CASE-BASED TEACHER PROFESSIONAL DEVELOPMENT

CRITICAL SUCCESS FACTORS IMPLEMENTING MULTIMEDIA CASE-BASED TEACHER PROFESSIONAL DEVELOPMENT

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CONTENTS

Abstract

This document presents research findings concerning Critical Success Factors (CSF)—those few activity areas that deserve special attention to success—implementing multimedia case-based teacher professional development in school districts where this is an educational innovation. Our findings emerge from data collected during the first pilot implementation of the Seeing Math Telecommunications project. This is an initiative devoted to helping elementary and middle school teachers improve their teaching practices by means of reflecting on and discussing relevant teaching episodes, documented as multimedia information. Four U.S. school districts from different regions of the country and with very different characteristics participated in the experience. Each of them, committed to the idea of implementing video case-based teacher professional development, tried to explore it as an educational innovation. A local facilitator, designated by each school district, led the process of appropriating and customizing the idea, as well as of helping groups of teachers benefit from it. Different levels of success institutionalizing video case-based teacher professional development were obtained by participating school districts, as a result of multiple intervening variables. Its study was our research focus. Our research findings are subsets of these variables, those that may make a difference for the success or failure of an innovation at its different stages.

Literature Review

Teacher professional development (TPD) is an effort that can be approached from many different perspectives, with different strategies and tools, obtaining different levels of accomplishment. Multimedia case-based TPD is a particular and promising way of helping teachers grow professionally, and the core of the Seeing Math Telecommunications Project.[1] In this study we are focused on determining CSF related to the use of multimedia case-based for TPD, which is an educational innovation in many school districts. The following section will elaborate on what the educational promises of video cases are and how these can be used for math TPD. It will consider the different stages of multimedia case-based TPD as an innovation, each of these with specific indicators of success.

Educational Promise of Video Cases

Discussion of teaching cases can make a significant difference in teacher preparation, by helping teachers reflect on their professional practices and reviewing both other teachers' cases and their own documented experiences (Barnett, 1998). A *good case* is "the vehicle by which a chunk of reality is brought into the classroom to be worked over by the class and the instructor. A good case keeps the class discussion grounded upon some of the stubborn facts that must be faced in real life situations. It is the anchor on academic flights of speculation. It is the record of complex situations that must be literally pulled apart and put together again for the expression of attitudes or ways of thinking brought into the classroom (Lawrence, 1953).

In the past two decades there have been major efforts for creating, using and learning from teaching cases, most of them presented as written narratives and/or videotaped episodes (Barnett, 1998; Sherin, 2003, in press). A new kind of teaching cases have emerged more recently, with the increasing affordability of digital video cameras and mass storage devices by the educational sector, as well as with the growing existence of powerful and user-friendly software for editing and managing multimedia databases (Georgi & Redmond, 2003; Nemirovsky , Lara-Meloy, Earnest, & Ribeiro, 2001; Sherin, in press). These teaching cases integrate multimedia learning resources by using interactive computer-based environments. The user is able to consult relevant texts, images, audios, or videos, and to explore and conjecture from digital manipulatives. The user can also participate in electronic forums that are focused on discussing the case. In this sense these teaching cases are called interactive multimedia cases studies, not only interactive video case studies. It is common now to talk about different kind of multimedia case studies, some of which are digital portfolios that make use of multimedia documents telling the story of a teaching experience (Clark, Neal, & Goeman, 2003; Kelly, Rankin, & de Freitas, 2003; Reilly, 2003; Royer, 2003); others are videopapers that deliver multimedia case-based papers (Nemirovsky et al., 2001). Multimedia-based cases have become a new way of doing Teacher Professional Development and are an important object of study from multiple perspectives in the educational setting (Barnett, 1998; Dexter & Greenbow, 2002; Joint Venture, 2000; Nathan & Kalmon, 2000; Pfeiffer-Childs et al., 2001).

The evolution of the Internet has also contributed to the educational use of digital video cases. It is increasingly common to have high-bandwidth access at school facilities and many educators have home PCs with access to the Internet. In addition, stream-video technologies and CD ROM media, have helped to deliver digital video cases to be discussed by teachers. In this way, it has become possible to create learning communities of teachers that discuss video cases either

online, onsite, or both, as in fact educators are now doing at a growing number of school districts (Barab, Barnett, & Squire, 2002; Barab, MaKinster, Moore, & Cunningham, 2001; Brown Yoder, 2002; Brownyn, 2002; deCourcy Hinds, 2002; Moore & Barab, 2002; Waddoups, Levin, & Levin, 2000; Wenger, McDermott, & Snyder, 2002). In addition, there is a significant[2] commercial offering of video-case based TPD opportunities, as well as a rising number of teachers who build their own video cases (Barnett & Friedman, 1997; Nathan & Kalmon, 2000) and of school districts that build local collections of teaching cases to be used with TPD purposes (Edens, 2003).

Case-based Math Teacher Professional Development

Basic beliefs about teaching and learning and different needs and circumstances are behind the different ways of doing TPD. The following are some of the assumptions leading our Seeing Math Telecommunications Project, a multimedia case-based TPD opportunity available for school districts.

Twenty-first century societies need to prepare teachers in a significantly different way from past approaches. Educators must be willing to help students develop their potential, rather than simply filling their heads with proved knowledge (Benne, 1982; Mead & Heyman, 1975). Teachers must think of education as a lifelong process—not a mere preparation for future life (Lindeman, 1926). Education and learning must be seen as continuous processes of changing our internal structures based on deep processing of external and internal events that challenge our mental and affective structures (Lyndsay & Norman, 1972; Norman, 1980; Piaget, 1970, 1971; Rummelhart & Norman, 1978; Wertheimer, 1944)—instead of discrete events that occur during schooling.

Teachers must appreciate the value of different kinds of learning experiences as a source of knowledge—expositive, active or interactive experiences (Forté, 1997)—finding educational value in multiple media that are available for learning and recognizing a central role for them in the leadership and orchestration of these learning environments and media (Galvis, 1998a, 1998b; Lampert & Ball, 1998). Professional development in this context, like teaching, is to a large extent about decision making—designing optimal opportunities tailored to the unique situation (Loucks-Horsley, 1998) and, as a consequence, it is audience-based.

Multimedia case-based TPD is potentially a unique way of helping teachers grow professionally. Instead of just listening to or reading about good ideas that may help participating teachers improve their professional practice, case discussants and case creators are invited to reflect about teaching practices in which decision making in real time has happened and in which beliefs supporting these decisions can be pointed at.

The ideas outlined above are behind current reform education efforts reflected in teaching standards for the content and processes of mathematics teaching at different school levels. *Principles and Standards for School Mathematics* (NCTM, 2000), for instance, is a national frame of reference for mathematics teaching. Many school districts have adapted or adopted these standards. The Seeing Math Telecommunications Project considers that the greatest challenge generated by the new standards is that their effective implementation requires teachers to make fundamental changes in teaching practice, acquire deeper understanding of content, and become familiar with technology (Concord Consortium, 2001). Multimedia case-based math TPD seems to be an appropriate avenue for attending to these challenges, and this is the core strategy encouraged by the Seeing Math Project.

Success Innovating Educational Practices

According to researchers in educational innovations, an innovation—an idea, practice or object that is perceived as new—follows different stages:

1. *Adoption* or *rejection*, depending on the perceived attributes of the innovation. Adoption of an innovation depends on the decision-makers' perception of five attributes: (a) the innovation's relative advantage as compared with status quo; (b) its compatibility with the individual existing values, past experiences and needs; (c) its simplicity or complexity; (d) the degree to which it may be experimented with of a limited (and safe) basis; and (d) the degree to which its results are visible to others (Rogers, 1995, p. 15 - 16).

2. *Implementation* with different levels of use. Implementation moves the organization from non use of the innovation to being prepared for its use, to mechanical use, to routine use, and to refinement (Hall & Hord, 1987). Movement from one to other implementation stage seems to be governed by learning cycles. According to Charles (1990), at each learning cycle: (a) the organization generates visions of the world that help realize alternative paths in which the innovation may fit or not; (b) leaders of the innovation process conceive and organize the next implementation cycle and generate an action plan; (c) cooperation between participating members puts in place the implementation cycle; this leads to results—partial and cumulative—from which the organization learns; (d) reflection about the results, having in mind the expected vision and the planned process, leads to satisfaction—or not—of the stakeholders. This process is repeated through consecutive implementation cycles, as long as the innovation adds value to the system.

3. *Institutionalization*, meaning continued or expanded use of the newly implemented change or stabilized use of the innovation (Sherry, 2002, p.214). According to Rogers (1995, p.173), "the implementation stage may continue for a lengthy period of time, depending on the nature of the innovation. But eventually a point is reached at which the idea becomes an institutionalized and regularized part of the adopter's ongoing operation. The innovation finally loses its distinctive quality as the separate identity of the new idea disappears." When an innovation has been institutionalized, "the change is no longer seen as change, but has become 'invisible', and is 'taken for granted'" (Saxl, Miles, & Lieberman, 1989).

Stages of Success Implementing TPD Innovations

Applying the innovation stages to video case-based TPD in the context of a given school district, it is possible to establish success indicators that help realizing how successful has been a pilot implementation:

- Success indicators at *adoption stage of innovation*: The school district decides to offer video case-based TPD to elementary and middle school math teachers.
- Success indicators at *basic implementation stage of innovation*: Elementary and middle school math teachers decide to participate in video case-based TPD.
- Success indicators at *intermediate implementation stage of innovation*: Elementary and middle school math teachers effectively participate in video case-based TPD activities.
- Success indicators at *advanced implementation stage of innovation*: Teachers change their teaching practices in dimensions that reflect lessons derived from video case-based TPD. Changes in teaching practices may generate gains in students learning.

- Success indicators at *institutionalization stage of innovation*: The school district TPD strategy includes expansion and cares about sustainability of video case-based TPD, beyond the pilot implementation.

Critical Success Factors Implementing TPD Innovations

Critical Success Factors (CSF) are related to those few activity areas of an organization that deserve special attention to success and those whose failure may make the organization fail (Rockart, 1983). We will also look at the relationships between diverse CSF. Those that belong to only one of the positive or negative dimensions of CSF are *operational*; their attention will help succeeding or avoid failing respectively. Those that are included in both sides, positive and negative, become *strategic*, because taking them into consideration leads to success and not taking them into consideration leads to failure (Galvis, 1997, p.210). *Operational CSF* should be considered necessary to resolve, since they may help success or failure in the process; but *strategic CSF* must be considered crucial, since success or failure depends on them. For example, not having access to computers in online education may lead e-learning experiences to fail; but having computers does not mean that e-learning courses will succeed; computer access is an operational CSF in e-learning. Not having a good online facilitator will make an e-learning course fail, but having a good facilitator will help participants have a good learning experience. The quality of the facilitator is a strategic CSF in e-learning.

With this in mind, and considering that there are different levels—or stages—of an innovation, the focus of this study is to establish those few key elements that may help school districts succeed improving teaching practices with the incorporation of multimedia case-based TPD, or fail in this effort if these factors are not considered.

Context for the Study

Four U.S. public school districts accepted an invitation from the Concord Consortium to participate in the pilot testing of an educational innovation, multimedia case-based teacher professional development. These school districts shared an interest in reformed math education and were technologically ready to benefit from interactive video cases. The math coordinator at each of the participating school districts became the local leader of the innovation process, assuming the role of local facilitator for the Seeing Math (SM) courses. The project offered face-to-face and online seminars on facilitation of multimedia case-based teacher professional development to local math coordinators and provided continuous support concerning the use of the Seeing Math courses.

The Seeing Math project prepared a portfolio of nine multimedia cases[3] dealing with math education topics that are hard to teach or learn at the elementary level (grades 3-6). Each case includes a set of short video episodes that tell a teaching story. Elementary math educators that teach math according to NCTM standards were videotaped in classroom sessions, as a base for creating the stories told as multimedia teaching cases. Video episodes are accompanied by a comprehensive set of surrounding materials that help to understand the context of the case, to dive into the activities in which the students were engaged, as well as to focus on content-, pedagogy- or language-related issues that are behind the case. Reflection and discussion seeds are proposed for each of the video episodes and at the end of the case study. In addition to project-created multimedia cases, the project generated a tool for teachers to create their own video cases.[4]

Local facilitators were encouraged to build their own models for offering Seeing Math courses, attending to their own district's teacher professional development strategies. This allowed

the project to explore and learn from several blended (face-to-face and online) implementation models created by the local facilitators. Online discussions were held using Teachscape's interactive platform,[5] which allows to articulate asynchronous discussions with case reviewing and to organize forums in public or private discussion spaces. Face-to-face discussions were held at each participating pilot site, at each group's convenience. Participating teachers had access to computers and Internet both at their school building and at home; each of them got from the project a set of CD-ROMS that helped properly setting up their machines for viewing and discussing the cases. A CD-ROM copy of the videos for all of the cases allowed participants to overcome bandwidth limitations of their Internet connection.

Appendix 1—Context for the Study—gives detailed information about the Seeing Math project and its implementation sites. It explains how the project was proposed, approved and implemented, and how this impacted school district participation in the project. Information about facilitators' training and initial course selection is provided. A comprehensive view of each of the four participating school districts is also included; this helps understanding major characteristics and teacher professional development challenges at each of the pilot sites, which we have named SD1, SD2, SD3 and SD4 (School District 1 to 4).

Study Methods

This study's goal is finding those few activity areas that make a difference for success or failure at the different stages of multimedia case-based TPD. In order to solve this question we broke the problem into five subproblems, trying to find for each one of the five stages implementing an educational innovation, what the corresponding CSF were, that is, those few aspects that make a difference in achieving success at the corresponding implementation stage. We collected data from different sources, as follows:

- At *adoption* or *rejection stage* of SM: oral and written communications with school district superintendents or math coordinators from school districts that were originally part of the SM proposal.
- At *basic implementation stage* (teachers want to participate) of SM: log data from courses offered using Teachscape course delivery platform by school districts to teachers during the pilot experience. Oral and written reports from math coordinators at SD1, SD2, SD3 and SD4 concerning incentives, recruitment strategies, organizational and situational variables, its effects and relevance.
- At *intermediate implementation stage* (teachers effectively participate) of SM: content and statistical analysis of online interactions and final products generated during SM courses offered by the different school districts from January 2002 to June 2003; written documentation of face-to-face interactions during SM courses; oral and written reports from local facilitators concerning the implementation of SM courses at their school districts.
- At *advanced implementation stage* (teachers change their teaching practices according to lessons derived from SM cases; students gain with these changes) of SM: content analysis of online interactions and final course projects, as well as written feedback from teachers and facilitators. Action research was done in cooperation of the external evaluator with volunteer teacher in SD2.

