the National Writing Project – may be far enough along in their development to warrant inclusion in this type of investigation.

The complexity of the research design for a large-scale longitudinal field study of multiple professional development programs will undoubtedly require data collection and analysis tools that do not yet exist. Thus, in contrast to Phases 1 and 2, Phase 3 research projects will include substantial design work on research tools rather than professional development resources. Further, because of their scope and resource requirements it will be necessary that state and local policy makers work with researchers and teachers to make the research possible.

Next Steps for Professional Development Design and Research

I conclude with several suggestions about future directions for professional development design and research. Just as the three phases and the paths between them are not the only way to

characterize the field, these ideas are not meant to provide a comprehensive action agenda. Further, although each phase builds on the previous one, this does not imply that design and research efforts can, or should, proceed in a linear fashion from Phase 1 through Phase 3. On the contrary, there is important work to be done in all three phases, and new insights gained from design and research efforts in one phase will undoubtedly lead to ideas for new projects in the other two phases.

Turning first to **Phase 1**, the professional development programs I discussed focus on a limited number of subject areas and grade levels. My selections were based on availability. Many more professional development resources exist for some subject areas and grade levels than others – most notably elementary and middle school mathematics, science, and literacy. This situation is due, in part, to an historical unevenness in funding for educational research and development. It is a situation that must change. No Child Left Behind (2001) appropriately calls for highly qualified teachers and high quality professional development in all academic subjects and at all grade levels. There is an urgent need for Phase 1 work in areas that have received little attention to date. As one example, researchers might investigate whether professional development programs with demonstrated effectiveness for elementary mathematics teachers can be adapted to different subject areas and grade levels.

Design experiments, with their repeated cycles of design, enactment, analysis, and redesign, can be particularly useful for such investigations (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003; Design-Based Research Collective, 2003). For example, a Phase 1 design experiment might bring researchers and professional developers together to adapt an existing professional development program to a new subject area, engaging in multiple design/research cycles to refine

the program and study its impact on the development of professional community and the learning of individual teachers.

With respect to **Phase 2**, one key question for Developing Mathematical Ideas, VideoCases for Mathematics Professional Development, and the National Writing Project is whether the materials and resources provided by the programs are sufficient to ensure that multiple users in diverse settings can maintain integrity with the designers' intentions. In considering this question, it is important to clarify that maintaining integrity does not imply rigidly implementing a specific set of activities and procedures. "Mutual adaptation" – the term used by Berman and McLaughlin (1978) to account for the ways in which educational innovations and their users change in the process of implementation – is equally applicable to professional development programs. As they attempt to scale up, designers of these programs will inevitably face the dilemma that policymakers face: On the one hand, mutual adaptation to the needs and conditions of local sites is essential if a program is to be implemented effectively; on the other hand, too much adaptation can mean that the overall intent of the program is lost. Thus, Phase 2 studies must investigate the balances and tradeoffs between fidelity and adaptation, and consider which elements of a program must be preserved to ensure the integrity of its underlying goals and principles.

The nature of elements needed to preserve integrity will vary across programs. For curriculum-based professional development programs such as DMI and VCMPD, successful implementation requires a dynamic, interactive relationship between the written and enacted curriculum, one that takes into account unique features of participants and contexts as well as the program materials and resources (Remillard & Geist, 2002; LeFevre, 2004). For NWP, in

contrast, appropriate use of curricular materials is not the central issue. Instead, content and activities of the summer institutes and workshops must maintain integrity with the Project's conception of the writing process and writing instruction.

There are also numerous other small-scale professional development projects in existence today – many more than I was able to discuss here. For these projects, additional development and testing, with the goal of producing well-specified and clearly articulated professional development systems with resources to support widespread use, is an appropriate and important next step. My recommendation is that professional development designers collaborate with researchers, drawing upon the experiences and findings of programs such as DMI, VCMPD, and NWP as they engage in this work.

