Professional Development and Teacher Change: A Longitudinal Investigation of Teacher Generative Growth

Chrystalla Mouza
301D Willard Hall, School of Education, University of Delaware, Newark, DE 19716
Tel: 302.831.3108, Fax: 302.831.4100
Email: cmouza@udel.edu

Abstract: The purpose of this study is to investigate teacher generative growth as a result of participation in a research-based professional development program on the use of technology. Specifically, the study investigates the ways in which teachers integrated and extended the key facets of the program two years after its completion with particular emphasis on a) individual teacher characteristics, b) school contextual factors, and c) key components of professional development. The paper focuses on the elements of success in longitudinal technology integration, rather than on the inhibitors to such technology adoption. Therefore, while the investigation draws on case study research of eight teachers, the center of attention remains on the one exemplary teacher who exhibited the maximum characteristics of long-term professional growth. Results indicate that participation in professional development fostered increased technological knowledge and awareness, sustained use of technology integration into classroom instruction, and generation of more elaborate beliefs on the role of technology in teaching and learning. Finally, key findings from this study are incorporated into a framework for articulating teacher generative change.

Introduction

Nearly every educational reform initiative that seeks to improve student learning is accompanied by teacher professional development efforts. Professional development is a key ingredient for both teacher growth and organizational school change (Fullan, 1991). Both of these elements are considered necessary for true educational reform to occur. Yet, it is now widely recognized that many professional development experiences available to teachers are ineffective and fail to promote self sustaining learning (Garet, Porter, Desimone, Birman & Yoon, 2001). Most in-service activities for teachers are still short-term experiences disconnected from issues of practice, fragmented, and misaligned (Ball & Cohen, 1999). Such approaches to professional development fail to recognize the necessity for coherent, on-going teacher learning and, therefore, are not very useful in helping us understand the process by which teachers learn and grow professionally (Wilson & Berne, 1999). Only recently have we started witnessing the development of some quality professional development programs that are research-based and pay explicit attention to both teacher change and student learning outcome (e.g. Fishman, Marx, Best, & Tal, 2003). As a result, carefully constructed theories of teacher change have slowly begun to emerge in the literature.

Earlier professional development programs attempted to modify teacher beliefs and attitudes hoping that such modifications will lead to changes in classroom practices and ultimately to student learning outcome (Richardson, Anders, Tidwell, & Lloyed, 1991). This perspective to professional development assumed that teachers change their beliefs and attitudes prior to changing their practices. Guskey (1986) challenged this view of change and claimed that changes in beliefs and attitudes follow changes in practice. Changes in practice allow teachers to witness positive effects on students and modify their beliefs accordingly. More contemporary theories of teacher change recognize that teacher knowledge, beliefs and attitudes are formed interactively with classroom practices (Richardson, 1996; Clarke & Hollingsworth, 2002). A recent model of teacher change, proposed by Clarke and Hollingsworth (2002), suggests that change occurs through the mediating processes of reflection and enactment in four domains: the personal domain (teacher knowledge, beliefs and attitudes), the domain of practice (professional experimentation), the domain of consequence (salient outcomes), and the external domain (sources of information, stimulus or support). Change can begin in any of the four domains and it produces changes in other domains. Therefore, there are different entry points and multiple growth pathways between domains.

In attempting to capture teacher change as a result of participation in professional development, it is also important to make a distinction between short-term change and long-term generative change (Franke, Carpenter, Levi, & Fennema, 2001). It is not uncommon for teachers to employ newly acquired teaching strategies demonstrated at professional development. Yet, many teachers return back to their old strategies when the professional development program ends. Even if teachers continue to use the new strategies, few of them seek to explore additional strategies that would help them further refine their practice. In their research, Franke et al. (2001) documented the ways in which teachers who participated in a professional development program on understanding the development of students' mathematical thinking continued to implement the principles of the program four years after its ending. Findings revealed that all teachers sustained into their classroom instruction some elements of teaching which were based on the children's thinking process. However, only half of the teachers continued to learn and engage in generative growth.

