

A Design for Using Long-Term Face-to-Face Workshops to Support Systemic Reform

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Demand for reform in science education is not new. From the Industrial Revolution of the late 1800s to Sputnik in 1957 and through the 2001 *No Child Left Behind Act*, science education has been adapted according to societal demands about what students need to know and be able to do. With each of these reforms came curriculum designed to address the issues of the time. More recent reform movements have been accompanied by the recognition that teachers require extensive support in order to implement reform; however, little research exists informing the creation and sustaining of such support, which usually takes the form of professional development. The purpose of this paper is to present a model for the design of sustainable professional development in the form of face-to-face workshops to support long-term reform. The model discussed in this paper was empirically developed in the context of an inquiry-oriented science education curriculum reform project with accompanying professional development aligned to the goals of the new curriculum materials.

Theoretical Framework

There are multiple avenues or sites for professional development intended to support teachers' adoption of inquiry-oriented science curricula: online support, educative curricula, summer institutes and in-class support to name a few. A traditional site is the face-to-face workshop. Although current research disparages the face-to-face workshop as a professional development approach (Garet, Porter, Desimone, Birman, & Yoon, 2001; Loucks-Horsley, Hewson, Love, & Stiles, 1998), it isn't the *form* of the workshop that is ill-suited to teacher learning, but often the content and delivery of workshops. In this paper we present evidence of successful use of face-to-face workshops to support curriculum adoption and identify the characteristics of these workshops that further inform the design of successful professional development. We take the position, based on our research, that face-to-face workshops are successful when they are offered in relation to classroom practice, provide opportunities for teachers to gauge and react to student responses to their teaching, and are designed not as "one shot" interactions but rather as recurring experiences for teachers to continuously build their understanding of the reform teaching ideas. We discuss how we developed our model of successful professional development, especially in terms of relationships between design elements, below.

Teacher Learning Model

We employ a model of teacher learning (see Figure 1) that puts teacher learning in a reciprocal relationships between the professional development activities, enactment and student response (Fishman, Marx, Best, & Tal, 2003). Beliefs and knowledge both influence and are

influenced by teaching practice (Richardson, 1996). Student learning works as a mediating factor since it is influenced by enactment as well as influences teachers' judgments about how successful an enactment was. The evidence from these features informs design decisions about professional development (and sometimes the redesign of the curriculum itself), which in turn influence teachers' knowledge and beliefs through various professional development activities. This model of teacher learning provided a useful template for examining teacher learning from face-to-face workshops in the context of science education reform. The model of teacher learning does not; however, inform professional development design itself, nor was that its intent. Others have examined the influence of educative components of curriculum materials on teacher learning (Schneider & Krajcik, 2002). Our studies focus on examining the intricacies of teacher learning from the workshop, informed by the written curriculum, the impact of the workshop on practice and the impact of practice on teacher learning. We accept the premise that the educative curriculum, too, contributes to teacher learning, but for our studies we focused on how the curriculum informs the professional development design.

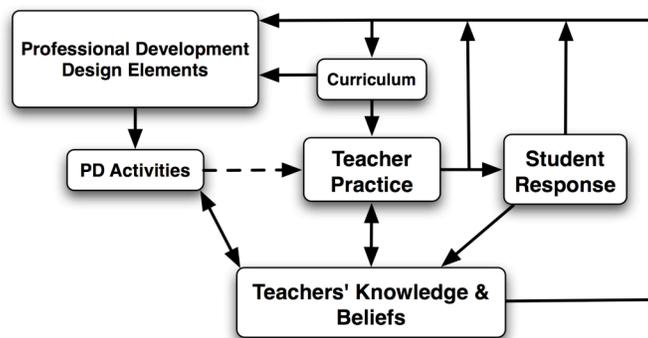


Figure 1. Model of teacher learning (modified from Fishman, Marx, Best, & Tal, 2003).

Professional Development Design – an Iterative Approach

We adopted an iterative model for the design of and research on professional development as described by Fishman, Marx, Best, & Tal (2003) (see Figure 2). This model provides a template for design-based research allowing for the study of professional development while informing the design of professional development.

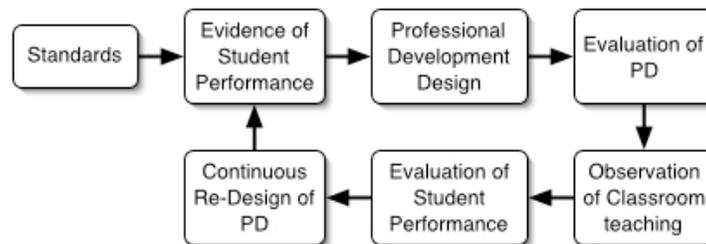


Figure 2. Iterative professional development design-research model (Fishman, Marx, Best, & Tal, 2003).