- At *institutionalization stage* of SM: reports form school district facilitators concerning expansion and sustainability of the project at different moments.

In addition, a survey was conducted at the end of the year-and-a-half pilot experience. We asked the following two questions to each of the four school district onsite coordinators:

- TO DO. What must I, as a local facilitator, or my school district's Teacher Professional Development system as a whole, do extremely well in order to be successful in implementing video case-based TPD programs?
- NOT TO DO. From the reverse side, in which aspects of video case-based TPD can I, or the school district, not fail, because it would lead the innovation to fall flat?

Study Data

The first pilot implementation of the Seeing Math Telecommunications Project took place during a year and a half—2002 and first semester of 2003—with participation of teachers and local facilitators from four school districts. Each of the districts defined its own implementation strategy, making it part of its own math TPD program.

The SM project worked to create a global community of learners—with distributed members from participating school districts—nurtured from local communities of practice created by each local facilitator and participating teachers. To facilitate the formation of this networked community the first SM course was collegiate: school district facilitators decided to initiate the program offering a common course, Number and Operations: Division with Reminders, to a multi-district group of teachers, with collegiate facilitation. After this shared experience with a few voluntary teachers from the four school districts, each one of the pilot school districts defined its own video case-based TPD program attending to local educational needs and to local strategies concerning math education and TPD.

From the multimedia resources available from the project, five cases and a case-authoring tool were selected by school districts to offer TPD opportunities to teachers. Case discussions took place using blended environments (public online space for shared discussions, onsite, and online private spaces for local discussions). There was neither a unique timeline, nor a unique way of using the interaction spaces; each school district followed a different path in response to its particular needs.

Quantitative Participation in the First Pilot Implementation of Seeing Math

Tables 1 to 3 summarize the total number of facilitators, teachers and preservice teachers that took part in video case-based TPD courses offered per school district during a year and a half in which the first pilot implementation took place. This overall view of teacher participation serves as a frame for later data desegregation.

TABLE 1. Total Number of Educators Per School District (SD1…SD4) Directly Involved in SM Courses Across One-and-a-half-Years

School districts and related characteristics	Facilitators	Inservice teachers	Preservice teachers
SD1 - Urban, > 100 elementary and middle school	1	15	
SD2 - Suburban, 22 elementary and middle schools	1	42	5
SD3 - Suburban, 5 elementary and middle schools	1	6	
SD4 - Rural, 9 elementary and middle schools	1	7	
Total participants per type of educator	4	70	5

This table shows that SD1, in spite of its large number of elementary and middle school buildings, only reached a reduced number of teachers. SD2 served a significant number of inservice teachers as well as some preservice teachers. SD3 and SD4 reached a limited number of teachers.

Facilitators reported that SM video cases were also presented as demos and discussion objects to math teacher leaders in SD2 and SD3 and to para-professionals in SD4.

TABLE 2. Courses Offered Per School District by Year Period Participating in the SM Project

Courses offered using Seeing Math Multimedia Resources	Spring 2002	Fall-winter 2002	Spring 2003
Number and Operations: Division with remainders	SD1, SD2, SD3, SD4	SD1 SD2	SD1 SD2
Number and Operations: Fractions			SD2
Pre-algebra: Pan balance equations		SD3	SD4
Geometry: Calculating the area of a triangle		SD4	
Data analysis and probability: Using data to make predictions		SD4	
Teacher created video cases: VideoPaper Builder	SD3		SD2 SD3

Table 2 shows that the "Number and Operations: Division with Remainders" course was used by facilitators not only as the opening case for the pilot implementation, but also to introduce new teachers to case-based TPD experiences in SD1 and SD2. The first offering of this course was collegiate, with participants from the four school districts and co-facilitation between district facilitators. Four other courses, related to different NCTM standards, were also offered during the 2002-03 school year. These courses were offered by SD2, SD3 and SD4 facilitators taking into consideration local TPD needs. SD2 and SD3 included teacher created video cases in their SM TPD program.

Considering 12 to 20 participants a reasonable inquiry-based course size—12 allows a nurtured discussion and over 20 makes participation very difficult— Table 3 shows that both the collegiate course (Division with Remainders, Spring 2002), as well as all of the SD2 courses and the second of SD1 courses had a reasonable size. Courses from SD3, SD4 and the first of SD1 had small groups of participants, below the reasonable number for this type of course.

The creation of video cases required combination of individual and small group activity; and this was the case in both SD2 and SD3.

TABLE 3. *Number of Participant Teachers (T), Preservice Teachers (PST) and Facilitators (F) in SM Courses Per School District by Year Period*

	Spring 2002	Fall-winter 2002	Spring 2003
SD1 - Number and Operations: Division with remainders	3 T, 1F	4T, 1F	12T, 1F
SD2 - Number and Operations: Division with remainders	4T, 1F	16T, 5PST, 1F	11T, 1F
SD2 - Number and Operations: Fractions			20T, 1F
SD2 - Teacher created video cases: VideoPaper Builder			2T, 1F
SD3 - Number and Operations: Division with remainders	1T, 1F		
SD3 - Pre-algebra: Pan balance equations		5T, 1F	
SD3 - Teacher created video cases: VideoPaper Builder	1T, 1F		3T, 1F
SD4 - Data analysis and probability: Using data to make predictions		4T, 1F	
SD4 - Geometry: Calculating the area of a triangle			
SD4 - Number and Operations: Division with remainders	4T, 1F		
SD4 - Pre-algebra: Pan balance equations			6T, 1F

Incentives for Teacher Participation at the Four School Districts

Excluding the first course, in which participants were voluntary teachers that wanted to know about this form of TPD, SM courses were mostly offered as part of district TPD opportunities. SD1 offered seat-hours and graduate credits on demand; its second course was offered as a teacher-union TPD program. SD2 offered payment per seat-hour and graduate credits on demand. SD3 offered seat-hours and graduate credits on demand. SD4 offered seat-hours recognition.

What "Participation" Implies in the SM TPD Program

Participation is at the core of a TPD program. Before we present participation data in SM-based TPD events, it is important to clarify what school district facilitators meant by *participation* when *multimedia case-based TPD* dealing both with reflection on existing teaching cases and on their own practices as they created their own video cases. In the first case there was a facilitated

interaction between local and distributed participants using synchronous face-to-face and asynchronous, online discussion spaces In the second case there was a local community of practice focused on sharing and discussing their own videotaped teaching episodes and helping each other build their own cases.

TPD Centered on the Discussion of Multimedia Teaching Cases

In this section we will present what kind of participation was expected from teachers and what effective participation was obtained in three different type of courses: the opening collegiate course, three small size courses and four regular size courses.

"Participation" Concept in SM Courses Focused on Multimedia Case-based Discussions

Some of the course syllabi that were created by school district facilitators stated that participants were expected to attend all face-to-face class sessions, complete class assignments, contribute to online discussions a minimum of two times per week, and work collaboratively to complete the final lesson-redesign project. Other syllabi had a subset of this requirement, skipping either the final activity project or being unspecific about participation in face-to-face discussions.

Online contributions were qualified in some of these syllabi by making reference to an Online Posting Rubric that "may assist you in composing your postings so they build on the ideas of other participant, create seeds for meaningful discussion, or deepen reflective dialog" [SD2].

Final activity in each video case-based course "gives you an opportunity to connect what you have learned in this course with your own practice. Seeing Math organizes the final activity in two areas: content and pedagogy. Both areas of the final activity will be addressed. There are rubrics, or scoring guides, for the final activity. Use these to guide you as you work, and to assess your work" [SD2].

We reviewed the Web conversations at the public and local discussion spaces each course offered. We also followed face-to-face course meetings and final project feedback through email-based or oral and video- or audio-taped reports given by the local facilitator to the SM implementation coordinator.

Participation in Multimedia Case-based Courses during Spring 2002 and School Year 2002-2003

Very different kind and level of participation was obtained at the four school districts. Our data consider the following elements:

- *Participation at the different discussion spaces* (onsite, online-public/online-private). The SM project did not impose a model for organizing the discussions; it allowed each site facilitator to choose the place and frequency of the face-to-face meetings, as well as how to use the online public and private discussion areas. We studied the content of the discussions held online and established the level of weekly participation by each of the participant teachers. We also studied oral or written reports given by the school district facilitators concerning face-to-face meetings and final projects.
- *Type of online postings,* both at the private and public online discussion spaces. There are major categories of online discussions, such as social, argumentative and pragmatic (Collison, Elbaum, Haavind, & Tinker, 2000). We created a new categorization for analyzing dialogue around video

cases (Nemirovsky & Galvis, 2003) since we wanted to differentiate between (a) postings that referred to the video case classroom from those that referred to the teachers' own classrooms and (b) general references to ideas and classrooms, and references that identified or described particular moments and events in the case study.

We defined the following type of content-related postings:

General remarks:

- Type A = Postings in which the participants express their general views about a certain matter.
- General remarks connected to the case or the classroom:
- Type C = Postings that refer to the overall quality of teaching shown in a video case.
- Type D = Postings that refer to general characteristics of participants' own classrooms.

Grounded remarks:

- Type B = Postings in which participants refer to specific events or utterances in the video case.
- Type E = Postings that refer to specific events in participants' own classroom.
- Type H = Grounded remarks that make explicit mention to changes in teaching practices related to the case study.

We also studied *non-content related postings*, using to the following classification:

- Type S = Social dialogue (breaking ice, building community, social interaction)
- Type T = Technical Dialogue (related to the use of technology)
- Type U = Administrative dialogue (related to course administration issues)

Participation at a "collegiate" course on Division with Remainders, spring 2002.

This six-week course shared a common syllabus and program; each week focused on the discussion of a Division with Remainders video episode and surrounding materials. The four district facilitators shared online facilitation responsibilities. Online discussions were asynchronous and public. The public discussion area at Teachscape's course delivery platform was organized in two types, one devoted to "mathematical dialogue," the other to "social interaction." Local interaction was defined and facilitated by each school district facilitator. S/he defined where and when to have the weekly face-to-face meeting. Issues of local interest and internal coordination of actions were posted online at the private space of each school district.

TABLE 4. Number of postings per Type of Posting per Type of Participant per School District, Spring 2002 Collegiate Course "Number and Operations: Division with Remainders"

School District	Type of postings	General remarks	General remarks connected to the case		Grounded remarks		Other remarks	**Total**
	Role and number of participants	A	C	D	B	E	S	
SD1	Facilitator (1)	2						2
	Teachers that posted (0 out of 3)							0
SD2	Facilitator (1)	4	1	3			1	9
	Teachers that posted (3 out of 4)	10	1	9		1	1	22
SD3	Facilitator (1)	1						1
	Teachers that posted (1 out of 1)	3		9				12
SD4	Facilitators (1)	4	1					5
	Teachers that posted (0 out of 4)							0
	Total postings per type	24	3	21	0	1	2	51

We invited the facilitators to comment on the results shown in the above table. This is what local facilitators commented:

- I think there were a couple of good general threads but my impression is that everyone was getting to know each other. It was like being at a cocktail party where you don't know everyone. You're not sure how much of your life (in this case, your teaching experience) to share with unknown people. This is especially true with teaching. What if a teacher shared a specific event and then felt "stupid" about it? There has to be trust before people will expose their real practice and be ready to share it with other people. I think these discussions were beginning to build that trust .[SD4]
- I suspect that the online community may be similar to the school environment, in that reflective participation is at best tricky. Some teachers are very skillful and are willing to take risks in how they reflect on their own practice. The trust factor is absolutely critical whether it is the math coach making ongoing visits to the classroom, teachers speaking up in the school-sponsored PD, or teachers interacting in an online community. Perhaps there is another factor that has to be recognized- the critical mass or lack there of with regard to the number of participants. We were on the whole a small group who did not really know one another very well and who were at times unsure how to keep threads alive. [SD3]
- I agree with SD4's statement about participants getting to know each other, and with the limited levels of participation it was difficult to sustain a productive discussion. I also feel that participants had their own issues and were wrestling with new ideas and strategies. When I read through the discussions again, they were more productive than I had remembered. Many of the discussions about specific teaching practices portrayed in the video case took place at our face-

to-face meetings, and didn't appear in the online discussion. It would have been helpful to have had a discussion at the winter meeting about the level of discussion you were anticipating or "aiming" for. As facilitators, we could have framed questions to support and encourage dialog around connecting specifics of the case with classroom practice. [SD2]

- I found many of the postings to be generic. I believe that this occurred because participants feel the need to evaluate the case studies after viewing them. Teachers on my local level held discussions with less generic comments. They were more interested in specific happenings in a particular video and what could they do to adapt the strategies used to their personal situations. [SD1].

Videotaped and transcribed oral reports by the part of the facilitators at the end of the first course (July 2002 meeting with onsite facilitators at Concord, MA) helped understanding how face-to-face discussions were and their value added to the process.

- Each individual teacher viewed the video cases on their own time. The activities [suggested by the case creators] led the discussions in our face-to-face meetings. Teachers were truly concerned with what was being done to involve students in the learning process. Teachers shared verbally with me that they thought activities used in the case study were helpful and that they related some of the ideas to their own teaching experiences. [SD1]

- Teachers felt a need for face-to-face interaction… Sometimes those face-to-face meetings keep us honest. They keep us on track. That to me was kind of an aha moment…. It is crucial to build sense of community with the group you are working with so they're not scattered individuals all out there despite the fact that they are in the same district. They need that sense of community, of being able to rely on each other out a lot. [SD2]

- At the beginning of every face-to-face we debriefed what had gone well online and what frustration had been online. And a lot of times I was able to just sit back and let somebody else in the group answer it. And so they really worked at building that cohesiveness by helping each other out. I would do more technology at the first meeting, before we ever delved into introduction, more with becoming familiar with just technology itself. I think I would focus our first meeting more on discovering how technology works. [SD2]

- The real challenge was getting the teachers to log on. I went to see all of them numerous times at their rural schools. One of the teachers was sort of offended by the idea of computers so she didn't really made much effort to be online at home. I set up a little Yahoo Group account to send them nagging letters to say Hey! Haven't seen any of you guys on post recently, let's agree that we're going to make a deadline to post… I probably sent out a dozen remainders, went visited classrooms, how is it going, do you have the materials. [SD4]

Participation in small-size video case-based TPD courses in three school districts.