The purpose of this study is to investigate teacher generative growth as a result of participation in a research-based professional development program on the use of technology. Specifically, this study seeks to a) describe the ways in which teachers integrated and extended the features of the program two years after its completion, b) identify individual and organizational attributes that enabled or inhibited teacher self-sustaining change, and c) identify key components of the program that facilitated teacher change. The paper focuses on the elements of success in longitudinal technology integration, rather than on the inhibitors to such technology adoption. Therefore, while the investigation draws on case study research of eight teachers, the center of attention remains on the one exemplary teacher who exhibited the maximum characteristics of long-term professional growth.

Context and Methods
Description of the Professional Development Program
The professional development program employed in this study was designed by the Institute for Learning Technologies (ILT) at Teachers College, Columbia University. This program was part of the *Eiffel* Project, a five-year Technology Innovation Challenge Grant Project. The purpose of the Eiffel Project was to infuse technology in New York City public schools and prepare teachers to make effective use of digital resources in their classrooms. During the five-year life cycle of the Project, the ILT staff designed several professional development programs for teachers. The programs designed during the last year of the Eiffel Project, however, were considered the most comprehensive for two reasons. First, they built on rich experiences acquired by the ILT staff over time. Second, they explicitly took into account the characteristics of effective professional development reported in the literature (i.e. sufficient time, collaboration, follow up support etc.) along with current constructivist principles of learning.

The ILT professional development program that served as the basis of this investigation was a year long program that operated during 2000-2001. This program consisted of three primary components: a) introductory workshops that emphasized skill development followed by discussion on issues of technology integration, b) advanced workshops that focused on project development, and c) in-classroom support. All workshops were two hours long and took place at the ILT facilities. Since none of the participants had prior experience with computer-based instruction, the initial objective was to help teachers become comfortable with technology and acquire an understanding of technology integration into classroom instruction. As teachers started using technology into their existing practices, professional development activities focused on helping them plan and enact more meaningful curriculum projects that afforded students opportunities for inquiry, collaboration, and critical thinking.

Participants
Even though this investigation follows a group of eight teachers over a three-year period, this paper focuses only on Mary, a fourth grade teacher who exhibited the maximum characteristics of long-term growth. When she enrolled in the ILT program, Mary was only in her second year of teaching. She had a background in English and a Masters degree in writing. Throughout the duration of the study, Mary had two computers available in her classroom that were loaded with productivity software, such as word processors, spreadsheets, authoring tools and painting programs. Both computers were connected to the Internet. In the third year, however, Mary was also selected to participate in a notebook program initiative. As a result, all of her students were distributed notebook computers. Although these computers were used

primarily within the classroom, students were also allowed to use them at home. The notebooks were refurbished and were loaded with Microsoft Office tools and some educational software that included Inspiration and TimeLiner. Mary's school was an under-resourced school located in a predominantly Hispanic neighborhood of New York City. At the time of this study, the school was serving about 1, 400 students with 93.6% being Hispanic. In addition, 95.6% of the students were eligible for free lunch indicating that almost all the students were from economically disadvantaged families.

Data Collection

Data for this study were collected from multiple sources over a period of three years (2000-2003). Data sources included: Surveys, interviews, workshop and classroom observations, collection of documents, and email exchanges. Surveys were used to assess teacher technological skills with regard to basic computer operations, use of productivity software, and use of the Internet. The surveys compared teacher skills both prior and after the ILT professional development. Interviews captured teacher technological awareness, practices and beliefs with regard to technology at different points in time. They also identified the school organizational structures and key professional development elements that enabled teacher learning. All interviews were approximately 45 minutes long. Workshop observations generated data related to the content and pedagogy of professional development. They also documented teacher questions, concerns, interactions, and technological progress during the course of professional development. Classroom observations elicited data related to teacher overall teaching style and use of technology over time (e.g. frequency, types of activities etc.). Some classroom observations were video-taped in order to document the ways in which technology activities were structured and the role of the teacher and the students on the use of technology. Each classroom observation was followed by a 5-10 minute debriefing session to ensure that the researcher understood the purpose and context of the activities performed. Systematic examination of teacher lesson plans and student work was used to corroborate evidence from other sources (Yin, 1984). Finally, email exchanges between Mary and the investigator provided information on curriculum units enacted and obstacles and successes encountered by the teacher. Table 1 provides a summary of data collected from Mary over the three year period:

