

CONCEPTUALIZING PROFESSIONAL DEVELOPMENT IN MATHEMATICS: ELEMENTS OF A MODEL

Paola Sztajn, Matthew P. Campbell, and Kwang S. Yoon

This theoretical paper discusses the concept of models for mathematics professional development. After examining the related literature, we propose a definition of this concept that includes four elements: goals, theories, contexts, and structure. We present aspects of professional development that comprise each element.

Keywords: Mathematics teacher education; Professional development; Theoretical models

Conceptualización del Desarrollo Profesional en Matemáticas: Elementos de un Modelo

En este artículo teórico discutimos sobre el concepto de modelos para el desarrollo profesional en matemáticas. Después de examinar la literatura relacionada, proponemos una definición de este concepto que incluye cuatro elementos: metas, teorías, contextos y estructura. Presentamos los aspectos del desarrollo profesional que abarca cada elemento.

Términos clave: Desarrollo profesional; Formación del profesor de matemáticas; Modelos teóricos

In the United States, the current focus on accountability has increased attention to the effectiveness of Mathematics Professional Development (MPD), and many recent studies have examined MPD initiatives to determine which ones were effective (e.g., Heck, Banilower, Weiss, & Rosenberg, 2008; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). Despite differences in the definition of effectiveness used across studies (Darling-Hammond & Youngs, 2002; Guskey, 2003), the search for effectiveness has generated interest in finding a common set of features that are present in various MPD programs deemed successful. Creating such lists of features of effective MPD can lead, some believe, to a consensus in

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the field about what constitute best practices in educating practicing mathematics teachers.

In this theoretical paper we claim that, by focusing on discrete features, these efforts to define effectiveness have supported the perspective of MPD as a research field that lacks a more systematic approach (Ball & Cohen, 1999), continuing to shy the field away from considering the conceptual and theoretical frameworks that support (or not) the combination of various features of successful MPD into coherent MPD programs. To address this problem, we propose a set of elements that should be included in the design and description of MPD initiatives, creating what we are calling *models* for MPD. We contend that a more systematic approach to examining elements within a model of effective MPD (instead of discrete features) can strengthen the emerging, and still under-theorized, field of research and development in MPD. We also argue that by defining elements that comprise models of MPD, the field can begin to more consistently examine what is being done and learned in MPD through the development of shared language and frameworks.

EXAMINING THE MPD LITERATURE

In her review of the literature about MPD, Sowder (2007) claimed that the fast growth of the field since the early 1990s was due to the realization that the improvement of instructional practices required better-prepared teachers who could change the way mathematics was taught. This need to reform, Sowder noted, was true across many countries. She summarized various synthesis studies that examined successful MPD initiatives (e.g., Borasi & Fonzi, 2002; Clarke, 1994; Hargreaves, 1995; Hawley & Valli, 1999). The commonalities she found across these studies indicated that, to be effective, MPD should include: (a) teacher participation in deciding the purpose of the intervention, (b) support from various stakeholders, (c) engagement in collaborative problem solving, (d) modeling of appropriate instruction, (e) continuation over time, and (f) use of formative assessment.

Although such lists of features that make professional development effective can be helpful for researchers and developers in MPD, they are also vague. Many terms used in the MPD literature can be interpreted in various ways. As an example of this vagueness in MPD language, consider the term *workshop*. Loucks-Horsley, Hewson, Love, and Stiles (1998) defined workshops as “structured opportunities for educators to learn from facilitators or leaders with specialized expertise as well as from peers” (p. 86). They noted that workshops allowed participants to focus intensely on an issue of interest. When one examines the MPD literature, however, the term *workshop*, although frequent, is used in many different ways. In one description of an MPD program, workshops were one feature within a constructivist program that included a two-week summer institute,

weekly meetings throughout the school year and four workshops to support collegial sharing among participants. In a different MPD, professional developers called workshop a two-week, university-level mathematics education course in the summer, with a one-day follow up after the school year started. In a third example, professional developers implemented a two-year intervention designed from a situated perspective on learning and developed around a sequence of iterations comprised of three workshops each, all focusing on the same mathematical task. In their more systematic review of the literature on effective MPD, all interventions Yoon, Duncan, Lee, Scarloss, and Shapley (2007) examined used workshops. These interventions, however, differed in terms of content, duration, contact hours, follow-up activities, and level of teacher engagement in learning opportunities.

Far from being exhaustive, these descriptions are illustrative of the variance that is present when one talks about offering workshops for mathematics teachers. They show that little meaning exists in the statement that a teacher participated in a workshop. Borrowing from the same examples, all three studies also used the term model to refer to their programs. As in the case of the workshop, model was also used with varying meanings and there were varying amounts of explanation in each article about what these models were. Further, there was no consistency across articles about how to describe a model, which makes these examples characteristic of the MPD literature: key terms are often used but rarely defined.