The face-to-face workshops at the focus of these studies were first informed by the national science education *standards* (e.g. American Association for the Advancement of

Science, 1993; National Research Council, 1996) and curriculum materials based on those standards (Singer, Marx, Krajcik, & Clay-Chambers, 2000) in order to identify what we wanted students to learn. We investigated *evidence of student performance* to develop goals that inform the *professional development design* intended to impact the teachers' enactment of the curriculum (Loucks-Horsley, Hewson, Love, & Stiles, 1998). After teachers participated in a professional development activity, we interviewed teachers to *evaluate the professional development*. We *observed classroom teaching* during the enactment of a lesson covered during the professional development and *evaluated student performance* of this activity, using this information to inform the *redesign of future professional development*, an essential component of quality professional development (Loucks-Horsley, Hewson, Love, & Stiles, 1998). Using this model, we have examined shifts in teachers' knowledge and beliefs from workshops and its impact on teacher practice and student learning, looking for specific characteristics of professional development that result in successful professional development (Fishman, Marx, Best, & Tal, 2003; Kubitskey, Fishman, & Marx, 2002; 2003).

The Fishman, Marx, Best and Tal (2003) iterative design research model used in the context of our studies allowed us to empirically examine the impact of face-to-face workshops on practice and student learning, measuring the success of the workshop. This iterative research model proved useful in developing and implementing long-term curriculum aligned workshops as researchers. We used this model to both study face-to-face workshops as well as inform the next workshop cycle. Yet, this model depends on a researcher or otherwise independent observer to inform the workshop design. Hopefully the reform will outlast the need for researchers to be present. This model (see Figure 2) does not lend itself to long-term face-to-face workshop design because it depends on external evaluation. Our research using this model, however, suggests a new model for face-to-face workshop design that is both iterative and self-sustaining, discussed below.

Background and Context

The Center for Highly Interactive Classrooms, Curricula and Computing in Education (hi-ce) creates inquiry-based curricula and learner centered technology. Hi-ce also develops and supplies professional development to support these activities (www.hice.org). In particular, this study takes place surrounding one of hi-ce's research projects, LeTUS (The Center for Learning Technology in Urban Schools), which was a collaboration between the Detroit Public Schools, Chicago Public Schools, Northwestern University and University of Michigan. LeTUS created and disseminated technology-rich, inquiry-based middle school science curricula. This involved extensive curriculum development (Singer, Marx, Krajcik, & Clay-Chambers, 2000), designed to integrate technology to support student and teacher learning (Marx, Blumenfeld, Krajcik, & Soloway, 1998) and included broad-based professional development. LeTUS developed five units, one in the 6th grade, three in the 7th grade, and one in the 8th grade. Approximately 85 teachers in Detroit from 25 middle and over 5000 students used LeTUS curricula in 2004. LeTUS teachers participated in a broad range of professional development activities, including intensive summer institutes, monthly Saturday face-to-face workshops, periodic in-classroom support by peer teachers and graduate students, on-line materials, and graduate extension courses. LeTUS curriculum materials are designed to be educative (Ball & Cohen, 1996; Schneider & Krajcik, 2002), and are treated as another potential source of professional

development. Teachers selected from among these professional development options, but few, if any, participated in all of them.

The research described in this paper was part of a larger project: *Teacher Knowledge, Beliefs, and Technology: Constructing Models of Change in Systemic Reform* (Funded by the National Science Foundation, Award #REC-9876150). The goals of this project were to explore the relationships between teachers' knowledge and beliefs with respect to inquiry-based, technology-rich middle school science curricula and the resulting classroom practice. We were interested in teacher change both through the adoption of said curricula as well as professional development designed to support its implementation. In particular we focused on examining professional development in the form of Saturday face-to-face workshops, and teacher learning and practice related to the enactment of a particular unit, called the Communicable Disease Unit (Hug & Center for Highly Interactive Computing in Education, 2002), taught mid-year in the 7th grade during the 2002-2004 school years. The Communicable Disease (CD) Unit focused on students interrogating the question "How can good friends make you sick?" to learn about the characteristics of the spread of disease, cells, bacteria and viruses.

Data and Methods of Analyses

In this section we give a brief overview of the research approach we have taken to study face-to-face workshops offered to teachers to support their adoption of a LeTUS middle school science curriculum. We used the iterative design research model (see Figure 2) over three years of enactment (2002, 2003, 2004), resulting in four different analyses and papers (Kubitskey, Fishman & Marx, 2003, 2004; Kubitskey & Fishman, 2005, 2006). Below we describe our application of this model, noting differences by year of data collection (2002, 2003 or 2004).

Professional Development Design – the Enacted Professional Development

The 2002 face-to-face workshops represented the first year of widespread curriculum adoption, although the unit had been piloted the previous year. A curriculum developer acted as the professional development (PD) leader assisted by an experienced teacher from the pilot enactment. Thus the workshops were strongly influenced by what the curriculum developer thought necessary for enactment, informed both by the curriculum design as well as the previous year experience. In 2003 and 2004 lead teachers experienced with the unit took on the responsibility of the face-to-face workshops as local PD leaders. Researchers assisted these local PD leaders in designing the workshops, informed both by the curriculum as well as the findings from the previous years' application of the design research model (Figure 2).