Table 1: Summary of data collected from Mary over a three-year period

	Year 1	Year 2	Year 3
Number of surveys	3	1	1
Number of interviews	3	1	1
Number of workshop observations	21 (42 hours)	-	-
Number of classroom observations	7 (12 hours)	2 (4 hours)	6 (10 hours)
Number of email exchanges	10	5	19

Data Analysis

Field notes from workshop and classroom observations were transcribed and reviewed. Audio-taped interview data were also transcribed and reviewed. Analysis was ongoing throughout the study and each phase of data collection was shaped by prior data. A preliminary coding scheme was developed after analyzing data from three individual teachers collected in the first year of this study. The coding scheme was developed through various iterations, and included the following categories: a) changes in teacher knowledge, b) changes in teacher beliefs, c) changes in teacher practice, d) process and timing of change, e) elements of the school context that facilitate teacher change, and f) key elements of professional development that influence teacher learning. The final iteration of the coding scheme was applied in all data and a data analysis matrix was developed that displayed teacher knowledge, practices, and beliefs as they emerged over time. Other data analysis matrices displayed data relevant to the school context and effective elements of professional development. In assessing whether individual change had occurred, the teacher display matrix was thoroughly analyzed and comparisons were made across the five sets of interviews over the three-year period. Change was acknowledged when Mary appeared to have modified her initial practices and beliefs in light of a new set of learned beliefs and practices that resulted from the acquisition of new knowledge. Data from other sources were then used to triangulate interview data and confirm change.

Findings

Teacher Knowledge

When Mary started participating in the ILT program in the fall of 2000, she had very limited familiarity with technology. Even basic computer operations such as file management presented a challenge to her. She was only comfortable with word processing software and use of email. During her participation in the ILT program Mary became more comfortable with basic technology skills and learned how to use a variety of software tools (e.g. PowerPoint, MS Word, Internet Browsers etc.) and computer peripherals (e.g. scanner). The acquisition of such skills was an important accomplishment because it helped Mary build confidence in her ability to use technology in the classroom. As shown in Figure 1, Mary was able to retain and build on her skills over the three-year period of this study. In addition to the technological skills shown in Figure 1, Mary learned how to use a variety of other software tools not introduced during the ILT program, such as MS Excel, MS FrontPage, MS Publisher etc. She also learned how to troubleshoot equipment, search the web effectively and produce video on the web.
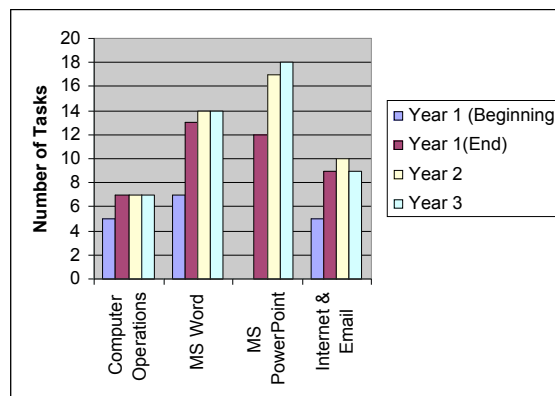

Figure 1: Mary's technological competence: Number of successful tasks completed by function over time

Mary did not only become more technologically savvy but she also became increasingly aware of the ways in which technology can be integrated into the classroom in order to enrich student understanding. During her second year interview Mary explained:

> I have realized over time that there is a plethora of tasks I can do with technology. Prior to participating in the ILT program I was just using technology for word processing and minor research tasks. Now I use technology in practically every project I initiate in class. As I develop my lesson plans, I always come up with activities that integrate technology, such as creating multimedia presentations, using Excel to collect and analyze data, developing flowcharts in Inspiration, etc.

Teacher Practices

Year 1

Prior to participating in the ILT program, Mary's students had mainly used computers for typing essays and poems and conducting some research on the Internet. During the year in which she participated in the ILT program, Mary initiated two technology-enriched units. The first unit was related to science and ran throughout the entire school year. The science project focused on acid rain and was divided into three phases. In the first phase, students worked in groups and performed research on the Internet on various aspects of acid rain. Research findings were culminated in multimedia presentations that were featured in class. In the second phase, students conducted experiments to determine whether the soil in their schoolyard had been polluted by acid rain. In the last phase, students graphed and analyzed the results of their experiments using spreadsheets. The second unit initiated by Mary was related to language arts and aimed at teaching an audience of fourth graders about various poetic elements. Students worked independently and in small groups, wrote definitions, drew and scanned pictures to illustrate their lessons, and inserted sound files taken from reading their own poetry. The final product resulted in a slideshow presentation that was featured to fourth graders during a poetry day celebration in the school auditorium.