CONSIDERING THE IDEA OF MODELS

In the general literature about staff development, a few efforts to define general professional development models can be found. Sparks and Loucks-Horsley (1989) discussed five models for staff development. Their description of each model included three elements: (a) assumptions that guided the design of the professional development, (b) research underpinnings, and (c) phases that constituted the work with the teachers. For example, one of their models, named individually-guided staff development, was designed based on the underlying assumption that individuals are the best judges of their learning needs and are capable of self-initiated and directed learning. The research work of Rogers (1969), Knowles (1980), and Levine (1989) supported this model due to their focus on adults' search for growth, self-directedness, and needs at various professional stages, respectively. Professional development under this model included several phases such as: need identification, development of a plan, learning activities, and assessment of whether learning fulfilled the need. Training, another model proposed by Sparks and Loucks-Horsley (1989), rested on the assumption that teachers can learn to replicate behaviors and techniques that are new to their

repertoire. Joyce and Showers' (1988) research findings about components for skills development supported the training model.

A training model was also considered by Little (1993) in her critical piece about the lack of fit between professional development configurations and reform teaching. She proposed four alternatives to the training model that rested on the common claim that:

The most promising forms of professional development engage teachers in the pursuit of genuine questions, problems, and curiosities over time, ... and communicate a view of teachers not only as classroom experts, but also as productive and responsible members of a broader professional community. (Little, 1993, p. 133)

The alternatives that Little proposed to the training model were teacher networks, subject matter professional associations, collaborations for school reform, and institutes or centers. Common across these alternative models were principles such as meaningful intellectual engagement, pursuit of knowledge, and explicit accounting of the contexts of teaching and schooling. Elmore (2002) built on Little's criticisms to define a consensus model for teachers' professional development. His model included a focus on student learning, a clearly articulated theory of adult learning, active participation of administrators, use of data, and alignment between practice and message.

In the United States, the recent government regulation No Child Left Behind Act (2001) defined professional development (section 9101.34) through fifteen features of the activities included in interventions. These features ranged from targets for the professional development to the broader picture surrounding the initiative to what the intervention should address. Although the No Child Left Behind Act did not discuss professional development models, its definition of professional development included features related to the goals, context, and content of interventions. Context and content, together with processes, were also included in the National Staff Development Council (2001) standards.

Also regularly used in mathematics education is Loucks-Horsley et al. (1998) discussion of strategies. In the opening section of their book, these authors propose a framework to guide the design of MPD. This framework highlights the ways programs are designed to target particular contexts and goals, as well as guided by beliefs and knowledge about learners, teaching, change, and the nature of mathematics. Critical issues influencing the MPD design include features that occur across various contexts such as issues of equity, leadership and cultures. In their framework, contexts, goals, and knowledge and beliefs influence the plan that is implemented and then assessed before being revised.

PROPOSING A MODEL FOR MPD

Building on Loucks-Horsley and colleagues' goal, context, knowledge, and plans, we propose a definition of a model for MPD that includes four elements: goals, contexts, theories, and structure. In this definition, the structure of an MPD intervention is what mathematics teachers experience as participants. Structure is at the center of the model; it is shaped by and un-detachable from the goals, contexts, and theories that guide the intervention. Goals specify what is to be accomplished through a particular intervention; they define what needs are being addressed. Contexts are features from the environment that surrounds the intervention. Contexts shape the conceptualization of the intervention and help explain why an MPD is set up in a particular way to address a particular need. Theories are the larger assumptions about teaching and learning that guide all aspects of the MPD.

DEFINING ELEMENTS OF A MODEL FOR MPD

In this section we briefly present what particular features of MPD should be included in each of the elements proposed to define a model for MPD. These features are based on previous findings from the emerging MPD research literature.

Goals

In her review of existing interventions, Sowder (2007) organized MPD around the goals to develop: (a) a shared vision for mathematics teaching and learning, (b) a sound understanding of mathematics for the level taught, (c) an understanding of how students learn mathematics, (d) a deep pedagogical content knowledge, (e) an understanding of the role of equity in school mathematics, and (f) a sense of self as a mathematics teacher. These goals reflect some of the progress made in different areas of research within mathematics education. For example, research has begun to associate mathematics-related goals of MPD to student learning. Concepts such as mathematical knowledge for teaching (Ball, Hill, & Bass, 2005) and its connections to student achievement (Hill, Rowan, & Ball, 2005) increased the need to assure teachers have appropriate and teacher-specific content knowledge of mathematics. Similarly, research showing that when teachers attend to student reasoning there are gains in student achievement made research results from studies about student development of understanding in areas such as word problems (Carpenter, Fennema, Franke, Levi, & Empson, 1999), rational numbers (Lamon, 1999), geometry (Battista, 2007), and proofs (Harel, 2006), to mention just a few, essential for teachers. We propose that these six goals be included in the definition goals for an MPD model. However, all these goals represent perceived needs of teachers. Thus, we also propose that in examining the goals of an MPD intervention, researchers and developers also take into

account other possible goals emerging from needs of the designers, administrators, policymakers, or others.