Between January, 2002 and May, 2004 we attended and collected running records of monthly Saturday workshops, recording the activities of the workshops into a database, noting "turns" in the PD activities in the form of shifts in either the content of the professional development or the instructional strategy being used to teach the professional development. Table 1 breaks down the data by year.

Table 1. Data Collected

	Workshops	Teachers	Post-WS interviews	Observations	Student work	Post-Practice Interviews
CD 2002	5	7 ¹	27	12	245 pre and post tests	12
CD 2003	4	5 ²	14	7	121 pre and post tests	7
CD 2004	2 ³	11	17	26	351 concept maps	11
Total	11	23	58	45	717	30

Evaluation of Professional Development

After each workshop we conducted phone interviews with those the teachers who had attended the workshops primarily within a week from the workshop (see Table 1). During the interview we asked the teachers to share their thoughts about what stood out from the workshop for them, what they learned from the workshop, if anything would influence their future instruction, and, if so, could we observe that lesson. In addition, we listened for markers to expand upon during the interview (Weiss, 1994). All interviews were transcribed. During 2002 and 2003 we separated the post-workshop interviews into discrete units of analysis by change in topic of discussion, often represented by turns, and mapped these onto the coded workshop notes. We coded units of the interviews that did not map neatly onto the workshop notes separately using grounded theory looking for emerging themes, e.g. characteristics of workshop, identity in context of workshop, perceptions of others etc. In addition, if applicable, we coded these isolated interview units for content and strategies mentioned by teachers in the interviews. From this analysis we identified what teachers expressed about different types of content and strategies in order to deduce the types of professional development activities teachers believed were salient. We compared the types of strategies and content the teachers identified as informing their instruction to the types of strategies and content evidenced in the workshop. Classroom observations from 2002 and 2003 suggested that teachers were not incorporating an activity used in the curriculum as intended by its authors: concept mapping. Thus, during the 2004 enactment, we shifted our research to specifically focus on the workshop, interviews, and enactments covering concept maps. In addition to the post workshop interviews, we also conducted pre- and post-unit knowledge and belief interviews about concept maps with the teachers.

¹ Our macro-analysis of the data allowed us to select 3 teachers for case study.

² From this sample we selected one teacher for elaborated case study.

³ Please note that only 2 of the 3 workshops supporting the Communicable Disease Unit informed the final study since these were the only ones that directly informed the observed practice, discussed below.

Observation of Classroom Practice

To investigate how the teacher learning from the workshops influenced their instruction, we observed teachers' enactments of activities covered during the previous workshops, taking jottings that were immediately transcribed into field notes (Emerson, Fretz, & Shaw, 1995) (Table 1). In 2004 we focused on concept mapping. During these observations, we looked for teachers' use of techniques, strategies or materials from the workshop in addition to the student's response to these activities. We compared the field notes from the enactment observations to the directions given at the workshop, identifying the similarities and differences between the two. For the first two studies conducted in 2002 and 2003 we looked for "successful activities" (those resulting in both positive feedback from teachers and student learning) and possible areas for improvement where teachers mentioned dissatisfaction and/or student performance did not meet with expectations. We used the post-enactment interview as a means to determine teachers' reaction to the activity and their perception of the impact of the face-to-face workshops on their teaching. We identified the workshop activities that correspond with the enacted lesson, isolated the appropriate workshop field notes and post-workshop interview and conducted a constant comparative analysis (Glaser & Strauss, 1967) between these two data sets. From the analysis we identified teacher learning from the face-to-face workshops as it was demonstrated through teacher action. For the 2004 enactment we looked for alignment between teacher practice, the curriculum and what was taught at the workshop, identifying strengths and weaknesses in instruction and looking for shifts in knowledge and beliefs over time through classroom observations and the knowledge and belief interviews.

Student Learning

We used multiple means to identify student learning from the activities: classroom observations, teacher perceptions, pre- and posttest data, and student artifacts in various combinations (see Table 1). Teachers often shared their perceptions about students learning during the post-enactment interview. Although depending on this as the sole source of measure of student learning is problematic, in tandem with other methods, teachers offer rich insight because of their experience with the students, experience with the content, and other characteristics that may not be obvious to the observer or through more formal means of evaluation. For the first and second studies in 2002 and 2003 the in-class observations also allowed for a means to examine student performance and infer learning as demonstrated through student participation and interaction. Such measures are often insufficient in isolation due to the sporadic nature of observations, but they do inform the analysis in conjunction with other types of evaluation. We examined student artifacts produced during the activities; developed rubrics based on the outcome objective and applied the rubric to the student work. We calculated gain scores from pre- and posttest data collected from the students and the standard effect size of these gain scores. We identified questions that reflected knowledge taught through the activities observed and looked at the performance of classes of the teachers observed. For the third study in 2004 we collected students' concept maps and coded these for alignment with the structure intended by the curriculum and professional development.