The following three experiences have in common a reduced number of participants in video case-based TPD. They differ in many other aspects, all of them worth studying as we try to find out CSF.

1. During Fall 2002 SD1 local facilitators offered "Number and Operation: Division with Remainders" at the school building level as a seven-week course that combined weekly face-to-face with online interactions. Four teachers from the same building joined the effort, but one

dropped early in the process and the rest participated only in four sessions. There are very few teacher interactions documented on the web at the private discussion area of SD1. Course sessions were mostly face-to-face and centered in viewing and discussing teaching episodes. The site facilitator reported weekly about the first four face-to-face meetings. These are some of SD1 facilitator comments through the process, in emails to the project research director reporting on Fall-2002 course activities:

- Face-to-face discussions are especially effective for the new teachers on the staff because they are gaining so much from the veteran teachers.
- Viewing and commenting about teaching episodes gave me the opportunity to hear some of the things they were doing that I didn't get chance to see during my visits with their classes.
- I am finding that teachers are not completing all activities and I see this as hindering them from getting the full benefit of each chapter.

2. SD3 local facilitator included in the school district TPD catalog a six-week course on "Pre-algebra: Pan balance Equations." SD3 says in a personal communication to Alvaro Galvis (Sept. 25, 2002) "the school superintendent spoke about SM during his address to the staff before the start of school. Teachers received a flyer inviting them to participate, and I contacted by email or in person many teachers. Everyone has acknowledged that it sounds terrific and if they were not so busy, they would participate. The fact is that we could be on curriculum initiative overload here in SD3. As wonderful as the experience sounds to many, it simply comes at a time when people are stretched thin and in a district where there are many competing PD opportunities". The SD3 facilitator got one elementary school teacher, two middle school teachers and one high school teachers registered for the course. Only one of the participants applied for graduate credits from a public university in the region. The course program considered the use of blended environments, as well as participant-driven face-to-face discussions: "A group member will facilitate the face-to-face (F2F) discussion, selecting the discussion prompts to emphasize during the meeting. This person will also provide follow-up postings at the site to further the discussion following the F2F meeting." Online discussions were held at the public discussion area, under the "Mathematical dialogs" category. There were very few postings, most of them a dialogue between the facilitator and one of the participant teachers. From the written reports submitted by SD3 facilitator and his oral report at the facilitators' meeting (Burlington, MA, December 2003), these were major issues through the process:

   - This small group is very diverse; it has gotten people together who would not normally have the opportunity to speak one another. It helps having very rich discussions and increases the awareness that there are many issues that are common through the grades in the area of mathematics.
   - Our first meeting was more an introduction to the materials, the platform and the whole SM experience. However, participants did not complete the independent assignment and thus we did it during the [second] meeting.
   - One of the participant teachers is hooked [in online discussions] and finds this to be valuable. The others are either hanging back or simply not logging on between face-to-face meetings. My main reflection is that I need to nudge participants to post during the time between our F2F meetings. It is a time-consuming yet necessary component if there is any expectation of the online community having a significant impact on their PD.

- I see real value in this kind of vertical conversations across grade levels, they just don't happen enough often. For me it has been a nice mechanism for bringing in different ways of looking at ideas.

3. SD4 facilitator had great expectation on SM TPD program since it "fits neatly into the needs of several teachers who want to learn more about math instruction but need the flexibility of online coursework". In his plans for school year 2002-03 he included inservice teachers "who will commit to four inservice training days (3 half days and one full day) when they will work together on the courses, both online and student materials they bring from their classrooms". He also planned to use the SM materials to "train Title One paraprofessionals in the content and pedagogy of good math instruction," on a face-to-face bases.

SD4 facilitator offered three courses to inservice teachers (Probability: Using Data to Make Predictions; Geometry: Area of Triangle; Pre-algebra: Pan Balance Equations), sequenced in a way that could help participants teach the topics after the courses. Six teachers from five different school buildings (that belong to school districts at different towns) registered for SM courses. None of them was interested in getting credits [teachers in SD4 are only required to gain 9 graduate credits every 7 years]. After the F2F initial meeting the SD4 facilitator visited each of the participants at his/her school every week. "We talk about the latest video that I've asked them to watch. If they haven't, we watch it right then and there. And then we have a discussion about their practice with kids and how kids understand math concepts. Then we go to the public discussion site and read through the threads, analyzing and commenting on the content of the discussion. When the teacher comments something interesting I say 'that would be a great thing to post'. And a couple of teachers posted. And the next time I visit the teacher, I am about to say "why didn't you post?" In his comments about the experience (June 2003) SD4 facilitator said:

- We tried offering a variety of incentives: course credit, recertification credit, conference attendance, release time, and Amazon gift certificate. The last two were modestly successful… Teachers in SD4 need to be highly qualified but it does not mean certified; what matter in middle school are NCBL requirements: to pass the practice exam or to have a major in the teaching area.

- I visited each of the teachers before we began to be sure they had access to Internet and that they were committed to being part of the group. We follow this individual session with a one-day face-to-face session... In the second course we spent the morning in a face-to-face session, focused on the mathematics the teachers were about to engage in; and in the afternoon teachers could either engage with questions online at the school or at home; all participants posted something at our SD4 site on Teachscape.

- Face-to-face individual discussions are very rich. While we review video, for example, we do an exercise called "What would you want to ask this student?" where teachers have a go at questioning based on watching the video model.

- I am inordinately frustrated trying to get my teachers logged on. We are having good discussions about practice, but they are not logging on to the site at all. When I questioned a couple of teachers they expressed a strong inhibition about posting things "where anyone can read". They seemed to feel that they would embarrass themselves with their postings.

- People are reading what is posted at Teachscape's discussion area. But it seems to be, as in list servers, there are a few thousand teachers there and only twenty who post regularly. Should I consider "lurking" as participation?

SD4 facilitator also used SM materials with paraprofessionals who do math remediation with students, and with school staff who spend a month in intensive professional development in math pedagogy. In his report about the experience (June 2003) SD4 facilitator said:

- After we worked with math content we would review a sample of videos and dig into questioning techniques of the video instructors. I frequently paused the work to ask teachers, "Why is she asking about that? What does she want the students to think about? Why is it better for her to ask them than to tell them?"
- I am thinking of using SM materials for professional development for principals at our monthly staff meetings. These materials would be helpful to those principals because it's really a concrete way to get them reconnect to practice.

Participation in regular-size video case-based courses.

As mentioned before, SD1 and SD2 managed to engage a reasonable number of teachers in SM courses. In spring 2003 SD1 facilitator did a strategic alliance with the TPD unit of the local teacher union, and was able to expand the offer of SM courses beyond the school building in which the local facilitator collaborated; this alliance helped the facilitator overcome difficulties for including SM courses in SD1 TPD program and allowed her to have a good group of participating teachers from school buildings in the sub-district she worked on. SD2 always managed to include SM courses in the school district TPD program and was able to offer three SM courses to large-size and regular-size groups over the school year 2002-03. The following data help understanding the kind of participation that was obtained in both school districts.

A blended course with discussions in private spaces

SD1 facilitator decided to use for online discussions the private area assigned to SD1 at Teachscape site instead of the public discussion area, since she had realized from prior experience that SD1 teachers did not necessarily felt comfortable discussing at the public discussion area. She encouraged teachers to participate in the public discussion area when they felt it of their interest. On the other hand, she got access to a computer classroom at a school building in the neighborhood where there was a technical person willing to host the course. She offered "Number and Operations: Division with Remainders," the same she had offered before, using a revised version of the syllabus, building on her and on SD2 facilitator's experience. The course was scheduled for a six-week interaction, but because of technology-related problems the course was reinitiated three weeks after the initial date, when all of the participants had access to computer, had an email account and some experience surfing through Teachscape's course delivery platform. Twelve out of 14 teachers decided to keep participating after these introductory weeks.xxx

TABLE 5. SD1. "Division with Remainders" Spring 2003 Course. Number, Average and Percentage of Postings per Week, Before and During the Course

Spring 2003	**Previous weeks**		**SD1- Division with Remainders course**						**Totals**
Online discussions	**4/7**	**4/21**	**4/28**	**5/5**	**5/12**	**5/19**	**5/26**	**6/2**	
Postings (from 13 participants)	18	12	64	41	42	38	16	25	256
Average posting/week	1.38	0.92	4.92	3.15	3.23	2.92	1.23	1.92	3.28
Percentage of postings/week	7.03	4.69	25.00	16.02	16.41	14.84	6.25	9.77	100

Tables 5 and 6 help understanding SD1 teachers' online participation. There were 256 postings over an eight-week period of interaction, organized in 62 threads. Many of the threads had one or two postings. Data from the previous weeks to offering the course are included in Table 5 since they served an important purpose of building community and helping solve technical problems.

Online participation during the first four effective weeks of the course, in terms of average postings per week, was above the minimum of three-per-week established in the syllabus. The end-of-school year period impacted participation during the last two weeks, where final projects were expected. The following table shows the kind of contributions posted by participants. Some postings belong to more than one category; this explains why the Total A..U (A through U) is greater than total postings at Table 5.

TABLE 6. SD1. Division with Remainders. Spring 2003.. Posting per Type, with Percentages Considering Academic Postings (A…H) and Total Postings (A…U)

	Total A..H	**General remarks**	**General remarks connected to the case**		**Grounded remarks**		**Teacher practice change remarks**	**Other remarks**			**Total A..U**
		A	**C**	**D**	**B**	**E**	**H**	**S**	**T**	**U**	
Private discussions	202	71	37	23	30	27	14	28	8	29	267
% academic postings (A-E)	100	35.15	18.32	11.39	14.85	13.37	6.93				
% total postings (A-U)		26.59	13.86	8.61	11.24	10.11	5.24	10.49	3.00	10.86	100

Figures in Table 6 show that online interaction between SD1 participants was abundant and varied in type of postings. Near 75% of the interaction was academic (A…H). Other kinds of remarks happened before (10%) and during (15%) the course. General academic remarks were a significant portion of the discussion (35%), and the great majority of the interaction (65%) was case-related or classroom-related. Grounded remarks were near 28% of the academic discussion. This overall picture is very positive. However not all the goals were achieved, since according to SD1 facilitator not all final projects were as good as expected, and the discussion was not always deep enough. In her comments about this course (June 2003) SD1 facilitator mentioned:

- Teachers were given 45 seat hours (15 per credit, 3 credits) as well as three recertification credits. I believe that this was a determining factor in student-teachers taking the course. Some were genuinely interested in improving their math teaching strategies.
- Each of the F2F meetings started with comments about online activities. Teachers shared their experiences, insights, and problems. There was an agenda for each one of the sessions, which included a prepared discussion led by two of the participants, rotating, focused both on the pedagogy and content of the video episode. There were very good examples from teacher's experiences as related to the content of video.
- Online interaction was good in terms of number of postings but not that good in terms of a threaded and in dept dialogue. Many teachers limited their postings to answer my questions, without building on other teacher's postings; so, there are many "opening" postings and very few "reply" postings.
- Final project demanded reflections about the kind of questions that each teacher asked to her students, based on ten-minutes video- or audio-taped class session. Some teachers created audiotapes and some did videotapes as part of their Seeing Math final projects. The main focus was to comment on their questioning methods and identify what methods of questioning were effective. Teachers shared their final projects during the last F2F meeting.
- Final products delivered by teachers showed a variety of results, with different degrees of accomplishment. Superficial analysis was the main problem. The next time I offer this course I will include, with the syllabus, exemplary final projects and exemplary interventions in web discussions.

Three blended courses using both public and private online discussion areas

From the beginning of the pilot implementation SD2 facilitator was able to recruit enough teachers for each of the SM courses she offered. Two of the three courses were new instances of "Number and Operations: Division with Remainders," "Number and Operations: Fractions" was the third course.

The following three sections include two tables per course offering that reflect the participation across the different weeks and the kind of postings at the different online discussion areas.

SD2, FALL 2002 COURSE. NUMBER AND OPERATIONS: DIVISION WITH REMAINDERS:

The course was a six-week course but discussions lasted one more week. As shown in Table 3, there were 21 participants, 16 in-service teachers, five pre-service teachers, and one facilitator. As it is shown in Table 7, there were 27 people involved in public discussions, five of them from other school districts. The average number of postings per week at the public discussion area is relatively low if we consider the whole group (27 people, average postings per week=0.4). We calculated also the average number of postings per in-service teachers (16 in-service teachers, average postings per week=0.76); the difference between the two averages can be explained since outsiders participated under a voluntary base and were not required to post as frequently as SD2 participants. In the private discussion area the average participation of the 22 participants from SD2 was 0.8 postings per person; breaking this into pre-service and in-service teachers we find that the average postings

per week for in-service teachers was 1.61, while the average for pre-service teachers was 0.65. Compound participation—considering both the public and private discussion areas—gives an average of 1.09 postings per person based on the 27 people that took part in the dialogues; however, in-service teachers averaged 2.37 postings per week, which corresponds to the expected participation per week.

TABLE 7. SD2. Number and Operations: Division with Remainders. Fall 2002. Number of Online Postings per Type of Discussion Area, Averages and Percentages of Postings Per Week

Fall, 2002	**SD2. Number and Operations: Division with Remainders course**							
Online discussions	**10/21**	**10/28**	**11/4**	**11/11**	**11/18**	**11/25**	**12/2**	**Totals**
Participants in public discussions: 27	15	10	13	15	22	15	18	108
Average postings/week	0.56	0.37	0.48	0.56	0.81	0.56	0.67	0.444
% postings/week	13.89	9.26	12.04	13.89	20.37	13.89	16.67	100
Participants in private discussions: 22	18	13	27	25	23	26	25	157
Average postings/week	0.82	0.59	1.23	1.14	1.05	1.18	1.14	0.79
% postings/week	11.46	8.28	17.20	15.92	14.65	16.56	15.92	100
Total participants in online discs. 27	33	23	40	40	45	41	43	265
Average postings/week	1.22	0.85	1.48	1.48	1.67	1.52	1.59	1.09
% postings/week	12.45	8.67	15.09	15.09	16.98	15.47	16.23	100

The distribution of the total number of postings per discussion space and total across the seven weeks (percentage of postings per week) is irregular. Note that the participation during the first two weeks is lower at the private space and in total than during the rest of the weeks; this might have been the case because the group was building trust during the first two weeks.