Central research issues to be investigated in **Phase 3** include resource requirements for successful enactment of professional development programs and impact on teacher and student learning. In addition, research should continue to explore the trade-offs between fidelity and adaptation that are necessary to ensure program effectiveness across multiple settings. To conduct the large-scale, multi-method field studies needed to address these questions will require new data collection and analysis tools – for example, instruments to measure change over time in teachers' subject matter knowledge for teaching and instructional practices, and analytic tools that can separate out the influences of various program, school, and individual factors on teacher and student learning. Some development work is currently underway. In January 2004, for example, the Consortium for Policy Research in Education sponsored a small working conference entitled *The Measurement of Instruction: Technical Challenges and Implications for Research, Policy, and Practice*. Researchers representing diverse substantive and methodological

perspectives shared lessons learned and challenges in our work. More importantly, the conference provided an opportunity for participants to think collaboratively about the state of knowledge on measurement of instruction, and to consider directions for future research.

This article began by calling upon the educational research community to play a leadership role in providing high quality professional development for all teachers. The multi-phase research agenda I outlined will help us to achieve this goal. I close with one additional challenge.

At its January 2003 meeting AERA Council unanimously passed a resolution promoting the essential elements of sound, scientifically-based research. In this resolution, which is posted on the AERA website (http://www.aera.net/), Council reasserted that there are multiple sound methodologies available to the educational research community and reminded us that for any given investigation, research questions should guide the selection of inquiry methods (see also Shavelson & Towne, 2002). Our impetus for passing the resolution was, in part, to urge the U.S. Department of Education to expand its current conception of scientifically-based research and its funding opportunities. My challenge to the educational research community is this: We have much work to do and many questions to answer in order to provide high quality professional development to all teachers. It will take many different types of inquiries and a vast array of research tools to generate the rich source of knowledge needed to achieve this goal. As we engage in all three phases of professional development design and research, we must make thoughtful, informed decisions about the designs and methods most appropriate to the specific questions we are asking.

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Figures for Hilda Borko:
Professional Development and Teacher Learning: Mapping the Terrain

Figure Captions

Figure 1.
Elements of a Professional Development System

Figure 2.
Phase 1 Research: Existence Proofs of Effective Professional Development

Figure 3.
Phase 2 Research: Well-Specified Professional Development Programs

Figure 4.
Phase 3 Research: Multiple Effective Professional Development Programs

Figure 1.

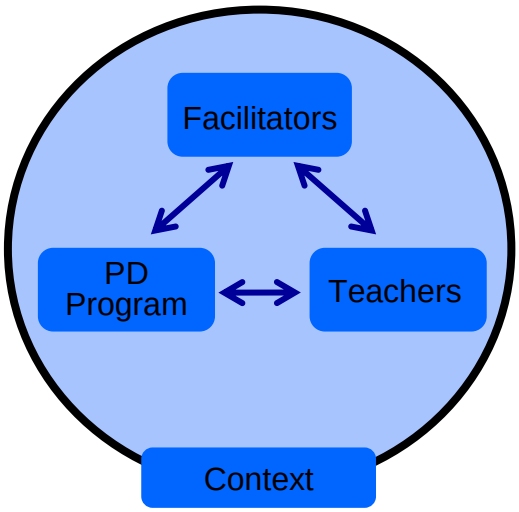


Figure 2.