Application to Re-Design of Professional Development

Finally, we used the information from the individual analysis of the activity with respect to the teacher learning and conservatively inferred the link to the resulting student learning. Thus we evaluated the quality of the workshops from both the teachers expressed beliefs, observed teacher instruction as a measure of learning that resulted in action and student learning as a measure of success. From this evaluation during 2002 we developed reasonable hypotheses about what was successful and what was in need of improvement for the observed professional development cycle. From these hypotheses we suggest possible adaptations for the next iteration of the professional development cycle and tested the success of our adaptations in 2003. The findings from the 2003 study confirmed our hypotheses and expanded on our findings.

Focused Study

During the 2004 study we were able to code and rate the interviews for congruence with the intent of the curriculum as well as the teachers' beliefs about the effectiveness of concept maps in instruction, how to use concept maps as assessment tools and how to use concept maps as a means for fostering student understanding. In this case, rather than using grounded theory (Glaser & Strauss, 1967), we analyzed the data three ways. First, we quantitatively identified shifts in teachers' knowledge and beliefs by comparing pre and post unit interview ratings using a Wilcoxon Signed Ranks Test (see Kubitskey & Fishman, 2006, for details). We then analyzed eleven teachers' enactments to create two different types of case studies: logic model technique and cross-case synthesis (Yin, 2003). We used the logic model technique to examine the individual cases. In particular we developed an individual-level logic model to examine shifts in teachers' knowledge and beliefs over time. In these cases the intervention of the workshop is intended to inform the teachers' knowledge and beliefs, which then impacts the teachers' practice, which ultimately impacts student response. Rather than being a linear experience, the practice and student response to that practice also influence the teachers' learning, thus practice and student response impacts teacher knowledge and beliefs. For a sample of five of these cases, please see our 2005 AERA paper (Kubitskey & Fishman, 2005). Finally, we looked across all teachers to create the cross-case synthesis by identifying specific instances of teacher learning as demonstrated by interview or action. We created a template for examining applicable quotes from teachers and used this to draw conclusions across teachers in order to match patterns of teacher learning. These findings informed the 2006 AERA paper (Kubitskey & Fishman, 2006).

Teacher Learning from Curriculum Aligned Professional Development

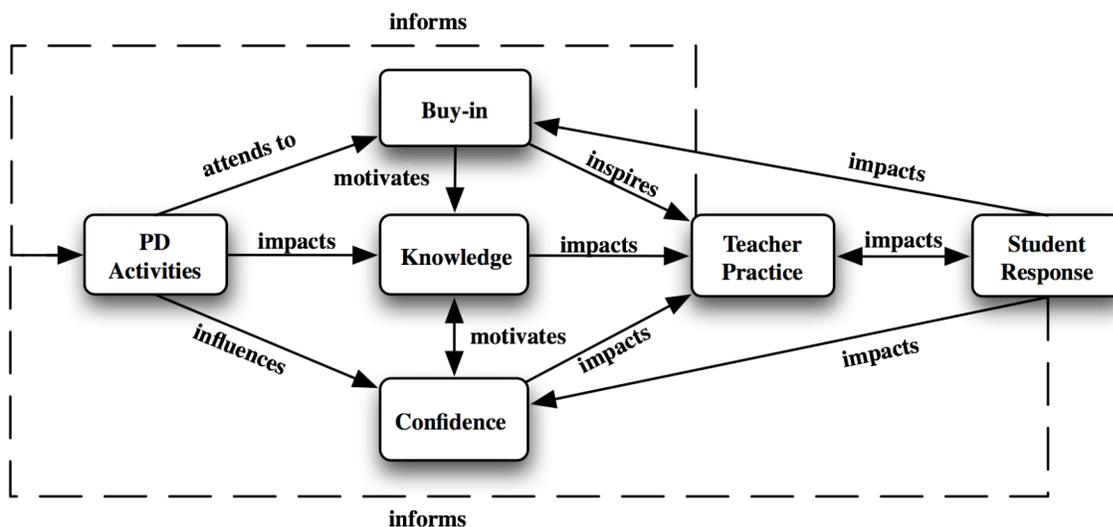


Figure 3. Teacher learning model from professional development.

Our 2004 study suggested an expanded teacher learning model from professional development and practice (see Figure 3). From this study we identified three key influences the workshops had on teacher learning. First, the workshops needed to motivate the teachers to learn new practice, change an existing practice, or adopt a practice they had previously chosen not to use. This attention to teacher “buy-in” proved a key component to translating teacher knowledge to practice, as well as motivating the teachers to learn what was taught at the workshop. Second, the workshops were shown to influence teachers content knowledge and instructional (pedagogical and pedagogical content) knowledge. This change in knowledge was both motivated by initial lack of confidence on the part of the teacher and the teachers “buy in” to the validity of what was being presented. Teachers who felt their instruction needed improvement were motivated to learn. In addition, the teachers felt more confident in their teaching after their participation in the face-to-face workshop. Teachers initially confident in their practice needed to be convinced the new information would improve their instruction. “Buy-in”, change in knowledge and increased confidence combined to result in classroom practice influenced by the workshop. This practice, in turn, influenced the student response, which teachers used as indicators of student learning. These responses either reinforced the teacher learning and increased confidence and buy-in or challenged the teachers’ confidence and buy-in, motivating the teachers to adapt their practices. Thus the practice, rather than an outcome of the workshop, becomes a vital component of the professional development as a whole. Teachers dissatisfied with their instruction had reduced confidence and were motivated to change their practice. The follow-up workshops provided a space for teachers to interrogate their practices and discuss adaptations to meet the needs of their students guided by a local PD leader to make sure the discussed adaptations maintained the integrity of the written curriculum. Thus, for sustainable long-term support for adoption of reform-oriented curriculum, we need to provide a professional development design model that can be maintained in the absence of formal researchers while providing a space to incorporate practice and student learning independent of the researcher.