It is important to observe in Table 7 that the facilitator opened discussions using the public and private discussion areas in similar proportions. As the reader will see in tables 9 and 11, this strategy changed in later implementations at the same SD2, using the private discussion area mostly for opening the course and building trust, and centering the discussion at the public area.

The content of the discussion during this course (see Table 8) shows a significant proportion of pragmatic dialogue (94% of the remarks were pragmatic, “other remarks” were less than 6% of total postings), largely centered on analyzing the case (see categories B to E). Private discussions were more abundant and grounded than discussions in the public area. “General remarks” were numerous, most of them related to the case. These figures are very positive from a qualitative point of view.

TABLE 8. SD2. Number and Operations: Division with Remainders. Fall 2002. Online Postings per Type of Posting, Averages and Percentages per Discussion Area*

SD2. Number and Operations: Division with Remainders course, Fall 2002	**Total A..H**	**General remarks**	**General remarks connected to the case**		**Grounded remarks**		**Teacher practice change remarks**	**Other remarks**			**Total A..U**
		A	C	D	B	E	H	S	T	U	
Public - Mathematical dialogues	119	45	8	39	5	20	2	5		2	126
% public academic postings	100	37.82	6.723	32.77	4.202	16.81	1.681				
% public postings		35.71	6.35	30.95	3.97	15.87	1.59	3.97	0.00	1.59	100
Private discussions	213	22	76	49	28	32	6	2	1	4	220
% private academic postings	100	10.33	35.68	23	13.15	15.02	2.817				
%private postings		10.00	34.55	22.27	12.73	14.55	2.73	0.91	0.45	1.82	100.00
Total postings Fractions	332	67	84	88	33	52	8	7	1	6	346
% total academic postings	100	20.18	25.3	26.51	9.94	15.66	2.41				
% total postings		19.36	24.28	25.43	9.54	15.03	2.31	2.02	0.29	1.73	100

*Total number of postings in Table 8 is greater that total postings in Table 7, because there are postings that belong to more than one category.

Reports about the *face-to-face meetings* sent by SD2 facilitator to the project help understanding the relationships that existed between online and onsite participation:

> [First meeting.] We began to uncover issues and concerns around the current teaching of division. We discussed our feelings about division and possible reasons our students did not mirror these feelings. The topic of concept versus procedure began to emerge. Participants also expressed appreciation for the "user friendly" qualities of the site.
>
> [Second meeting.] Many participants viewed the introduction video prior to our class meeting. The tone of their dialog online began to change from "This is how I do it." to a realization that there was another method for teaching division. The video helped create a vision of what teaching math could be which was confirmed in Chapter 1. Teachers expressed some of the same feelings Mary Beth shared in the video clip.
>
> [Third meeting.] Great discussions on "types of questioning and purpose for different types of questions." Teachers sharing justification for their choices and further deepening their understanding. Teachers have a clearer understanding of the two types of division and various modes of representations. Two teachers brought student work samples to share and discuss.

> [Fourth meeting.] I need to spend more time with face-to-face questioning discussions. Use videocase to explore more "in depth." The project supports the focuses of Teaching for Understanding and Inquiry Based Instruction.
>
> [Fifth meeting.] The content activity provided additional clarification and practice in constructing division sentences with multiple answers dependent on the problem context, and identifying types of division problems. Additional discussion focused on types of and purposes for questioning, use of diagrams to support concept development, and "clue" statements in the videocase that identify awareness of the "big ideas" using questioning to assist students in uncovering the "big ideas."
>
> [Sixth meeting.] Teachers are finally becoming confident and comfortable using and recognizing the two division models. Participants were able to transfer their knowledge of division models with whole numbers to division using fractions. They solved story problems using various modes of representation and shared representations and thinking strategies as well as solutions. The discussion of "wait time" came up as well as expansion of questioning strategies.
>
> [Seventh meeting.] Hopefully we improved our knowledge in the area of intentional questioning. We will continue to work on questioning. Teachers are developing "cueing bulletin boards" in their classrooms to help increase their ability to question appropriately.

Fourteen of the fifteen in-service participating teachers took this course for credits registering the course at a state college in Massachusetts. The graduate-course teacher of record followed the discussions, graded the final projects and gave all the teachers passing grades (3 A+, 4A, 4 A-, 3 B+); these grading variations, according to the teacher-of-record, were related to the depth of the reflections..

SD2, SPRING 2003 COURSE. NUMBER AND OPERATIONS: DIVISION WITH REMAINDERS:

In this course there were eleven student-teachers and one facilitator. All of them participated in online discussions both at the public and private discussion areas. There were no external contributions to the discussion from members of other school districts. This was a six-week course but discussions lasted one more week because of the final projects.

TABLE 9. SD2. Number and Operations: Division with Remainders. Spring 2003. Online Postings per Discussion Area, Averages and Percentages of Postings per Week

Spring 2003	**SD2. Number and Operations: Division with Remainders course**							
Online discussions	2/26	3/5	3/12	3/19	3/26	4/2	4/9	Totals
Participants in public discussions 12	2	17	20	28	15	10	14	106
Average postings/week	0.17	1.42	1.67	2.33	1.25	0.83	1.17	0.98
% postings/week	1.89	16.04	18.87	26.42	14.15	9.43	13.21	100
Participants in private discussions 12	47	13	9	21	15	8	4	117
Average postings/week	3.92	1.08	0.75	1.75	1.25	0.67	0.33	1.08
% postings/week	40.17	11.11	7.69	17.95	12.82	6.84	3.42	100
Total participants in online discs. 12	49	30	29	49	30	18	18	223
Average postings/week	4.08	2.50	2.42	4.08	2.50	1.50	1.50	2.06
% postings/week	21.973	13.45	13	21.97	13.45	8.072	8.072	100

As shown in Table 9, participation across the course was abundant (the total average is greater than 2 postings per person per week) and distributed among the two discussion areas. The course opened using the private space for building community and familiarizing participants with the type of contributions they were expected to make; during the rest of the course discussions were held both at the private and public discussion areas, being public discussion more abundant than private after the first week.

TABLE 10. SD2. Number and Operations: Division with Remainders. Spring 2003. Online Postings per Type of Posting, Averages and Percentages per Discussion Area.*

SD2. Number and Operations: Division with Remainders course, Spring 2003	**Total A..H**	General remarks	General remarks connected to the case		Grounded remarks		Teacher practice change remarks	Other remarks			**Total A..U**
		A	C	D	B	E	H	S	T	U	
Public - Math dialogues	144	47	10	30	17	31	9	9	1	7	161
% public academic postings	100	32.64	6.944	20.83	11.81	21.53	6.25				
% public postings		29.19	6.21	18.63	10.56	19.25	5.59	5.59	0.62	4.35	100
Private discussions	125	15		3	1	95	11	4		10	139
% private academic postings	100	12.00	0.00	2.40	0.80	76.00	8.80				
%private postings		10.79	0.00	2.16	0.72	68.35	7.91	2.88	0.00	7.19	100
Total postings Fractions	269	62	10	33	18	126	20	13	1	17	300
% total academic postings	100	23.05	3.72	12.27	6.69	46.84	7.43				
%total postings		20.67	3.33	11	6	42	6.67	4.333	0.33	5.67	100

*Total number of postings in Table 10 is greater that total postings in Table 9, since there are postings that belong to more than one category.

The content of the discussion (see Table 10) was predominantly pragmatic (near 90% of postings belong to categories A..H). Most of the private dialogue turned around grounded postings making reference to classroom episodes that were related to the content of the discussion (see "Grounded Remarks" E). Dialogue in the public space had a distributed amount of postings between "general remarks," "general remarks related to the case" and "grounded remarks." The content of the discussion had a significant number of remarks that included evidences of changes in teaching practices (see category H).

SD2, SPRING 2003 COURSE. NUMBER AND OPERATIONS: FRACTIONS:

In this six-week course there were 20 student-teachers and one facilitator; 8 participants had taken the "Division with Remainders" course. All participants contributed to online discussions both at the public and private discussion areas; there were no contributions to public discussions from members of other school districts.

TABLE 11. SD2. Number and Operations: Fractions. Spring 2003. Number of Online Postings per Type of Discussion Area, Averages and Percentages of Postings per Week

Spring 2003	**SD2. Number and operations: Fractions course**						
Online discussions	**5/1**	**5/8**	**5/15**	**5/22**	**5/29**	**6/4**	**Totals**
Participants in public discussions 21	0	60	48	41	74	9	232
Average postings/week	0.00	2.86	2.29	1.95	3.52	0.43	1.84
% postings/week	0.00	25.86	20.69	17.67	31.90	3.88	100
Participants in private discussions 21	27	1	2	1	1	36	68
Average postings/week	1.29	0.05	0.10	0.05	0.05	1.71	0.54
% postings/week	39.71	1.47	2.94	1.47	1.47	52.94	100
Total participants in online discs. 21	27	61	50	42	75	45	300
Average postings/week	1.29	2.90	2.38	2.00	3.57	2.14	2.38
% postingss/week	9.00	20.33	16.67	14.00	25.00	15.00	100

It is evident from Table 11 the strategy of using the private space for opening and closing the interaction, but channeling the great majority of the online dialogues at the public discussion area. The average number of postings was higher than in the two other courses offered by SD2, in part thanks to the participation of teachers who had already taken SM courses.

TABLE 12. SD2. Number and Operations: Fractions. Spring 2003. Online Postings per Type of Posting, Averages and Percentages per Discussion Area*

SD2. Number and operations: Fractions course, Spring 2003	**Total A..H**	**General remarks**	**General remarks connected to the case**		**Grounded remarks**		**Teacher practice change remarks**	**Other remarks**			**Total A..U**
		A	**C**	**D**	**B**	**E**	**H**	**S**	**T**	**U**	
Public - Mathematical dialogues	245	95	38	43	19	26	24	3	3	7	258
% public academic postings	100.00	38.78	15.51	17.55	7.76	10.61	9.80				
% public postings		36.82	14.73	16.67	7.36	10.08	9.30	1.16	1.16	2.71	100.00
Private discussions	56	4		8	26	9	9	13		6	75
% private academic postings	100.00	7.14	0.00	14.29	46.43	16.07	16.07				
% private postings		5.33	0.00	10.67	34.67	12.00	12.00	17.33	0.00	8.00	100.00
Total postings Fractions	301	99	38	51	45	35	33	16	3	13	333
% total academic postings	100.00	32.89	12.62	16.94	14.95	11.63	10.96				
%total postings		29.73	11.41	15.32	13.51	10.51	9.91	4.80	0.90	3.90	100

*Total number of postings in Table 12 is greater that total postings in table 11, since there are postings that belong to more than one category.

The content of the discussion in this course was also highly pragmatic (near 90% of postings belong to categories A…H). The initial week had a lot of "grounded" postings making reference both to the case and to classroom episodes. The following weeks had a combination of "general remarks," "remarks connected to the case" and "grounded remarks." There were many grounded postings (see category H) with remarks that made evident changes in teaching practices, related to the content of the discussion.

OVERALL IMPRESSIONS DERIVED FROM PARTICIPATING IN SM COURSES IN SD2:

Commenting on the SM courses offered in SD2 and their materials, SD2 facilitator said:

- Teachers [participating in SM] have become more intentional in their instruction. They have become "noticing teachers" and they are moving from "telling and explaining" to facilitating. How can we document this? We will be implementing an evaluation protocol in the fall as well as tools to measure teacher content knowledge.
- We *rarely completed discussions at our f2f meetings.* I tried to get us to "cliff hanger" moments that we could more fully explore online. Teachers were so excited by what they observed in the video cases, that they implemented action research projects into their classrooms with sometimes surprising results. Many teachers shared, "I saw students in the video and thought, my students don't think like that. When I gave them the opportunity to think and share, I was amazed by

what I observed. They were no different from the students in the video. What made the difference was a different teaching approach."

- The *Diving In activity* is always such an "aha" moment for teachers. It uncovers the lack of depth in their knowledge and generates a tremendously open discussion about their own feelings concerning their math experiences as both a student and a teacher.
- We liked the modified format used in the Magnitude of Fractions course: breaking research information into smaller digestible pieces.
- The *student work* is a section I always print out. Teachers have found it problematic to try to analyze it from the site. In the last course, I printed out the student work, with the teacher analyses stapled (print side not visible) to the back. Groups of teachers analyzed the student work and recorded their conclusions, then checked against the teacher analysis. All my teachers felt that student work analyses needed to be done in f2f working groups.

TPD Centered on the Creation of Multimedia Teaching Cases

A teacher-authored video case combines multimedia resources to deliver a case of teaching. This kind of product emerges from the reflection on teacher's own practice, both as an individual and as a member of a community of practice. It requires from the part of the teacher willingness to expose his/her usually private professional practice, to be analytical and critical about teaching issues, to deepen into them, and to be able to generate a story that tells the case.

Participation Guidelines for Teacher-created Multimedia Cases

Guidelines for participation in this kind of TPD were open ended, based on the definition of expected products—a video case and reflective documentation of the process—with a methodology and tools for achieving the goals. According to the Guidelines provided by the SM project, effective participation by the part of a teacher-author includes:

> Through all the process, keep a journal that helps tracking and reflecting on the process.
>
> Video record one or more classroom sessions; document all of the academic resources and elements that will help understanding the case (e.g., handouts, lesson plan, blackboard or slide images; list of students video recorded).
>
> Review video episodes, looking for tensions, problems, issues related to teaching and/or learning processes.
>
> Delineate a story that tells the teaching case.
>
> For those kids that will appear in the video case—based in the story to be told—collect parent permissions for including their kids in the video paper, by using the appropriate Human Subjects format.
>
> Learn how to edit digital video and obtain an edited version of the rough video, showing those elements that help telling the story; ask for technical help—locally or to the SM project—if necessary.
>
> Transcribe the edited video and video-caption it with the corresponding text.

Learn how to use the authoring tool created by the project—VideoPaper Builder 2 (VPB2)—as well as commercial tools for editing hypertexts and digital images;

Define the logical structure of the video case and create each of the corresponding (hyper)text pages, identifying video sequences and images that help understanding or reflecting on the objects of study.

Using VPB2 create the structure of the case (menu to surf through its pages) and a draft version of synchronized text, video and images that tell the story.

Invite colleagues and facilitators of the process to comment on the draft video case.

Edit the elements of the video case that require adjustment and include comments that add value to the case.

Review notes taken through the process and create a reflection document that captures the process, major challenges, doubts, alternatives, insights, lessons learned and suggestions for further work.