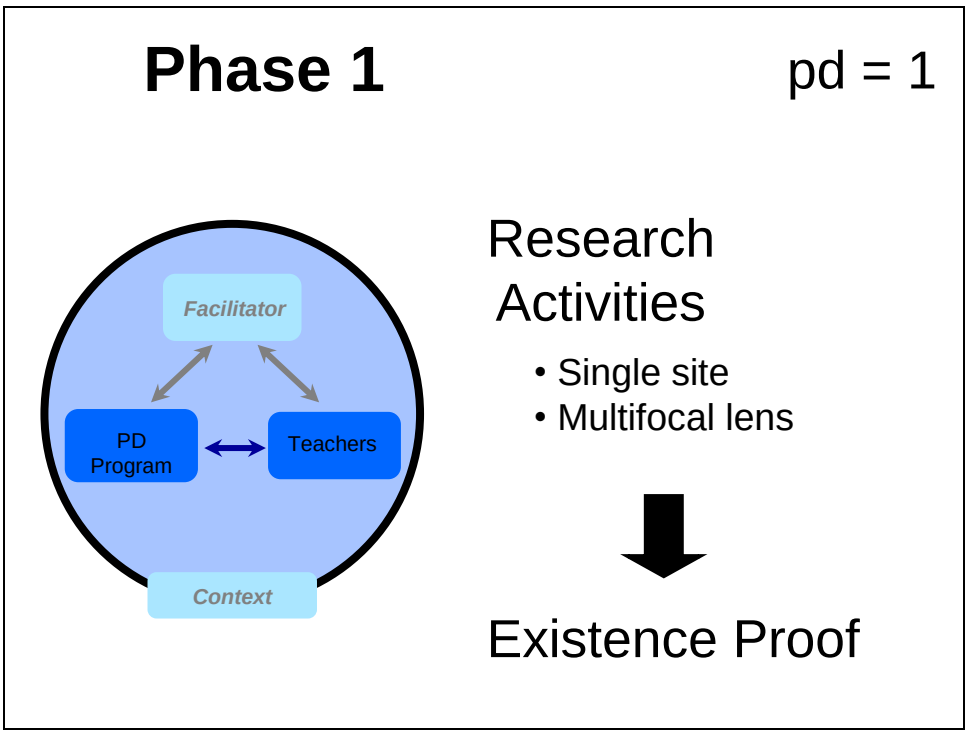

Phase 1
pd = 1
Facilitator
PD Program
Teachers
Context
Research Activities
• Single site
• Multifocal lens
Existence Proof

Figure 3.