Sustainable Professional Development Design Model

With long-term sustainability in mind, we suggest the following model for sustainable professional development design (see Figure 4), incorporating the findings of our teacher learning model. We apply the findings from our analysis of characteristics of successful face-to-face workshops identified through our research/design approach (see Figure 2) to describe and inform our sustainable professional development design model (see Figure 4). Below we describe each component of the design model and how it is informed by our past research.

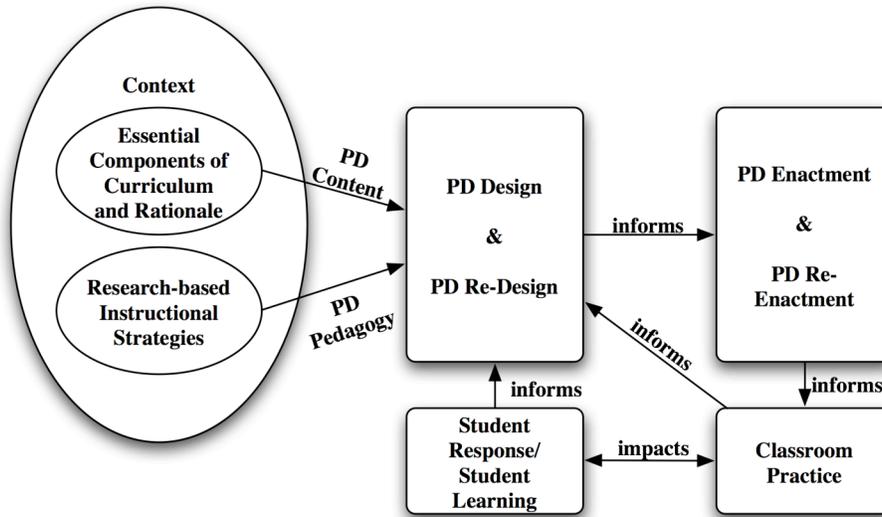


Figure 4. Professional development design model for long-term systemic change.

Context

The iterative design research model for professional development (see Figure 2) allowed us to identify content and strategies that result in teacher learning and ultimately improved student learning. Curriculum developers can use such a model when creating workshops for first time adopter, thus being able to customize the specific types of content and strategies that lend themselves to their context. However, the curriculum developers acting as professional development leaders need to invest time and resources into developing materials for and training the eventual local PD leaders, using findings from their own studies as well as the broader professional development literature. Although one can argue the context of the professional development is unique to the curriculum, our research suggested certain characteristics of quality workshops that seemed consistent, discussed below.

Essential Components of the Curriculum and Rationale

Content knowledge. When looking at content knowledge for teacher education/professional development we are not limited to what one might call “subject matter” such as math, science, history, etc. Content knowledge also includes the content of what a

teacher needs to teach: definitions of various strategies, learning theories, etc. Curriculum authors should identify clear lists of content knowledge needed to enact the curriculum. These can be included as educative components of the curriculum itself and/or provided by PD planning supplement for the curriculum to inform the PD designers. Otherwise the responsibility falls on the local PD designer, who must use the curriculum to guide him/her in selecting what content is important, which may or may not align with the intent of the curriculum designers.

Our research indicates that our workshops initially generally failed to impact teachers' subject matter knowledge, however classroom observations suggest increased subject matter knowledge is needed. Thus merely presenting the subject matter knowledge at the level of the curriculum only in the context of discussing the curriculum did not change teachers' subject matter knowledge. One suggested change is to spend time to elaborate on the subject matter, although still in the context of the curriculum, but beyond the scope of that expected of the teachers' students. (Kubitskey, Fishman & Marx, 2003).

Our research also showed at times a disconnect between the teachers content knowledge and the content presented, and this provided problems when PD leaders thought certain content was addressed, not realizing teachers were understanding the terms in a different manner (Kubitskey & Fishman, 2005; 2006). Teachers must be given clear definitions or descriptions of key components of the curriculum, in particular instructional strategies in addition to subject matter, to make sure both teachers and professional development leaders are speaking about the same thing.

In the case of our curriculum, teachers were also required to incorporate new technologies. What became apparent is the need to not just have the teachers use the technology as the students would use it, but also spend time setting the technology up to gain a more sophisticated understanding of the technology and how it works and be prepared to set it up in their own classes. Thus the workshops should plan to have teacher participate in the actual set-up process of technologies as well as the activities themselves. This proved true with laboratory set-ups teachers were not familiar with as well (Kubitskey, Fishman & Marx, 2003; 2004).