<u>Years 2 & 3</u>

Mary re-enacted the science project on acid rain both during the second and third year. During the last stage of the project, students were asked to compare their results with data collected in Mary's class during the previous year (in the third year, students compared their results with data collected during the prior two years). This comparison led to new insights about pollution in the area. The acid rain project was highlighted at the district science fair where Mary's students presented their work accompanied by excel graphs and charts. After interviewing Mary's students the review committee was extremely impressed with the level of understanding that students exhibited and their enhanced abilities for data manipulation and graphing. Moreover, the committee highlighted the seamless integration of science and technology. Mary's project received a "superior" grading and her students were awarded a medal. The science project on acid rain is just one example that illustrates the kind of technology units enacted in Mary's class. Similar projects that included long-term investigations or tasks sustained over an extended period of time were also undertaken in other content areas. Essentially, every project that she launched was enhanced by technology. In social studies for example, students studied the Revolutionary War by creating electronic newsletters on various revolutionary events (e.g. the Boston tea party) and developing an *interactive timeline* that featured the major battles of the revolution. The following example described by Mary, illustrates another exemplary unit enacted during the third year of this study that integrated technology in mathematics and language arts:

> Every activity in this unit was related to Judith Viorst's, "Alexander, Who Used to Be Rich Last Sunday." This is a story of a boy who kept spending his allowance money unwisely. We first started by reading aloud "Alexander, Who Used to Be Rich Last Sunday". Students kept track of how much money Alexander was losing. They created flowcharts in Inspiration showing how much money Alexander lost and what exactly he lost it on. In the next step, students wrote their own fictional stories modeled after Alexander's. Their stories were accompanied by an Excel spreadsheet that demonstrated the starting amount of money, the items money was spent on, and the remaining amount. The remaining amount was calculated automatically after students figured out the formula they had to enter in Excel.

Not only did Mary make technology an integral part of her instruction, but she also took initiative to lead various technology activities outside the classroom. Along with another colleague who had also participated in the ILT program, Mary launched an after-school computer club for selected students. Teachers and students worked on the development of a school web-based newsletter. They also received additional training from a non-profit organization in New York City. This training became possible through a small grant awarded to Mary for writing a successful proposal through an organization called *Donors Choose* (http://www.donorschoose.org). Technology also facilitated other qualitative changes in Mary's teaching. In the two years after participating in professional development, Mary initiated more project-based work and more cooperative group work. Her role in the classroom shifted in many occasions to that of an on-site guide. More importantly, she felt comfortable with that role. Peer teaching became a routine in Mary's classroom as she often relied on her students to provide help to each other particularly during the third year when all students had notebook computers. Finally, Mary developed a variety of classroom management techniques that allowed her to run a technology rich environment smoothly, something that many teachers struggle with.

Teacher Beliefs

Since Mary was a novice computer user, her initial beliefs were primarily based on a combination of intuition, experience with technology for personal purposes, and idealistic images of how technology can enrich her lessons. Participation in professional development enabled Mary to re-examine her beliefs with regard to the role of technology in teaching and learning. Table 2 summarizes Mary's beliefs over time. In some cases (e.g. advantages from using technology), Mary merely integrated new beliefs into existing ones. In other cases, however, Mary was able to modify her initial beliefs in light of a new set of learned beliefs (e.g. role of technology in education). At the beginning of her participation in the ILT program, for example, Mary thought that the primary role of technology was to help students build their technological skills, something that is widely valued in society. In subsequent interviews, however, Mary exhibited a new set of beliefs. She stated that the primary role of technology is to facilitate and enhance student learning. At the end of the first year she commented:

> I think computers play a huge role in education. Prior to participating in the ILT program, I did not really think that they were really necessary. Now I strongly believe that they enhance the learning process to a great extent. Computers are truly a valuable asset in the classroom.