Present the video paper and the accompanying reflections on the process to selected audiences (colleagues, seminars, conferences, electronic magazines, etc.). The school district is the primary audience, but also the project wants to disseminate the cases and experiences related to their creation.

Participation in Teacher-created Video Cases

As it is shown in Table 2, a few teachers from SD2 and SD3 decided to create their own video cases. This was done in two steps, the first one guided by SM researchers and the other guided by SD2 and SD3 facilitators.

Ricardo Nemirovsky, who accompanied SD3 facilitator and one of his teachers in the process of building the first teacher-created video-paper, coached the first experience. He oriented them and alleviated the building process by taking care of using some of the technology involved. By the time the first teacher-created video case was created the project was in the process of generating a revised version of VideoPaper Builder, the authoring tool to build video papers. In the second round, SD2 facilitator coached two of her teachers and SD3 facilitator coached three of his teachers. The project provided technological support—on demand—to participating teachers and facilitators, and helped them solve methodological or technical issues as they appeared.

We assessed participation in teacher-created video cases by means of having periodic follow up sessions with the corresponding district facilitators and teachers authoring the cases, combining face-to-face and telephone conferences. The guideline served as a reference for this interaction.

We reviewed draft and final versions of teacher-created video cases as well as the corresponding process documentation. This served to give feedback to the teachers and to help solving problems of different nature (conceptual, technical, operational) as they appeared.

First generation of teacher-created video cases.

One middle school teacher from SD3 volunteered to work with her school district facilitator in collaboratively creating a video paper on "The area of obtuse triangles". This was a complement to her participation in online discussions at the "division with remainders" collegiate course. The author and her facilitator were in charge of the academic part of the process, centered on defining and documenting the case. The project assumed the technical functions (digitalizing video, transcribing its content, video captioning, VPB2 usage for creating the structure and synchronizing video, text and images).

After this first teacher-created video paper was completed the project organized a "lessons learning" meeting (Concord, MA, Dec. 17, 2002) with the SD2 and SD4 facilitators and one teacher from each district. The following were major conclusions from the meeting:

> Videotaping lessons is a means for helping teachers reflect on their own practices and invite other teachers to discuss about challenging teaching episodes.
>
> Videotaping lessons is not an easy task. In order to get good images and sound, it is convenient to find out where in a classroom, and how, to use the video camera; also it is necessary to collect a lot of surrounding materials. Simple tricks include: avoid filming against the windows or against the light, be as near as possible to the target students/teacher in order to capture good sound and details, collect support materials that help understanding what has been videotaped. Also it helps to register the date, participants, resources that are involved in the videotaped lesson.
>
> The teacher is the first filter of any videotaped lesson. His/her own reflections lead the identification of tensions, or challenges, or problems that are worth analyzing. S/he decides what segments are worth sharing with other educators. However, s/he is not alone in the reflection process, his/her colleagues and TPD facilitator may contribute a lot.
>
> In order to enrich the experience of watching and discussing classroom episodes it makes a big difference to have time to work on the mathematics involved in the episode. It changes our own sensitivity to what the students are struggling with and improves our ability to hear what they are saying.
>
> The primary use of any videotaped lesson is to help participating teacher(s) grow professionally, as a member(s) of a learning community of practice. His/her own reflections, as well as feedback, comments and discussion with colleagues, are important components in the process.
>
> A teacher-created video-paper is, initially, a private document that, using multimedia information, systematizes events and surrounding materials that help reflect and learn from a given teaching situation. The case emerges from threading different episodes around a story that is of interest. It may become a public document if the teacher wants to share his/her case with a distributed community of teachers.
>
> Building a video-paper is an exercise that challenges and rewards many teachers, as long as it helps them grow professionally. However, converting a video-paper into a public document may become a burden for some teacher-authors. Making public a video-paper is very

demanding and teachers do not always have the time, or the need, to publish about their own professional practices. Human rights issues must be also considering when a video paper is going to be published.

The following are reflections from the part of SD3 facilitator concerning the process of collaboratively create a video paper:

> "Looking at the video with someone else was the most important part of the professional development experience." The teacher has expressed this sentiment over and over again as we talk to other educators about the VideoPaper case we developed together.
>
> After collecting video in her 7th grade mathematics classroom, the teacher and I revisited the footage several times in an effort to tell a mathematical story. We had different purposes for collecting and viewing the video. The teacher saw a genuine value in the reflective process that comes from viewing the same video several times. As the math staff developer, I also relished the opportunity to share my comments and questions. I could emphasize different aspects of her teaching that contribute to student success. Trust was an essential element that allowed us to work in this manner. We devoted many hours to building the VideoPaper in an effort to analyze the teaching and instructional strategies implemented in her classroom.
>
> The classroom story will vary depending upon the focus of the teachers involved. The issue that spoke to us was student voices - the teacher created opportunities for students to be seen as math experts. Building the VideoPaper allowed us to highlight the importance of giving students time to share their mathematical thinking. Other teachers might see different storylines.
>
> Teachers can use this process to reflect on their own practice and to discuss the pedagogy and content with other teachers. We gained immeasurably from having focused our attention on teaching and encourage other educators to use VideoPapers to do the same." SD3 facilitator.

Second generation of teacher-created video cases.

During 2003 five teachers from two school districts engaged in the process of building their own video cases, with local support from their respective SD2 or SD3 facilitator; the initial teacher was part of the group. A new version of the authoring tool—VPB2—was available and in this second round we wanted to see if the tool was friendly enough for the teachers to build videopapers by themselves. This was a great challenge, because participating teachers in this second round were required both to create their own video cases and to appropriate the tool.

Both groups adopted the methodology proposed by the project and worked on the creation of the cases working as communities of practice. They had sporadic, on demand support from the project. Extrinsic incentives were offered by the project to teachers and facilitators as recognition of the extra work that it demands to collaboratively build a teaching case using VPB2. One of the teachers from SD3 dropped out of the process because she felt she did not have the extra time needed in addition to her day-to-day duties. Teachers have delivered the two video cases from SD3. The production of the two video cases from SD2 has been rescheduled for the next academic year.

(Last year participating teachers form SD2 were very enthusiastic but it was unrealistic to complete this task while attending to their other duties.)

The following are reflections shared by a teacher from SD3 who finished her second video paper. They helped us understanding two different settings for building video paper: as a collaborative process and as a group process.

> This is the second video paper that I have participated in the creation of. While writing this paper I have been comparing it to the first experience I had. The first video paper that I worked on was of me teaching but the text of the paper was the result of watching and reflecting on my teaching with colleagues. This time I watched and reflected on my teaching, I wrote a paper and then shared it with others. In both cases it was powerful to sit and really watch and listen to my classes but I did find the first situation much more rewarding. Teaching is a career of isolation and my goal is to find ways for me to share my teaching so that I feel less isolated. In the first situation when the text came from a dialogue with colleagues I felt the support and involvement of them and did not feel isolated. This time around even though there was a group of us working on papers simultaneously I felt terribly isolated. Isolated to the point of feeling as though I was writing research rather than reflections. If I were to participate in creating a video paper again I would want the process to mirror more of my first experience rather than the second.
>
> There were other issues other than the isolation that would prevent me from repeating this process again. These issues deal with the technology. In the first paper that I was involved in I did very little of the technical pieces. When embarking on this paper I was excited to learn about the technology and to be involved with it more. As I moved through the paper I felt overwhelmed with the technology. The programs worked and had good directions, I knew that there was support available, but even with all of that there was just more technology than I could keep up with. The project was something I could only work on at home because the school did not have the technology that I needed. Then at home my computer was a bit frustrated with what I was asking it to do. Everything ran very slow which then meant everything took a long time to do. I knew what I wanted to do and knew how to do it but it still took more time than I wanted to give.
>
> The technology was not only an issue in writing the paper at school but it made it very difficult for our group to meet and share our progress. We had limited access to computers, which had loaded video paper builder so the only way to share what we had done was to publish our work. This limited us to sharing our work until we had the paper truly laid out in video paper builder otherwise it just looked empty and hard to comment on. This increased the frustration level and the feeling of isolation.
>
> So in brief if I were to participate in another video paper I would want certain conditions met. First I would want to work as a group on one paper. It could be a paper about multiple people teaching but I would want the brainstorming and writing of the text to come from group discussions about our joint video. The second condition would have to deal with the technology and having access to it at school. This access would be so that it could be either put together by one individual or so that we could sit and work together. It would also allow us to view and edit the paper as a group.

> Reflecting is a powerful action that is often overlooked. Creating a video paper causes you to slow down and do the reflecting but the real power comes in sharing your ideas with colleagues. I am not sure if a written video paper is as powerful of a means of communicating as the process of writing one with colleagues was for me.

Teacher Changes and Impact on Students

A project's goal is to prepare school district facilitators to make the most effective use of our multimedia case-based video cases and tools; then facilitators create and implement their own TPD strategies taking into consideration their school districts' needs and possibilities and participating teachers' needs; the teachers put into practice what they learn to the extent that they find it worth doing. All this may or may not produce changes in student learning. We wanted to know what kind of changes occurred in facilitators, teachers and students, since this is the ultimate reason for the project.

We studied changes in teachers that participated in SD2 courses since in this school district courses had a high level of participation, and the content of the discussion was pragmatic and increasingly grounded. We explored changes at the facilitation level by looking at the same variables across three semesters, using course syllabi, facilitator's reports and online discussion content. Similarly, we examined changes at teachers' level, based on online discussions and final projects. Regarding changes at the student level, our analysis is based on reflections in the online discussions and on action research with a subgroup of teachers conducted by the external evaluator.

Changes in the Facilitation of Case-based Discussions

A pilot project is by itself an institutional and personal learning experience. The project offered a three-day face-to-face introduction to the project, followed by a six-week online introductory seminar to online facilitation. The collegiate course that the facilitators offered to a reduced group of teachers from each school district served as a laboratory to explore what it means to facilitate in blended learning environments. National meetings at the end of each semester helped sharing facilitation experiences, learning from them, and coordinating new initiatives devoted to improve the facilitation. Each of the new SM courses that were offered served to implement these ideas and to refine knowledge concerning facilitation.

Comparing the evolution of the facilitation of online discussions in SD2 courses through three semesters, we realize that:

- After the collegiate course, discussion seeds have increasingly had the intention to generate both grounded math discussions and general math discussions. The following excerpts taken from three different offerings of the same course illustrate the point, and the figures shown in tables 7, 9 and 11 concerning the frequency per type of posting support this finding:

> Direct modeling is a natural, effective strategy used by many children to solve both routine and non-routine problems and is sufficient for problems involving small numbers, but as numbers become larger, students need to develop more efficient strategies.

> Standard algorithms are efficient, but rarely build on students' natural ways of thinking. When standard algorithms abruptly displace children's natural direct-modeling strategies, confusion rather than understanding usually results.

> How do we meet the challenge of moving students to more efficient strategies without just teaching a "standard algorithm," which is efficient, but rarely supports students' conceptual understanding? [SD2 facilitator, posted 11/21/02]

> What elements of instructional practice that you observed in the video created an "aha" moment for you? As you work in your classroom this week, do you find yourself trying out some of the approaches you observed in the teaching example? Have you felt freer to follow the students' lead, and how did it work out? How did you help students who were stuck or headed in the wrong direction without taking over their thinking? [SD2 facilitator, posted 5/7/03]

> Moraima falls into a common error: She thinks 1/3 is bigger than 3/4 possibly because she does not look at both the numerator and the denominator. (She may think that the larger the denominator, the smaller the fraction-which only works when the numerator is 1). Her statement '1/3 really doesn't compare to 3/4' indicates she may not yet understand how to compare fractions when both the numerators and the denominators are different?
>
> How can we know whether one fraction is bigger than another? And how can we know how close in magnitude one fraction is to another? What might you do as a follow-up to strengthen the understanding of a student like Moraima? [SD2 facilitator, posted 5/20/03]

- Facilitation interventions model collaborative and inquiry based learning: they are generative building on participant's ideas and threading them. The enhancement of the facilitation interventions can be attributed to individual effort based on feedback and lessons learned from the experience, and, in the case of SD2 facilitator, to expert coaching by the part of an expert in online facilitation, Dr. Collison. The following two excerpts, taken from moderation intervention by the part of SD2 facilitator in two different years illustrate the point.

> XX posed an excellent question regarding manipulatives and the transition from representation using concrete materials and direct modeling to abstract reasoning.
>
> When YY said, "I then pushed the conversation up a notched and asked if we could connect the dots of the coordinate graph" I thought about the NCTM process standards. Would connections have been made independently or was communication through questioning and sharing strategies the key?

> YY's second comment, "We probed their thinking and finally got the idea" reinforced for me the power of students sharing their solution methods and teachers moving them to the next level with good questioning? What part do you think communication plays in moving students to more abstract levels? [SD2 facilitator, posted 10/26/02]

> As I re-read the responses to this question, I noticed many comments related to the powerful impact of putting students at the heart of the thinking. MM said, "I thought the questioning technique was an excellent tool because it invited all the students into the process of problem solving." CC added, "I noticed that they guided the discussion but a lot of the talking was done by students telling the teacher how to do it, instead of the other way around." JJ shared, "They were eagerly thinking and responding to her questions" and I wondered why students seemed so eager to respond. What made the questioning invitational for students?
>
> How do we begin to shift our thinking from "can I ask instead of tell" or "is this a good question to ask them" to an attitude of "will my question interrupt their thinking and insert my thoughts or will my question cultivate their thinking?" [SD2 facilitator, posted 3/18/03]

Changes in Teacher Practices

SD2 facilitator pointed out at the end of the pilot experience that SD2 teachers have become more intentional in their instruction, that they have become "noticing teachers," i.e., teachers that are able to notice the existence or not of reformed educational practices, and they are moving from "telling and explaining" to facilitating. The following excerpts, two from the "Division with Remainders" (DWR) SD2 Spring 2003 course and the rest from the "Fractions" (FRC) SD2 Spring 2003 course, help illustrating the point:

> I agree that it is so important to allow time for our students to process and do lots of deep thinking. When I first started using questioning techniques, I also found myself saying 'was that the right way to ask that?' 'did I ask instead of tell for the most part in my lesson?' 'how can I present this information without giving away too much math?' I was in quite a state of disequilibrium. I found that the more I used questions and listening instead of directing and telling, I too found that my students became more excited about math, and I began to value their thinking—and thirst for more!
>
> It's exciting when you can have a colleague to learn from and bounce ideas off of. I didn't have that until I'd been using questioning for about 1/2 a year. It was so wonderful when I could share with someone else! [SD2 teacher, posted 3/25/03, DWR course]

It is difficult to know everything we need to know to be effective teachers. It takes research and planning. But I find that when I started using the inquiry-based approach last year, I didn't have to know as much! When I was up front, lecturing and telling kids how to do things, I really had to be on the ball. But now, KIDS come up with all the answers!