Instructional knowledge: Pedagogical knowledge and pedagogical content knowledge. In addition of having the definition of instructional strategies for teachers, teachers also must be made aware of how to use these instructional strategies for teaching. Often the instructional strategies are chosen by the curriculum designers to leverage a particular learning theory, or teach multiple skills in addition to the specific subject matter (decision making skills, knowledge on how to write explanation, how different concepts are connected, etc.). Teachers need to know how to assist students in the creation of the artifacts, but also how to facilitate student learning by the creation of the artifacts. It is not enough to know how to use a technology tool (for example Cooties simulation of the spread of disease on the palm pilot). Teachers must know how to teach students to use the tool. Thus the professional development must expand on just the knowledge (subject matter, technology, as well as instructional) to include strategies for teaching; or pedagogical and pedagogical content knowledge.

Knowledge of curriculum. Merely walking teachers through the curriculum step by step did not prove useful, discussed below (Kubitskey, Fishman & Marx, 2003). Teachers should

have access to the national or local goals the curriculum is designed to address (Kubitskey, Fishman & Marx, 2004). In addition, teachers need the information about how different parts of the curriculum fit together to meet the goals (Kubitskey, Fishman & Marx, 2003). These are important because of the need to assist the teachers in seeing the impact adaptations to the curriculum might have on both reaching the specific goals of the activity as well as other aspects of the curriculum as a whole. Teachers need to have the information about how different parts of the curriculum connects with each other to inform their instructional decisions (Kubitskey, Fishman & Marx, 2003).

Beliefs. Professional development need also intentionally attend to convincing teachers that the content of the professional development is worthy of learning and motivating the teachers to adopt in practice. This “buy-in” component is even more prevalent when the intent of the curriculum does not align with the beliefs of the teacher (Kubitskey & Fishman, 2005, 2006; Kubitskey, Fishman & Marx, 2003). One approach is to provide the teachers with the rationale for the lessons in the curriculum and other knowledge about the curriculum. In addition, the professional development needs to address concerns of the teachers in such a way that alleviates their misgivings and increases their confidences in both making an instructional choice and enacting it.

Research-based instructional strategies

Hands on opportunity. The face-to-face workshops should allow the teachers to do the pivotal activities (in the case of our research these include: spread of disease, microscope investigation, bacteria investigation, Cootie’s activities, Artemis investigation, model-it analysis and concept mapping) as students through model teaching. In addition, teachers need hands on experience preparing for the activities, the set up as well as anticipating issues students might have with their own attempts at the activities.

Limit direct instruction as an instructional strategy. Merely giving directions on how to do activities through lecture format showed little impact on teacher learning as reported through the interviews, and even less in classroom observations. One exception was direct instruction that was merely information exchange. For example sharing planning strategies unique to the local context at the time (what to do about standardized testing) and how to get materials (ordering information etc.) proved useful. However, such approach for explaining how to set-up technology was especially problematic. Teachers were better able to prepare and enact a lesson when they had a chance to go through the preparation, at least in part, during the professional development.

Curriculum review. Just walking the teachers through the curriculum did not noticeably influence their thinking or practice (Kubitskey, Fishman & Marx, 2003). However, it became apparent that teachers needed to have a broader sense of the curriculum as a whole to inform their instructional decisions about adaptations (Kubitskey, Fishman & Marx, 2004). One suggestion is to have the curriculum review integrated into the face-to-face workshop activities. As teachers learn about given activities: how to do them and how to set them up, they also spend time looking at how the activities are related to others. What do the students need to know to do the activity? How do the students use information from the lesson in later lessons? Contextualized curriculum review provides guidance for making adaptations. Also, allowing

teachers a chance to examine how the curriculum aligns with national and local standards provides motivation for adopting the curriculum and can increase “buy-in”. Finally, providing a space for teachers to discuss adaptations with a knowledgeable local PD leader helps the teachers make connections between the adaptations and broader picture of the curriculum as a whole.

Examining Student Work. A useful method for providing a space for teachers to discuss practice and learn both content and instructional strategies is by examining student work (Little, Gearhart, Curry, & Kafka, 2003). In addition to providing content for professional development, examining student work also provides a means for incorporating practice into the professional development. Experienced successful teachers sharing of work can be used as motivation for novice teachers when they see the possibilities (Kubitskey et al., 2006). Little, Gearhart, Curry and Kafka looked at three cases of professional development using student work (2003): The Harvard Project Zero’s Evidence Project, the Building School Capacity to Improve Student Learning Project of the Academy of Educational Development, and the Instructional Improvement Through inquiry and Collaboration project of the Coalition of Essential Schools. The Evidence Project had teachers use structured discussion guide, or protocol to discuss student work. These protocols were unique to different groups depending on the interest and needs of the teachers. The Building School Capacity to Improve Student Learning Project looked at student work with respect to learning goals. The Instructional Improvement Through Inquiry and Collaboration Project used critical friends and teacher inquiry, incorporating student work into the discussion. Little et al. (2003) identified four characteristics of these programs that inform our work: (1) The programs used flexible, creative use of tools for local purposes, such as protocols for discussion; (2) The programs provided opportunity to exploit subject expertise and examine subject issues; (3) The programs created an atmosphere with a delicate balance between comfort and challenge for the teacher; and (4) The discussions required facilitation to build a group and deepen a conversation. Thus the importance of having a well-trained and informed local PD leader is paramount.