During her third year interview she added:

> I read some articles and I talked with some people who say that technology is not really important because it does not raise test scores. But from my perspective, not only did it raise my student scores, but it also helped them make significant improvements in other areas. I know that everybody mentions how technology motivates students. I am also a firm believer. But I think it goes so much beyond that. It really facilitates learning in very constructive ways.

Table 2: Summary of Mary's beliefs

	Year 1 (beginning)	Year 1 (End)	Year 2	Year 3
Primary role of technology in education	1) Fosters skill development 2) Prepares students for the workplace	1) Enhances student learning and understanding 2) Fosters skill development	1) Enhances student learning and understanding	1) Enhances student learning and understanding
Advantages from using technology	1) Motivates students 2) Enhances student writing	1) Motivates students 2) Enhances student writing & learning 3) Facilitates peer teaching & sharing 4) Improves student self efficacy	1) Motivates students 2) Enhances student writing & learning 3) Facilitates peer teaching & sharing 4) Improves student self efficacy	1) Motivates students 2) Enhances student writing & learning 3) Facilitates peer teaching & sharing 4) Improves student self efficacy
Disadvantages from using technology	1) Students lack typing skills 2) Classroom becomes chaotic 3) Computer failure issues	1) Computer failure issues	1) Computer failure issues	1) Computer failure issues

Individual and Organizational Variables Influencing Change

Individual and organizational variables not only shape teacher practice but also influence the outcome of professional development. Mary was a highly motivated individual who exhibited willingness to learn new skills, improve her practice, and experiment with new ideas. Mary spent time on her own mastering new skills, redesigning her lesson plans to incorporate technology, and practicing new classroom management techniques. After the end of the ILT program, Mary sought support from her colleagues, joined the advisory board of an online publication for students, and even wrote a grant that allowed her to receive additional training on web publishing. Those were important activities that helped Mary extend her learning over time and refine her practice with regard to technology. Contrary to Mary, other teachers were only able to sustain or stabilize changes in their practice that resulted from their participation in professional development. Personal motivation and persistence were key qualities of Mary's individual characteristics that enabled her to overcome challenges associated with the use of technology. During the third year, for example, Mary experienced various difficulties as notebook computers continually malfunctioned and students kept complaining about them. Yet, Mary was able to overcome these challenging by seeking support from both within and outside the school and from the students themselves. Organizational school features were also vital in supporting Mary's change. Throughout the study, Mary made positive comments about the school context in which she was working. The school valued and encouraged her participation in professional development, publicly acknowledged her efforts to use technology, provided opportunities for sharing with other teachers, and tried to provide additional resources for her. This was particularly evident in the third year when Mary was selected by the school administration to participate in the notebook computer program initiative. Notebook computers themselves were also important in promoting advanced technology integration practices, peer-teaching and collaboration.
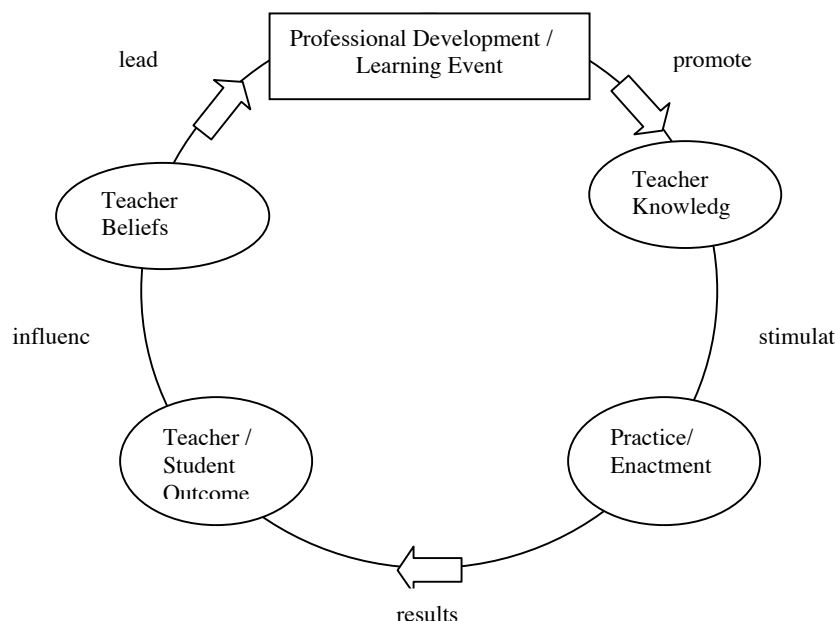
Figure 2: The teacher change process