It's not that I don't have to know stuff, this kind of teaching is very intentional. But it's not about how many "pieces" of knowledge I have, I think it's about helping kids to connect and construct their own pieces of knowledge. The exciting part is that you never know when or how they might make a connection. You just have to be there to celebrate that, and ask a question that will push it further! [SD2 teacher, posted 04 02 2003, DWR course]

Using better questioning strategies has definitely paid off in all areas of our instruction. Melanie and I often catch ourselves saying, "Tell us about your thinking." (And then we look at each other and say, "Good one!") The students think we're dorks, but it is helpful to remind ourselves to ask more insightful questions. The children are learning they need to be able to defend their reasoning, which is important in every subject area. It also helps to cut down on the amount of talking/lecturing the teacher does. The class is often better able to understand a concept from a student's point of view. [SD2 Teacher, posted 5/18/03, FRC course]

I have also noticed that I am questioning my students more and in other areas besides math. I think that they feel empowered when I always question them and encourage them to tell me what they are thinking or how they came up with an answer. I have also noticed that since I began questioning more, some of my quieter students have been participating more. They are realizing that they are not the only ones who got an answer a particular way or not the only ones who don't understand a particular question. I am learning so much about my students through question that I hope that after the long summer break I can remember to continue on with this line of thinking. [SD2 Teacher, posted 5/20/03, FRC course]

Through my experiences, I have found that remaining neutral is very beneficial in a math classroom. While we have always been taught to praise, praise, praise kids (and is something I have worked on in the past because I never felt I did enough of), with math it's different (and other subjects). What happens to other students' thinking the minute we say "Good job, Frank" or "Great strategy, Bill"? Others think we have found the "right" answer or the 'best' way, and their thinking stops. They think that since Frank did a good job, we may not be interested in their thinking, which is far from the truth. It is so hard to do. We want to jump for joy the minute a kiddo thinks of the coolest strategy we've ever seen—especially when it's one we would never have thought of ourselves! Building self-esteem requires students being their own judge of their skills.

> We want kids to feel mathematically powerful. It requires fostering an environment where everyone feels safe to share, not just the ones who get the praise. I find I have to save the praise for the teacher's lounge—it is a blast to share a-ha moments with our own peers! [SD2 Teacher, posted 05 27 2003, FRC course].
>
> There are a lot of things that I need to clean out from my teaching closet. First, I need to get rid of the teaching styles that are not effective. I need to use the inquiry method and throw out the long explanations. I need to throw out the standard algorithm worksheets and allow the kids to develop algorithms and methods for solving problems. I need to throw out quantity and develop quality. I need to throw out superficial meaningless problems and use meaningful deep problems. The notion that there is only one way to do things has to go, and challenging students to understand many ways to solve problems must become the expectation. The idea that only struggling kids use manipulatives needs to change, and allowing kids to use manipulatives until they become cumbersome for kids should be allowed. Making kids work alone most of the time needs to stop - kids need to work together to increase understanding. I think math doesn't always need to be taught in isolation, so I might get rid of the exact minute-by-minute lesson times for math, and integrate it into the curriculum much more. There are so many things to throw away, and there are so many new great things to replace them with. [SD2 Teacher, posted 6/6/03, FRC course]

The above excerpts do not mean that all the teachers taking part in SM courses achieved this kind of reflective practice but they are good examples of the kind of changes that the project may elicit when participation is good and facilitation is properly done.

We cannot infer that teachers achieving this level of understanding can transfer it directly to their classroom; there are contextual factors that need to be considered. The following excerpt illustrates the point.

> In our school we tend to rely on Accelerated Math and not just giving our students time to explore. We really are never asked to take the time to teach the why part, only the process to get them to the correct answer…
>
> I don't think that our curriculum matches the strategies used in the video, but I think that these strategies can be easily added in. We discussed in our face-to-face the benefit of exploration and just teaching the process. One of the things that came up was the time that exploration might take compared to just teaching the process first. I think that exploration does take some time, but I also think that if we would take the time to start with we wouldn't have to keep teaching the same processes over and over again. [SD2 Teacher, posted 2/4/02, DWR course]

Changes in Student Knowledge and Attitudes

During the spring 2003 Division with Remainders course at SD2 the external evaluator of the project and the SD2 facilitator invited participating teachers to conduct action research focused on establishing changes in student achievement.

Teachers selected a learning objective to be addressed in the classroom using concepts or strategies that were raised in the SM course; they created and applied pre- and post-tests to their students, as well as a rubric for grading both pre-and post-tests, which they did by themselves; teachers also answered a questionnaire that helped understanding findings.

The external evaluator processed and analyzed gains using pre- and post-test results from 190 students and was able to establish differences in mean scores at the global level (considering totals) and disaggregating data by items and type of them. The study concludes (Gadzuk, 2003, p.4) saying that:

> This action research project provided evidence of student achievement and growth in problem solving competence for the 190 students who participated…. While this pilot study did not yield comparison data from a so-called control group, many of the participant teachers were veteran teachers who informally compared their students to students from the past years. One teacher in her 18th year of teaching observed, "I see them catching on the concept of division so much easier than I have seen my students in the past."

> Teachers observed changes in student behavior and attitude as they implemented Seeing Math strategies. They described a new enthusiasm: "students enjoy the challenge of battling out a measurement division problem" and "I had students that were so eager to share hoe they solved the problem," engagement and time on task increased: "While I watched the students work to solve their problems I could see that they were truly engaged. Not a looked at other people's paper. They were overly concerned about solving their problem. They worked until the problem was done."

Looking at participation of teachers in the Division with Remainders course, Spring 2003, Tables 9 and 10, as well as the excerpts that we included above from the same course we hypothesize that these student gains are correlated with teachers gains. However, quantitative studies are needed to validate this statement.

From the perspective of this study it can be stated that documenting the level of success achieved by facilitators, teachers and students may serve an important function in the institutionalization of multimedia case-based teacher professional development. As the literature review pointed out, this evidence of added value helps the innovation proceed to a new implementation cycle. On the other hand, in school districts where the innovation did not add value to the expected beneficiaries it is possible that the innovation fades out.

Expansion of the Project in Pilot School Districts

One year and a half was enough to clearly differentiate school districts that were going to expand the project from those that not.

- Organizational problems—in particular lack of support by the TPD school district authorities—were behind the difficulties faced by SD1 in expanding from one school to a group of schools, in addition, a nurtured but not very effective participation of teachers did not help their facilitator to convince the district authorities to sign for the second pilot of SM, which starts during school year 2003-04.
- SD2 not only was able to show results from the beginning of the pilot experience but also was able to expand course offering per semester, in spite of counting with only one course facilitator. At the end of the first pilot experience this school district signed for the second pilot and decided to expand the number of facilitators, selecting two teacher leaders to collaborate with the existing facilitator.
- Difficulties generated by competing interests between SM TPD and other innovations at the school district were a constant at SD3; this led the pilot experience to be focused on teacher created videopapers; unfortunately this was not a collaborative process and teachers felt very isolated in the process; this school district did not sign up for the second pilot of SM.
- SD4 facilitator had numerous difficulties motivating teachers to effectively participate in online discussions; since the itinerant facilitation format he adopted was very difficult to expand, the facilitator thought of organizing SM around courses, but meanwhile he accepted a position in another school district and SD4 authorities did not sign for the second round of SM.

Study Findings

This study is focused on establishing those few aspects that make a crucial difference in implementing multimedia case-based Teacher Professional Development (TPD) as an innovation at a given school district. We are interested in establishing Critical Success Factors (CSF) related to each of the stages of this kind of innovation. They are interdependent: if the innovation is adopted, it can be implemented; if it is properly implemented, there will be powerful reasons for its expansion; if this happens and a critical mass is impacted, the innovation will become institutionalized. Institutionalization leads the innovation to end its "innovative" condition and become part of the normal culture of the institution.

We have organized our findings considering the adoption, implementation and expansion stages of an innovation. We have disaggregated the second stage in three sub-stages, since implementation can be broken into recruitment, participation, and impact on educators and students; any of these sub-stages is determinant for a successful implementation but at different levels.

As it was mentioned before, CSF are those few activities that deserve special attention for a process to be successful or not to fail. We will look at both dimensions of the concept, the positive and negative: what do I need to do extremely well in order to be successful? and, in which aspects I cannot fail because they would lead the process to fall flat?. We will also look at the relationships

between aspects that belong to only one of the positive or negative dimensions of CSF, these are *operational*, that is, their attention will help succeeding or avoid failing depending on the side in which they are. On the other hand there are those aspects included in both sides, which we call *strategic*, because taking them into consideration leads to success and not taking them into consideration leads to failure. *Operational CSF* are urgent to care about, their attention may help succeeding or failing in the process; but *strategic CSF* are crucial to consider because success or failure depends on them.

CSF Related to Adoption or Rejection of Multimedia Case-based TPD by School Districts

We found three CSF related to this initial stage. For multimedia case-based TPD to be properly adopted at a given school district there must be organizational readiness, pedagogic alignment and institutional support for TPD opportunities.

Organizational Readiness

Not all school districts are organizationally ready to implement multimedia case-based TPD. As it was mentioned in the context of the study, from the twenty pre-committed school districts that were initially interested in the SM project, only four signed up as pilot sites. The basic reason was that the project award, its budget being significantly less than expected, did not allow the project to assign resources for technology enhancement or project coordination at the interested school districts. School districts that had appropriate computing and networking capacities at their school buildings, that could afford a math-education leader devoting at least half time doing SM-based TPD, and that could offer the appropriate incentives for teachers to participate in the project, were able to participate. These three conditions were necessary to adopt the project but their accomplishment was not enough to make school district authorities decide to participate in an innovation as SM.

Organizational readiness is an operational CSF. If there is organizational readiness the project will not necessarily be adopted, however it will be rejected if there is not.

Pedagogic Alignment

Math coordinators at the school districts were in charge of confirming (or not) the willingness to participate in the project. They and school superintendents got letters of invitation explaining the basic ideas behind the project, its strategy, benefits and participation requirements. Two of the math coordinators requested further information concerning the foundations, philosophy, and pedagogy of the project before proceeding further. In one case this philosophical orientation led the school district not to participate because the math coordinator deemed that they could not afford changing the non-reformed curricula they had in place. On the other hand, SD2 math coordinator found that participating in SM would help her school district succeed in the curriculum adoption process in which they were engaged. SD1 facilitator was the change facilitator of a transformed school in which reformed education had been adopted. SD3 was already implementing reform-oriented math curricula. SD4 supervisory union had in place three math programs with similar goals and pedagogy, tuned with the project.

Pedagogic alignment between the project and the math education orientation of potentially interested school districts is a strategic CSF. If there is not pedagogic alignment the project is likely to be rejected, if there is pedagogic alignment the project is likely to be adopted.

Institutional Support for Offering SM TPD Opportunities

The adoption of a project by a school district is more than the administrative act signing in for participation. The adoption of an innovation requires creating conditions needed for a successful implementation. The school district facilitators examined the role of this institutional support as they shared their perceived CSF implementing SM TPD.

SD2 facilitator expressed that "a solid commitment to project success from both the facilitator and the district is the key." In her words, "the video case-based professional development needs to be regarded as integral part of a cohesive district professional development program, not just 'one more added thing' ." SD2 successful participation was due, in part, to the committed adoption of the project; it meant not only that the courses were in the school district catalog but also that appropriate incentives and participation conditions were created.

SD1 facilitator offered a complementary vision of the above idea when she mentioned that "first and foremost, the facilitator must have the capability of getting [the video case-based] course approved on the school system professional development calendar in a timely manner, since it is imperative that the facilitator has the capability of getting the course scheduled or else the course can't go on." The lack of commitment of the SD1 math TPD coordination with the SM project not including SM TPD courses in the district catalog was in part the cause of limited participation of teachers in the initial courses, while commitment of the SD1 teacher-union including SM TPD in their catalog was a key factor involving teachers in the final course, since they supported the accreditation that teachers were expecting.

SD3 gave a third view of the required institutional support on the part of the school district. He stated, "It might be necessary to have the video case-based program be the centerpiece of the school district TPD program. When it is an add-on or when it is part of a very full TPD program it can be very tricky to sustain interest. Adding video case-based TPD to a very full TPD schedule could very easily over saturate a district with TPD opportunities. Too many choices in a small school district will likely mean that the overall TPD program could loose its focus". This explanation helps understand what happened in SD3, in which there was organizational readiness and pedagogic alignment with the project but it did not engage a significant number of participants. Possibly, this was the result of the project not having a higher priority in the school district and of having too many competing projects.

Institutional support for offering SM TPD opportunities becomes a strategic CSF. Without this kind of commitment the TPD project will not be fully adopted.

CSF Related to Teacher Recruitment for Multimedia Case-based TPD

Recruiting teachers for multimedia case-based TPD is a challenging activity. The relative novelty of using multimedia digital resources for TPD, as well as the use of a relatively new format in education (case-based discussions), may help motivating certain groups of teachers, as it was the case of participants in the collegiate course. On the other hand, through the use of blended learning environments it is possible to overcome situational barriers related to time and space for learning, provided that technological barriers do not interfere with online interaction. These reasons are not enough for recruiting teachers. Participation in multimedia case-based TPD is demanding and participants must be conscious that they need to accomplish individual activities (e.g., review and reflect on video episodes and surrounding materials, document and reflect on classroom activities related to the case, develop a final project), as well as group activities both onsite (participation in course meetings) and online (participation in local and public discussions). Motivating people to

participate and engage them in these processes require more than access to excellent multimedia educational materials usable in a blended and flexible format.

We found two CSF concerning teacher recruitment for multimedia case-based TPD: Finding the appropriate incentives and configuring a program that sells.

Finding Appropriate Incentives

Appropriateness of incentives requires knowing the teachers and their personal and professional needs within the context of the external motivators for professional development applicable at the school district.