Peer Exchange. Finally, across all three years of examining face-to-face workshops, peer exchange proved one of the most oft cited learning opportunities for teachers. The learning was two-fold. First, teachers reported learning from other teachers who shared their experiences with the curriculum or lessons teaching in the same context. In addition, teachers reported the act of sharing made them recall issues from the past they had previously forgotten about. This informal opportunity for public reflection thus informs both the listener and the sharer (Kubitskey, Fishman & Marx, 2003). Peer exchange also offers a space to incorporate classroom practice into the professional development. Face-to-face workshops should provide ample opportunities for peer exchange, but this also proves a challenge for the local PD leader. Peer exchange can also take on a life of its own when teachers start sharing about techniques they can substitute into the curriculum that do not align with the curriculum itself. The local PD leaders needs to have enough information to recognize when this is happening and a skilled approach to redirecting the discussion, sharing the rationale for why the adaptation might not be the best fit, or re-adapt the adaptation to better align with the curriculum.

Initial PD Design

Once supplied with a list of content for the workshops and the strategies for enacting the workshops, the professional development designer is left trying to put these together. In this

sense the word “initial” means the first time a certain subject of professional development is offered to the teachers. Our research and others suggest active engagement during the face-to-face workshops improves teacher learning. When planning workshops, PD designers need to provide optimum opportunity for teachers for active participation. In addition, the workshops are intended to be proximal to the practice, thus the content covered should be roughly aligned with that which the teacher would be teaching shortly thereafter. Professional development designers need to identify the goals and content needed to be covered based on the curriculum and select strategies that teach the activities that engage the teachers. To maintain the reform of the curriculum, the curriculum designers should provide such information to the local PD leaders and also provide these leaders with the rationale for the decisions so that the later professional development maintains the intent of the curriculum. The professional development designer must include contextualized rationale for the curriculum and the specific content being covered to motivate teachers to make changes to their practice and “buy-in” to the curriculum. The professional development designers must also plan for opportunities for peer exchange. Thus the design of the workshops must provide enough content to cover what the teacher needs to know to successfully enact the curriculum using instructional strategies that are most likely to result in teacher learning, teachers’ buying-in to the curriculum, and teachers having enough knowledge to feel confident going into the classroom.

PD Enactment

During the enactment the PD leaders implements the plan. As with any instruction, this too provides a learning opportunity for the PD leader as well as the teacher participants. Therefore the curriculum developers need to provide the local PD leaders with information so that the adaptations necessary for instruction maintain the integrity of the curriculum. This flexibility is especially important for the local PD leader be able to facilitate the peer exchange, keeping the discussion consistent with the intent of the curriculum and/or making inconsistency visible to the teachers, as discussed above (Kubitskey & Fishman, 2005, 2006; Kubitskey, Fishman, & Marx, 2003).

Flexibility is also required to attend to teachers’ buy-in. Teachers come to the workshop with many ideas and pre-existing beliefs, and the local PD leader has to be prepared to address issues teachers might have about the curriculum in order to motivate cooperation on the part of the teachers, particularly if the participants are not all volunteers.

Finally, encouraging teachers to share artifacts of practice shifts part of the control of the content of the workshops from the local PD leader to the teachers. Local PD leaders need to be prepared to be able to adapt to this situation that both encourages teachers to continue to share their work as well as insure the examination of the student artifacts results in a teacher learning goal that aligns with the intent of the reform.

Classroom Practice

How does PD impact practice and how does practice impact teacher learning? Professional development can either provide teachers with new knowledge, adapt existing knowledge, or remind or convince teachers to use knowledge they already have if the professional development is going to impact the practice. The practice itself becomes the testing ground for the teachers (Kubitskey & Fishman, 2005; 2006). Video and running records were

used to collect evidence of teacher practice using the Professional Development Research Design Model (Figure 2). Shifting to local PD leaders, we need to provide a different means for collecting such data, discussed below.

Student Response

Our research showed that professional development impacted teacher practice and ultimately student learning as evidenced by their performance on subject aligned pre and post tests (Kubitskey, Fishman, & Marx, 2003, 2004) and creation of artifacts (Kubitskey & Fishman, 2005; 2006). As evidenced in our teacher learning model, the student response is a proxy for student learning and is influenced and influences teacher learning. Student work is one such response. The discussion above of examining student work in face-to-face workshops provides strategies for incorporating student work into the professional development. The local PD leaders need to identify lessons where student work should be collected and use these as evidence of student response in the future professional development using the strategies discussed above.