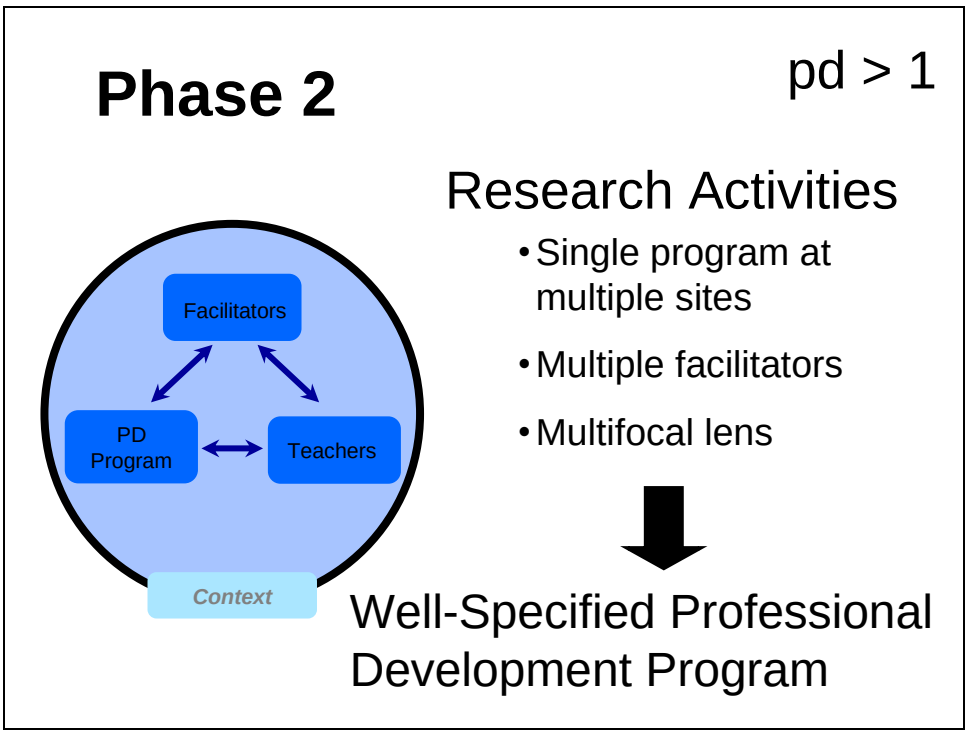
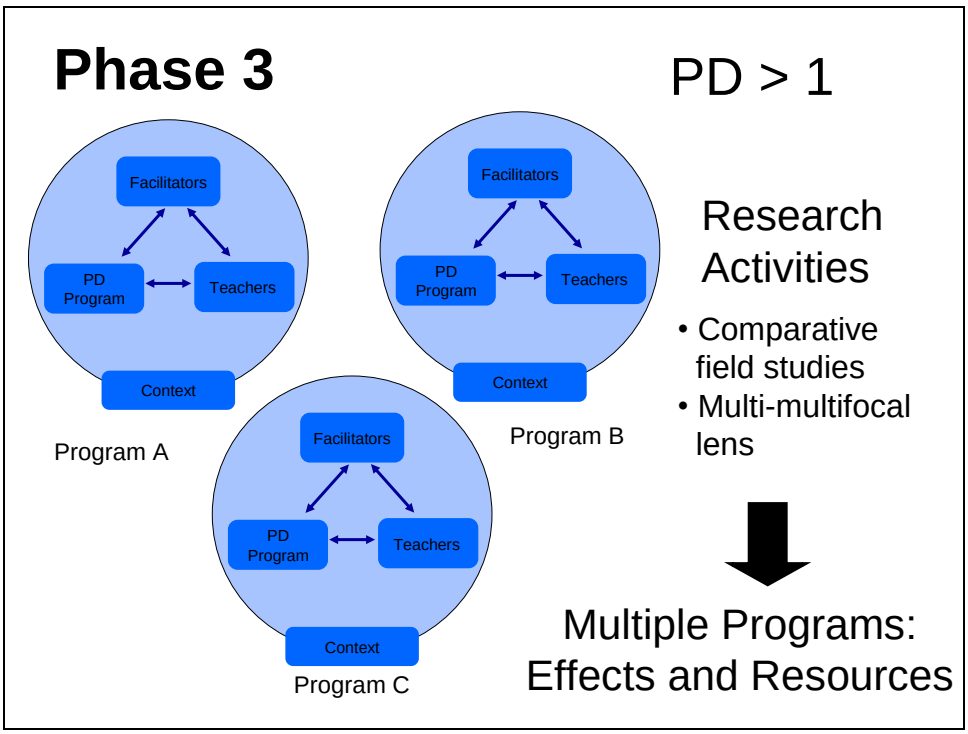

Phase 2
pd > 1
Research Activities
• Single program at multiple sites
• Multiple facilitators
• Multifocal lens
Facilitators
PD Program
Teachers
Context
Well-Specified Professional Development Program

Figure 4.



Endnotes:

1. I am certainly not the first person to use this type of figure to depict an educational system. I first encountered a similar representation in the work of Joseph Schwab (1978), who identified students, teachers, curriculum, and context as the four commonplaces of schooling. More recently, David Cohen, Deborah Ball and colleagues have used a similar representation to depict instruction as an interactional system that includes teachers, students, content, and environments (e.g., Cohen, Raudenbush, & Ball, 2003). In a professional development system, the "students" are teachers, the "teachers" are facilitators, and the "curriculum" is the professional development program.

ii.All teachers' and students' names are pseudonyms. I use teachers' first names to represent how the teachers in the STAAR project addressed each other and us.

iii. Phase 2, as I have conceptualized it, is not the only route to Phase 3. For example, another path might be to compare a single professional development program at a single site with another

single program at a similar site, identifying relative strengths and limitations to inform decisions about the allocation of resources to continued development efforts.