Key Elements of Professional Development

During her interviews, Mary acknowledged multiple times that it was her participation in the ILT program that triggered her interest in technology and enabled her to learn and change over time. She noted, "If it wasn't for the ILT program, I would still be stuck in word processing." Table 3 displays comments made by Mary illustrating how she valued key elements of the ILT program.

Table 3: Key elements of professional development that enabled teacher learning

Professional development elements	Related comments made by Mary
Emphasis on skill development	I really liked that we started with the basics. Even though I had some skills, I was getting easily confused. I now feel much more comfortable with the computer and not just the word processing (Interview 2).
Models for classroom management	The classroom management techniques modeled at the workshops were really great. Now I know how to manage my class when I use technology. Before, I was thinking that there is no way I could use technology without loosing control of the class (Interview 2).
Development of curriculum projects	I really liked the fact that we had to develop our own projects because we focused on what *we* wanted to learn and what *we* needed to do in our class. At the same time the help and support was there and that made our projects become possible (Interview 3).
Follow up support	Having the graduate assistant in my class and being able to talk to her was wonderful. Just having somebody to talk to, write an email and ask things. That was the best aspect of the program (Interview 2).

Discussion and Conclusions

This study demonstrates that the ILT professional development program promoted long-term, generative changes in Mary's knowledge, practices and beliefs. Mary started implementing strategies that integrated technology during her participation in the ILT program. After the end of the program, Mary not only maintained the use of those strategies but she also developed additional strategies that leveraged the power of technology to enhance student learning. Even though four other teachers exhibited changes in their knowledge, practices and beliefs during their participation in the ILT program, they were unable to extend their learning over time on the basis of what they had learned. Of particular importance to this study was not only the extent to which teachers integrated and extended the features of the program two years after its completion, but also the process by which teachers modified their knowledge, beliefs and

practices. A preliminary framework depicted in Figure 2, demonstrates the process by which professional development enabled Mary to change her initial knowledge, practices and beliefs and continue grow professionally. As shown, participation in the ILT program fostered changes in Mary's knowledge (i.e. mastery of technological skills and technological awareness). New knowledge stimulated changes in Mary's practice. Mary experimented with integrating various forms of technologies (e.g. Internet, multimedia etc.) into her classroom. Experimentation with technology and reflection on newly acquired practices allowed Mary to witness positive outcomes for both the students and herself. She realized that students became more motivated, developed a deeper understanding of subject matter, worked cooperatively and showed more confidence in their abilities. She also realized that technology enabled her to become a more effective teacher while maintaining control of the classroom. These new insights influenced Mary's beliefs with regard to the role of technology in teaching and learning. Changes in beliefs led Mary to seek additional opportunities for learning that enabled her professional growth and change and the adoption of technology as an integral part of her instruction.

Previous attempts to describe teacher professional growth illustrated teacher change in a linear fashion (e.g. Guskey, 1986). Such linearity assumes that teacher change occurs as a one-shot event. Only Clarke and Hollingsworth (2002) portrayed the multiple interactions that exist among the various change elements. Yet, they did not adequately present change as a continuous, career-long process. Figure 2 portrays teacher change as a continuous process. Each full cycle exemplifies only one instance of change (e.g. adoption of one strategy that integrates technology). As Mary's case demonstrated, by going through multiple change cycles in the context of professional development or other learning event, teachers progressively modify their knowledge, practices and beliefs. Even though there seems to be a linear relation among the elements in the cycle, in reality, teachers can always go back to a previous change element. For instance, changes in teacher beliefs might trigger further changes in practice before the teacher solicits new learning opportunities. Further data analysis will compare Mary's case with findings from other teachers to enable the refinement of the framework depicted in Figure 2. Findings from this work have implications to the design of professional development programs. It is important that staff development instills learning in such ways that enable teachers to continually reconsider their knowledge, practices and beliefs.

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