Professional Development Redesign

Face-to-face workshops need to revisit past practice and student work: preferably proximal to practice as well as during the next year enactment (Kubitskey & Fishman, 2005, 2006). The next follow-up workshop design has to have a mechanism for collecting information about the enactment, description of the practice and student work. As researchers, we are able to follow teacher practice, videotape and analyze teacher practice, collect and analyze student work and use this to inform professional development. Local PD leaders may collect such information by having teachers videotape lessons and select particular cases to share with the group. However, local PD leaders typically do not have access to such information. One approach is to train local PD leaders to illicit stories from the teachers and promote sharing of student work by encouraging teachers to bring in this work. As discussed above, peer exchange provides an opportunity to share practice, however; left completely free to just emerge has the local PD leader leaving much to chance. To become a habit of the group, this communal reflection has to be nurtured by the local PD leader, making the experience valued by the teachers so they feel compelled to continue to share experience and student work. One approach is to provide a formal mechanism for sharing (e.g. online reflective journals, assigning reflective worksheets to be filled out, even only focusing on one or two teachers at a time to examine their teaching etc.) This can be developed externally by curriculum designers, but also can emerge as a group decision much like the protocols used to discuss student work. The key is to make sure the activities bring added value to learning experience of the professional development and don't just end up being busy work for the teacher. Thus the local PD leader needs to be trained in both developing a means for sharing this information as well as incorporating this information into the matrix of the workshop itself. Doing so can (1) inform adaptations such that they maintain the integrity of the unit, (2) re-commit teachers to an instructional strategy by re-addressing buy-in that might have been challenged by enactment, and (3) give the teacher confidence that the instructional practice is worthwhile and they are prepared to enact the lessons and improve their past instruction. In addition, the years following the first year of adoption, the same curriculum will continue to need support. In this case a typical mixture of teachers attend the same workshop: those with experience with the curriculum and those without. It is a delicate challenge for the local PD leader to make the professional development fresh and applicable for the experienced

teacher as well as cover essential components for the new teacher. The peer exchange can help create an expert/novice experience where the expertise is not merely situated in the local PD leader. However the local PD leader is ultimately responsible to insure that these exchanges maintain the intent of the curriculum/reform.

Impact

Systemic change initiatives are often orphaned when the external funding supporting their creation run out. The school districts are left to maintain the change alone. One way to help facilitate long-term adoption that maintains the intent of the curriculum is to supply resources for designing quality professional development. This model supplies both a template for curriculum designers to use to give information about the content of professional development to the professional development designers and a mechanism for keeping such professional development supporting long-term practice as opposed to re-runs of professional development year in and year out.

Curriculum Designers' Responsibility

The initial curriculum designers can model the characteristics of quality professional development by choice of content of the professional development as well as the strategy for implementing the professional development, and must make sure to put as much care into planning the professional development as the curriculum development, using good sound research based strategies. During the first time adoption, leads teachers might emerge that can take over the professional development responsibilities once the curriculum developers responsibilities subside. However, if we take what we have learned about teaching teachers in professional development to the next logical step, this is not enough. We determined that it was not enough just to show teachers how to enact a given curriculum by merely doing the curriculum activities, therefore it would be equally ill-advised to assume teacher participation in quality professional development is enough experience to allow him/her to lead professional development. The training for local PD leaders needs to pay the same attention to philosophy, rationale and impact of adaptation of the professional development as the professional development does to the curriculum.

Incorporate Practice and Student Work

In addition to having the resources and training from the curriculum developers, the local PD leaders need to be able to incorporate the local experience into the follow-up professional development. The local PD leaders have to develop a mechanism for incorporating student work and practice into the professional development that does not require the intervention of the curriculum developers. Most research in this area involves researchers providing facilitation and technical and resource support because they are researching. However this is not a Schrodinger's Cat dilemma. Just because we can't watch doesn't mean something isn't happening. We can supply lists of techniques local PD leaders might use, as suggested above, and the local PD leaders can use their knowledge of the local context to create an opportunity for sharing of practice and student work. The essential component is ultimately that the teachers see added value by the exercise. Having teachers take the time to collect student work or reflect and

then not incorporating these into the professional development proves a waste of time for the teacher, who not continue to participate.

Conclusion

The appeal of our proposed Professional Development Design Model (see Figure 4), taken in tandem with the design-based professional development design research model (see Figure 2), is that it provides a space for curriculum developers to create quality professional development for first time adopters and a mechanism for maintain and broadening the scope of the professional development to include later teachers while maintaining the reform. The professional development design research model (see Figure 2) allows for research into professional development, informing the broader understanding of teacher learning from professional development as well as specific issues to the curricula being supported. These findings, with past findings, then inform the Professional Development Design Model (see Figure 4). This sustainable model provides a long-term template for supporting teachers' adoption of reform, while respecting the agency of the teacher. This model assumes differences between written, planned, and enacted curricula and a means to reconciling the three such that the enacted curriculum is congruent with the written while allowing for variation and adaptations on the part of the teachers.

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