The first group of teachers, those that took part in the collegiate course, did not require incentives for their participation. They were internally motivated by the possibility of exploring this alternative and trusted the facilitator who invited them to try. Some of these teachers, from SD2, had the possibility of getting graduate credits and seat hours or monetary compensation for the seat hours, but they did not accept it. However these incentives were successfully used in SD2 in the rest of SM courses; teachers paid for the graduate credits with the money they got from seat ours, and they made use of the credits for their professional career. SD4, on the other hand, did not use incentives; according to SD4 facilitator teachers in SD4 are not interested in graduate credits because they are required to gain only seven credits every nine years. However SD4 middle school teachers need to be qualified according to NCBL requirements, which entails passing the Praxis exam or having math as a teaching major. SD4 tried recertification credits, conference attendance, release time, and Yahoo gift certificates, but according to the facilitator only the last two were modestly successful. SD3 offered to SM participants the same kind of incentives that other math TPD programs offered, in the context of full support on the part of the school district superintendent, but only a few teachers bought the idea. In the end at the final course of the pilot experience, SD1 teachers got 45 seat hours and three recertification credits given by the teacher union TPD unit. According to SD1 facilitator this was a determining factor in student-teachers taking the course.

Finding appropriate incentives becomes a strategic CSF. If the school district fails finding them teachers do not participate in TPD, but if they are available it is possible to obtain a reasonable number of participants.

Configuring a Program that Sells

Motivating teachers to register for a course requires finding opportunities that fill participants' learning gaps and that match the situational conditions of potential members with the possibilities of the program. As a general principle of adult education this is a rule of thumb. Making it operational brought to the surface two dimensions—course selection and syllabus definition.

Course selection and sequence.

SM has nine cases organized around four NCTM 2000 standards; a course facilitation guide and the corresponding participants' guides accompany each case. Facilitators' initial training includes reviewing the different cases and exchanging ideas concerning their potential value from content and pedagogy perspectives. It is left to the facilitator's initiative to find out what case (or cases) are convenient to a given teaching community, why offer them to whom, when and how.

Division with Remainders was the SM course most frequently used. Reasons for its selection were of two types: it was important that the teachers felt comfortable with the content of the initial

course as well as its offering common problems on the teaching of mathematics at elementary and middle school level. In addition, facilitators felt that questioning strategies were central in this case and that reflecting on their use teachers could change their teaching approach.

Prealgebra: Pan Balance Equations was offered by SD3. TPD at SD3 each year focuses on a certain topic, and Algebra was the topic of the year 2002-03. Middle school teachers were particularly interested in studying pre-algebra and were the predominant group recruited. There was one high school and no elementary teachers participating,.

A sequence of three SM courses—*Using Data to Make Predictions, Calculating the Area of a Triangle, and Pan Balance Equations*—was offered to SD4 teachers through the school year 2002-03, organized in such a way that teachers could be prepared for teaching these topics by discussing the case before teaching the corresponding unit. A small group of teachers were recruited for the three courses.

Making the right selection of SM courses and sequencing them properly may motivate teachers to register for multimedia case-based courses; failing in course selection may lead not to recruit teachers or to recruit only those extrinsically motivated. It is a strategic CSF.

Syllabus definition.

At the beginning of the pilot experience course coordinators defined course syllabi with their own style and with different levels of specificity. However, by the end of the pilot almost all course syllabi adopted SD2 course syllabus model. Facilitators realized that teachers needed complete specification of goals, duties, requirements and timeline; and all this must be viable. As SD1 pointed out, "The facilitator must develop a course syllabus so that participants are clear on requirement and course guidelines to include assignments and dates of implementation. Just like the students we teach, teachers need clear, concise information as well…. Cannot make expectation of coursework unrealistic. Teachers have a busy schedule and must not be made to feel that overwhelmed with assignments." [SD1]

Making a complete, clear and realistic definition of course syllabus does not make teachers to engage in a course; but failing in this definition generates doubts that negatively affect recruitment. The syllabus definition is an operational CSF.

CSF Related to Effective Participation of Teachers in Multimedia Case-based Courses

Participation in SM courses meant more than attending to face-to-face meetings, posting online at least twice per week and delivering a final project. These events were valued if there was value added to the discussion with original ideas or comments on other teachers' postings, if reflections were grounded on the video case or on their own experiences, and if there was transference of concepts and principles from the case to classroom activities. We found the following CSF related to participation: Technology readiness, face-to-face meetings, building trust and organizing discussions, and giving support to a community of learners.

Technology Readiness and Readiness to Technology

Technology readiness was one of the pre-conditions to participate in SM. Teachscape gave check lists and technology assessment tools to local facilitators and was ready to help verifying appropriateness of computers to be used by teachers at the school buildings; in addition, Teachscape sent to facilitators as many CD ROM sets as participating teachers, to help them have the required

software at home including local copies of the videos, in case the internet bandwidth was not good. Theoretically technology was not a problem. However, at least in one school district that was not the case. SD1 managed to organize the face-to-face meetings at the computer lab of a school building conveniently located for participating teachers. In spite of this, at the first meeting it was evident that not all the machines were ready to use, that there were network security problems to be solved, and that part of the group of teachers did not have email addresses. As it shown in table 5, it was necessary to reinitiate the course three weeks later, when the preconditions were achieved; this required solving technical problems and, more importantly, introducing a group of teachers to computers and Internet before reinitiating.

Readiness to use technology was not only an issue from the part of novices in computer use. SD1 facilitator considered that "the facilitator must be computer literate and be able to respond to participants concerns and issues as they arise. Some participants are not computer literate and need guidance from the facilitator" [SD1]. In addition, SD2 facilitator realized that teachers appreciated the "user friendly" qualities of Teachscape site but that it was not enough. She wrote that "participants need a comfort level with technology and computer access both at home and at school" [SD2] and consequently she decided to devote the first face-to-face session of all her SM courses to help teachers explore and use Teachscape site comprehensively and effectively.

Technology readiness and readiness to technology is an operational CSF. If it is not present it may lead the experience to fall flat, but if present it does not mean that participation is assured.

Face-to-face Meetings

When the SM project started we did not have a clear sense for the role of face-to-face meetings for trust building and as a complement to online interactions. Practice showed us that they were crucial for engagement and participation. Teachers who are not used to study alone or to study online feel that face-to-face meetings help them manage the process through direct interaction with others in a well-known format. "Failing to provide opportunities for face-to-face conversation between participants in the district will help to diminish interest in the project" [SD3]. We found that in face-to-face meetings teachers felt freer to participate, more spontaneous, and more "themselves." With the exception of SD4 these meetings stimulated teachers' online participation because they created a space to share their impressions on what had been said via digital forums. Face-to-face sessions were also a means to "check" with each other before initiating new posts. Another contribution of face-to-face meetings was to articulate links between the local reality of the school and the postings coming from other schools and experiences.

Two major onsite/online blending formats were tried through the first pilot implementation, in order to offer courses with N (N= 5 or 6) teaching examples (video episodes): (1) N+2 face-to-face weekly (or biweekly) 2-hour or 3-hour sessions (one opening session, one closing session, and N discussion sessions) with N weeks with online discussions, as it was the case of SD1, SD2 and SD3 courses; (2) in SD4 they scheduled a one-day face-to-face introductory meeting and individualized meetings at each teacher school building for fostering reflection and participation in online discussions. This last format neither generated the expected results in terms of helping teachers participate in online discussions, nor it contributed to building a community of learners, since interaction was one-to-one with the facilitator. On the other hand, weekly meetings were found more effective than biweekly meetings, in terms of keeping the pace and the level of participation in the discussions.

Face-to-face meetings are a strategic CSF in multimedia case-based TPD, they make a difference concerning participation both in face-to-face and online discussions. If the facilitator includes them and uses a format that helps interacting and reflecting, making links with online activities, both face-to-face and online discussions may progress. If the facilitator does not organize frequent and efficient face-to-face meetings it is very likely the participation will suffer.

Building Trust and Organizing Discussions

A course delivery platform such as Teachscape's offers the possibility of having both local at the school district level, and/or public, at the project level, discussions; this depends on the virtual space that is used for the interaction. Participation of teachers in online discussions—posting at the different interaction spaces—seems to be related with to comfortable teachers feel expressing their ideas in writing for a virtual space and before a distributed audience as well as with how well organized the discussion is.

Facilitators did many things to build trust, with different results. SD1 facilitator decided to offer her last course at her school district private space and spent three weeks building community while teachers were acquainted with technology. It worked out but the interaction was limited to the school district participants. SD2 facilitator used both private and public spaces in all of her courses, but she changed the organization of discussions from one to another course. At the beginning of the pilot experience she used both spaces to keep mathematical and social discussions, differentiated by the scope of the discussion (local issues at the local space, global ones at the public space). At the end of the pilot she used the private space during the first and the last week of the course, since both discussions were around local practices that initially served to dive into the case, and at the end to build knowledge based on final projects. Discussions during intermediate weeks of the course were held at the public space and nurtured the local group with participation from other school districts. SD4 was not able to motivate their teachers to post online, regardless of the fact that they were following the public discussion and commenting in private with the facilitator. "When I questioned a couple of teachers they expressed a strong inhibition about posting things 'where anyone can read'. They seemed to feel that they would embarrass themselves with their postings… People are reading what is posted at Teachscape's discussion area, but they are not posting. Should I consider 'lurking' as participation?"

Building trust and organizing online discussion spaces are strategic CSF. If a building trust strategy is implemented paired with the corresponding organization of online discussion spaces, this may help teachers feel comfortable posting at the local and distributed discussion spaces. Not doing so may make online interaction almost impossible.

Giving Support to Communities of Learners

A community of learners is healthy when its members feel comfortable and participate actively in the different discussion spaces. We realized that beyond building trust facilitators made a difference by monitoring indicators of participation (onsite and online contributions) and by giving support to teachers when the level of participation was lower than expected. "Facilitators need to address individual teacher needs and concerns through additional assistance via e-mail, telephone, or personal contact. Teachers need to know that if they need help, it's available" [SD2]. "Supporting teachers who participate by encouraging them to post online and to contribute to the face-to-face discussions will increase the success of the project. A lack of communication between the facilitator and the participants will contribute to the lack of success" [SD3].

Monitoring participation indicators and giving support to learners when needed is a strategic CSF. This nearness to participating teachers from the part of the facilitator makes a difference.

CSF Related to Learning Gains Attributable to Participation in Multimedia Case-based TPD

A process in cascade such as the implementation of SM in participating school districts (the project trains facilitators, they train teachers, teachers teach students), needs to ensure that key actors—facilitators and teachers—are properly prepared to assume their role. In this sense, the continuing preparation of facilitators and the creation of communities of practices became CSF.

Continuing Preparation of Facilitators

The project offered facilitators two initial seminars, one face-to-face and one online, in order to help them feel comfortable with the multimedia cases produced by the project and with the inquiry-based pedagogy behind them. Through the process we realized that periodic feedback and support on demand made a qualitative difference.

After we found out that grounded discussions were almost absent from initial online dialogues, facilitators and staff members of the project realized that the initial training had missed this topic. SD2 facilitator said "it would have been helpful to have had a discussion at the winter meeting about the level of discussion you were anticipating or "aiming" for. As facilitators, we could have framed questions to support and encourage dialog around connecting specifics of the case with classroom practice." The topic was discussed in an online forum with facilitators and grounded discussions became the focus of two publications that have served for future work with facilitators (Galvis & Nemirovsky 2003; Nemirovsky & Galvis, 2003). This helped posting discussion seeds that invited to relate case content with classroom practices.

Facilitators felt the need of having additional support moderating online discussions. The project had given them an initiation to online facilitation and a reference book , but some facilitators felt it was not enough, that discussions were not always threaded, that collaborative building of knowledge demanded special moderation skills, and that inquiry-based knowledge construction required more than creating good discussion seeds. SD2 facilitator requested coaching from an experienced facilitator from Concord Consortium; in response, during one semester the coach had access to the content of the discussion and to postings to be proposed by the moderator. A closed dialogue between the facilitation coach and SD2 facilitator helped SD2 facilitator master moderation of online discussions, as it is evident in the data. Based on this positive experience the project has incorporated coaching to new facilitators during the first course they offer on the part of an expert in online moderation.

Periodic face-to-face meetings with facilitators (one per semester) served a very important function concerning building knowledge based on lessons learned. In each of these meetings onsite facilitators shared their experiences, challenges and solutions; project staff members had the opportunity to understand emerging situations and to coordinate support activities from different perspectives, including technology, pedagogy and logistic.

Continuing preparation of facilitators is a strategic CSF. It allows facilitators to lead with appropriate preparation those functions that make a difference. When this kind of ongoing support is not possible, needs felt by facilitators remain unattended and the quality of the process suffers.

Creation of Communities of Practice

Looking at postings type "H" (remarks related to changes in teaching practices) in tables 8, 10, and 12 we note that in a school year in the same school district, through SM courses offered by the same facilitator, the percentage of H-type academic postings (type A..H) raised from 2.41% (SD2-Division with remainders, Fall 2002) to 7.43% (SD2-Division with remainders, early Spring 2003) and to 9.91% (SD2-Fractions, late Spring 2003). Differences between the last two percentages could be attributed to participation of SM-experienced teachers (i.e., 8 out of 20 teachers had taken Division with Remainders), but near 5% of growth cannot be attributed to this cause. It was a result from the active work of the SD2 facilitator for creating communities of practice, in which teachers become share and reflect on their teaching experiences, and feel comfortable sharing what happens in their classroom In the excerpts selected for this article it is evident how teachers changed their mind and their practices because of the participation in SM courses. They felt comfortable trying in their classroom what they found valuable in the teaching cases, they acutely reflected on their own practices and opened to dialogue with colleagues.

The creation of communities practice is a strategic CSF. Including creation of communities of practices in the intention and strategy of SM courses help making difference in terms of teacher changes; leaving them out of the academic agenda may result in very low application of ideas and reflection.

CSF Related to TPD by Means of Teacher-created Video Cases

Reviewing the two cycles of TPD at SD3, where teacher-created video cases were the focus of the TPD experience, we realize that two CSF were evident: readiness to technology and building community of practice.