Contexts

The importance of context cannot be underestimated and is highlighted in most attempts to summarize what is known about MPD. In a recent discussion about design issues regarding the study of impacts of professional development, Wayne, Yoon, Zhu, Cronen, and Garet (2008) noted two important aspects of the school environment that shaped decisions about professional development: curricular context (adopted curricula at the schools) and ambient context (other professional development opportunities that co-exists with the intervention under focus). Beside considering curricular and ambient contexts in our definition of contexts, other features included under context of an MPD are descriptive information about participants and providers (background demographics, involvement of stakeholders other than teachers, teaching assignments, etc.), teacher engagement in decision-making processes related to the intervention, compulsory versus voluntary participation, and the role of accountability. Participation of stakeholders other than teachers and teacher engagement in decision-making processes are two contextual features discussed not only within the general professional development literature, but also within the literature about effective school organizations and school change.

Theories

Sowder (2007) concluded that “however professional development is designed, it will be ineffective unless it is grounded in sound theory of learning” (p. 171). In their review, Borasi and Fonzi (2002) also noted the importance of theories on “how people learn best” to the design of MPD. Wayne et al. (2008) considered two important learning theories for designing professional development: the theories that guide what providers do when interacting with teachers (theory of teacher change) and theories about K-12 instruction espoused by designers and providers of the intervention (theory of instruction). Whereas the former is connected to theories about adult development and learning, the latter is connected to theories about children learning. When an overarching learning theory guides the MPD, coherence between these two theories is to be expected. It is reasonable to hypothesize that the more congruency between these two sets of theories, the more effective an MPD is likely to be. Theory of teacher change and theory of instruction are both included in our definition of MPD models.

Structure

Structure is probably the aspect of the MPD model that has gained most attention from researchers and developers. How to design the content and format of learning experiences for teachers? How many hours should teachers meet? Where? When? To do what? For example, consider number of contact hours as an im-

portant aspect of MPD. Yoon et al. (2007) found that interventions with contact hours ranging from 30 to 100 hours showed positive and significant effects on student learning, while interventions with fewer hours (ranging from 5 to 14 hours) had no effects. Garet, Porter, Desimone, Birman, and Yoon (2001) examined both the number of contact hours and the span of time of MPD interventions. They found that both dimensions were important for the impact of MPD interventions and had independent effects on teachers' self-reported outcomes such as improved practice. Garet and colleagues identified additional features of high-quality MPD such as active learning, coherence, collective participation, and content focus. Kennedy (1998) also found that among MPD programs that examined their impact on student learning, programs with a stronger content focus had a bigger impact, despite differences in organizational features. Her work highlighted the importance of attending to the content of the intervention beyond recommendations on how the intervention should be organized (format). Thus, the structure of an MPD intervention needs to include both content and format. Content may consist of the mathematics topics covered, a focus on student learning of particular topics, or a focus on mathematics curriculum. Format describes how opportunities for learning are organized, and presented. It includes number of contact hours, span, location, type of contact (in person, distance learning, mixed), the activities carried out, and the artifacts used.

SUMMARY

Examining the current literature about MPD, we noted that there is no consistent use of language or framework for describing MPD initiatives. We also noted that studies have focused on discrete features of professional development when trying to examine what makes an MPD effective or successful. We believe there is a need to clarify language and frameworks in the emerging field of MPD, and in this theoretical paper we propose that researchers and developers of MPD should take into consideration the notion that to conceptualize an MPD initiative one should attend to models. Further, we proposed that such models are composed of four elements (goals, theories, contexts, and structure), and we suggested various features of MPD that should be included within each of these elements. We claim that an appropriate design or description of MPD should attend to all the four elements that constitute a model for MPD. More important, we propose that MPD is a multi-dimensional construct with (at least) four dimensions that interact with each other in a potentially complex way.

LOOKING FORWARD

We see our definition of MPD models as an initial definition to be discussed and revised by researchers and developers in the emerging field of MPD. After a

wide debate among researchers about what should constitute a model for MPD, we suggest it would be advantageous to the field to come to an agreement about the various elements that comprise a model for MPD. We believe this focus on models can help the field move the discussion of effective MPD away from the listing of discrete features and toward a system approach to examining MPD. The discussion of model and of elements such as goals, theories, and contexts can support a move toward a more careful examination of fundamental, but hard to measure, aspects of MPD. We believe that such changes in language and in the approach to provide and study MPD are necessary to support the growth of MPD as field of research and development within mathematics education.

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Paola Sztajn	Mathew Campbell
North Carolina State University	Oregon State University
paola_sztajn@ncsu.edu	campbmat@onid.orst.edu
	Kwang Suk Yoon
	American Institutes for Research
	kyoon@air.org