Readiness to Technology

One of the great differences between the first and the second generation of teacher-created video cases was the effort needed on the part of teachers to create multimedia cases. In the first round staff members from the project dealt with the technology aspects while the participating teacher and her coach—SD3 facilitator—worked collaboratively reflecting on her video-taped classroom experiences creating the story and documentation to build the case. Both teacher and SD3 facilitator found this worth doing. In the second round, the project asked participating teachers and facilitator to appropriate VPB2 and to assume also the technical production of video cases. Technology was a hurdle that required support from the part of the project and a lot of effort from participant teachers and SD3 facilitator. Teachers found that VPB2 was an excellent tool for creating a story that synchronizes video, hypertexts and still images, but was not powerful enough for editing the ingredients using a single tool (videos, hypertexts and images need to be prepared with separate tools in VPB2); and teachers struggled with these multiple tools. As a consequence two actions were taken: VPB3 is in design, with increased functions that will make easier for teachers to create video cases, and SD2, the other group producing video cases in SM, has integrated tech support members to the production of video case.

Readiness to technology on the part of teachers to create video cases is an operational factor. If teachers know how to use the different technologies needed to create a video case, building video cases is less difficult and problematic. But the quality of the video cases does not depend on the technology in use but on the reflective practice generated by their creators.

Working as a Community of Practice

Three teachers, SD3 facilitator and SD3 math coordinator met periodically to work as a group in the creation of video cases. Working as a group did not mean, however, that participants became a community of practice. The two teachers that completed their video cases felt very isolated in the creation process—it became their personal effort—While group meetings were useful for coordinating ideas, solving problems, and getting feedback; group meetings were not occasions to collectively reflect on their teaching practices and to collaboratively build knowledge from it. This lead teachers to assume the creation process as a personal endeavor. Teachers grew professionally, but the effort on their part was enormous.

Working as a community of practice in the creation of video cases becomes a strategic CSF. If it is present it leads to collaborative creations, if not, to individual creations. Both types of creations are important, but a culture of collaboration makes a difference when teachers use inquiry-based collaborative approach. In the words of SD2 facilitator "districts need to have fostered a value and appreciation for collaborative teacher work environments" [SD2].

CSF Related to Expansion of Multimedia Case-based TPD at the School District Level

A district philosophy and Professional Development plan that emphasizes sustained, on-going teacher learning is key [SD2].

The literature on innovations says that "a successful pilot experience does not ensure by itself a successful institutionalized experience" (Sherry, 2002). In order to survive beyond the limits of a parent project, innovations need to create the means for their autonomous expansion. In our experience school districts have explored three innovative directions:

- Some school districts have expanded their facilitation group with teacher leaders that help with video case-based TPD. Otherwise, it would not possible to scale-up the program. This was the case of SD2, where they created a parallel community of learners, with math teacher leaders from each school building, that explored the value of different ideas behind the nine cases and used selected video examples to help their math teachers with the discussion of specific events. This generates culture of case discussion among teachers. Two of these teacher leaders took two cases and participated in the next facilitators' training, so SD2 is able now to offer more than one course in parallel.
- A similar phenomenon happened in SD3 concerning the use of classroom videotapes as source for reflection. The math coordinator joined the group that was creating video cases, and math teacher leaders from the different school buildings were invited to presentations about the process and product of the first round. As a result the school district expanded its videotaping capacity and acquired more computers where video editing could be done, as a means of inviting math teachers to become members of communities of practice.
- SD2 has matched a project focused on helping students with math projects, in which teachers videotape every intervention, with the creation of video cases. This synergy helps motivating teachers who see video-based reflections as a normal part of their teaching and video case creation as a value added to it.

Final Remarks

The preparation of this article has been a way of understanding key issues are behind the implementation of an educational innovation such as Seeing Math multimedia cases. In essence, it is not the innovation by itself that makes the difference, but the way CSF that affect different stages of the innovation process are taken into consideration. Seeing Math multimedia cases are resources that can make a difference helping teachers reflect on other teachers' and on their own practices; however, each math TPD leader in each school district needs to figure out how to create the appropriate conditions for successful implementation. Our findings need to be adapted to the local context and the TPD strategy that each school district has in place. Building on the synergies and on the differences between existing TPD practices and what SM resources offer may generate new avenues of TPD worth exploring.

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Appendix 1: Context for the Study

In order to understand the findings of this study it is important to know the context in which the pilot experience was conducted. Four school districts, from different parts of the USA and with very different characteristics, took part in the pilot implementation of multimedia case-based TPD programs created by the Seeing Math Telecommunication Project.

The Seeing Math Project and its Pilot Implementation Sites

The Seeing Math Telecommunications project invited school districts because of their commitment "to making the kind of sustained and coordinated implementation of Seeing Math that is likely to make a significant impact on teacher practice and student learning" (Concord Consortium, 2000, p.14). Twenty school districts from fifteen states accepted the invitation to participate in the project when the initial proposal was submitted to the US Department of Education. The award announcement (US Department of Education, 2000) mentioned, "the key innovation in *Seeing Math* will be 10 highly interactive on-line digital video case studies, which will provide math teaching models that have proven to be highly effective in improving teaching techniques. The case studies can be linked to lesson plans, students' work, standards and assessments, teacher reflection, and on-line discussion groups." The grant announcement ensured resources for the first year and left open possibilities of continuing funding over five years, depending on availability of resources at the Telecommunications Mathematics Demonstration Project in the Education Department's Office of Educational Research and Improvement. Doubts about resources after the first year created uncertainty about the life span of the project.

Once funded, the Seeing Math project invited the original 20 pilot sites to participate. Concord Consortium—the case creator and research organization—and Teachscape—our partner for case building and delivery—offered free access to multimedia cases developed by the project and the corresponding training and online support. Each school district was supposed to assume the costs of a math coordinator or a math staff developer to lead these courses and of computers to be used during the pilot

Eight school districts were interested in the first pilot implementation of Seeing Math,. These school districts answered to the project invitation, either asking for more information or submitting signed letters of agreement. One school district declined because of financial constraints, another because of the lack of technological readiness; another declining school district indicated that the math curriculum they were using was not coherent with SM approach and they could not afford changing the curriculum. One of the accepting school districts asked for more information about the foundations and pedagogy behind the project to verify that SM pedagogy and their curricula were compatible with theirs.

The four school districts that confirmed their participation shared interest in reformed math education and the use of video case-based teacher professional development in the hope of helping students to achieve higher understanding of math and better math standardized test scores. All of them designated a local project coordinator, in charge of planning, facilitating and assessing the value of multimedia case-based TPD courses and had networked computers in their school buildings. On the other hand, the school districts differed greatly in size and complexity (large city, medium size city, small size city, and a union of small towns), differences that were related to each school district demographics and educational community needs. There were also differences in math curricula as well as in math TPD strategies.

Setting Up the Stage

Once the first set of four video cases created by Seeing Math were ready to use, the project invited the four math staff developers designated by the school districts to an implementation-planning meeting. In this meeting the developers shared ideas behind the project and participants shared major characteristics and issues in each of the participating school districts. Mathematics staff developers became onsite local facilitators for the project, leading groups of elementary and middle school teachers in video case-based teacher professional development experiences.

The expected life span of this first pilot experience was 1.5 years: the second half of school year 2001-02 and the school year 2002-03. The first two activities included training the local facilitators and creating the appropriate conditions for Seeing Math implementation at each site.

Training District Facilitators

A three-days face-to-face meeting served to introduce Seeing Math districts' facilitators to the resources and strategies of project. In depth exploration of the technology available behind the cases (Teachscape´s course delivery platform Vers. 1.0) allowed facilitators to understand the tools that they would have for offering courses. An overview of each of the existing four cases and heir corresponding facilitator's guides gave facilitators a first glance of the pedagogy and math content behind each of the cases.

Participating district facilitators took part during the next six weeks in an online course devoted to reflect and discuss about online facilitation of multimedia case-based teacher professional development. District facilitators had the opportunity to use at their own rhythm but within given time frames, the different resources that the Seeing Math multimedia cases included. Each one of the four video cases was an object of discussion. Facilitator's guides for each of the video cases served the purpose of articulating concepts and strategies facilitators would consider when they offered a course using the video case.

Creating the Conditions for the First SM Course Offering

School district facilitators decided that "Number and operations: Division with Remainders" was a good opening course because it had an important pedagogic component—questioning strategies—and its content dealt with a challenging idea for many elementary teachers. They decided to collaboratively offer this course to small groups of teachers from the different school districts. They created a blended—online and onsite—interaction format in which online discussions were going to happen in a shared virtual space, asynchronously, following a unique calendar, while onsite discussion were going to be synchronous and at each group's convenience concerning time and place. Each district facilitator decided whether the course would be offered for credits, for seat hours with monetary incentives, or just under a voluntary basis. Technology readiness was verified with Teachscape's support before the course started.

Participating School Districts

Participating school districts are a crucial contextual component for this study. The SM project does not tell the school districts how to use the resources available from the project. Each school district has to define how to benefit from the project, taking into consideration its local vision and strategy for math education and mathematics TPD. As a consequence, local conditions largely determine what the SM seeks and how it intends to achieve it. The following numerals will

provide a comprehensive view of the four school districts that decided to participate. We will mention them as SD1, SD2, SD3 and SD4.

School District 1 (SD1).

For the purposes of this study we will refer an urban school district that has more than 100 elementary school buildings where more than 42,000 pk-6 students are prepared, as "SD1." Documents provided by the district's facilitator allow us to synthesize the following major characteristics.

- SD1 is a standards-based system, in which standards have been set for teacher performance, principal performance and student performance.
- The school district has a comprehensive math TPD whose goal is to provide teachers with the direction and assistance needed to implement instruction that develops student's mathematical confidence and competence. At the beginning of the SM project SD1's math TPD plan included face-to-face meetings for orientation, for textbook training, for standards review and for innovation follow up. Teachers at SD1 must earn at least 15 seat hours each year in professional development.
- There are nine "transformed" elementary schools whose goal is to establish demonstration and professional development sites that provide exemplars of what mathematics instruction looks like.
- The math coordinator selected as the pilot site one of the transformed elementary schools. The school building change facilitator, a math specialist with experience teaching math and facilitating professional development, was designated by the school district math coordinator as the SM facilitator.
- The initial school district math coordinator was very enthusiastic and supportive of the idea of doing video case-based TPD. Upon her retirement (six months after the pilot implementation started) the new school district math coordinator did not oppose nor support the initiative. In this way, SM became a matter of the SM facilitator.
- When the time came to expand the project beyond the school building in which SM started, the teacher union at SD1 gave support to the SM facilitator for offering a course to interested teachers.

School District 2 (SD2)

SD2 is a suburban school district where sixteen elementary schools feed into six middle schools. Nearly 450 elementary teachers teach approximately 6000 K-5 students, and nearly 280 teachers prepare approximately 3000 6^{th} and 7^{th} graders. Two thirds of the staff is certified and the rest is classified staff. Based on reports from the local coordinator as well as from data taken from the SD2 web site, the following are SD2 major characteristics:

- SD2 has defined academic standards that promote student mastery of an essential core of knowledge, with emphasis on problem solving skills, acquisition of excellent communication skills, development of vocational and employment skills. Mathematics instruction in SD2 is guided by the corresponding State Content Standards.

- At the beginning of the SM pilot experience SD2 was in a curriculum adoption cycle and revising its district curriculum to provide clarification of state standards. SD2 started piloting math materials in the 2002-2003 school year.
- The SD2 Math Staff Development plan was in its first year of implementation when the SM pilot started. A K-5 math coordinator and trainer, in charge of sustained staff development in mathematics, assumed the district coordination for SM.
- SD2 has developed Math Teacher Leaders for each elementary building to provide additional communication and support as well as demonstration classrooms, lesson study groups, and training videos. Capacity building is a real challenge since there is only one math staff developer and nearly 450 elementary teachers.
- Professional development opportunities in SD2 include: grade level discussion groups, committee work, graduate level classes, and short and long-term workshops. The SM project is one of the opportunities offered to math teachers.

School District 3 (SD3)

SD3 is a small suburban school district having four elementary schools and one middle school. Approximately 1500 students learn with facilitation from 350 elementary school teachers, and around 700 middle school students learn with the support of around 60 teachers. Based on reports from the local coordinator as well as from data taken from the SD3 web site, the following are SD3 major characteristics:

- The state educational framework guides instruction throughout the SD3 Public Schools. The mathematics programs that are in place at the elementary and middle school level are closely aligned with the state frameworks documents.
- At the beginning of the SM program there were several math TPD initiatives at the school district, all of them about mastering the art of teaching. Many teachers were already engaged in inquiry-based math or science innovations. All kind of formats were in use at SD3 for offering Math TPD.
- The K-8 Math Staff Developer became the local contact and facilitator of the SM project. He has full support from the SD3 math coordinator. He works to provide a variety of math TPD experiences through workshops and team meetings. He leads a community of reflective practice and does math peer coaching with individual teachers. He also provides support and orientation to math teacher leaders at the different school buildings.

School District 4 (SD4)

SD4 is a supervisory union that has nine school boards representing eight towns, each with its own elementary school, and a joint board for middle and high schools that serve the region. The central office of the supervisory union is a persuasive body rather than an executive body, since each local education board keeps control of most of the decisions.

- SD4 has a student population of over 1,200 K-12 students. All of the schools are rural. All but the high school and the middle school have 100 students or less. The classes in SD4 elementary schools are small, frequently multiage, and deeply rooted in the community. Each town has its own school, its own school board, and a budget that must be approved by all town voters at an

annual town meeting. The school must be in tune with the town it serves or voters will not support the budget.

- Within SD4 there are three math programs in place. All three have similar goals (and similar pedagogy) but slightly different emphasis. This obeys to local control of educational decisions, which is common in rural areas.
- When SM started there were three ongoing math TPD initiatives in place. One of them was focused on improving teachers' mathematical knowledge, the other on inquiry-based teaching and the third of remedial math pedagogy. SM became part of this portfolio.
- At the beginning of each school year there are three TPD half-days to provide a menu of TPD choices to teachers from which they can choose for the remaining three half-days during the year.
- The SD4 mathematics curriculum coordinator provides individual in-class support for teachers at all eight elementary schools. This support includes providing demonstration lessons, problem solving resources for teachers, and instructional mentoring. He became the local facilitator for SM.

Footnotes

1 The *Seeing Math Telecommunications Project* is funded by a grant from the United States Department of Education to Concord Consortium, #R286A00006. The project creates multimedia math teacher professional development case studies and explores the impact they may have on math teaching practices and student learning.

2 See, for example, http://teachscape.com or http://www.riverdeep.net/pro_development/index.jhtml or http://www.intel.com/education

3 See previews and short explanation of the nice cases at http://seeingmath.concord.org/screenroom/

4 Go to the VideoPaper Builder site at http://vpb.concord.org

5 To know about Teachscape go to http://teachscape.com