Technology Use as a Catalyst for Change: A Leadership Framework for Transforming Urban Teacher Preparation

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A Leadership Framework for Transforming Urban Teacher Preparation

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Abstract

What research-based model can we develop for preparing tomorrow's teachers to use technology that is flexible to different New York urban contexts and to the needs of different teacher preparation institutions? This is the question guiding the three-year study of urban teacher

preparation in technology by the New York State Education Department, in collaboration with university-school district partnerships from four of the "big five" cities of New York State. In this report we present the results of the Catalyst Partners' grounded theory approach to building a learning organization and a systems change model for teacher preparation using technology as the catalyst for change in the state.

Introduction

"In the next decade, the United States will need over 2.2 million new teachers to fill the nation's classrooms—a rate of approximately 200,000 per year. Teachers of the new millennium will need a deep knowledge of their field, a thorough understanding of the learning process, a sincere commitment to nurturing a child's potential and a love of learning that is shared with their students. These attributes alone aren't enough for teachers to prepare their students to succeed in the Digital Age. Teachers must be comfortable with technology as a tool to engage students and enhance their learning. If new teachers are ill-equipped to use the instructional tools technology has made available, their professional education will be incomplete." (CEO Forum on Education & Technology, January 2000)

Faced with this challenge of preparing teachers to infuse technology into their instruction, the New York State Preparing Tomorrow's Teachers to Use Technology Catalyst partners asked the following overarching question: What research-based framework can we develop for preparing tomorrow's teachers to use technology that is flexible to different New York urban contexts and to the needs of different teacher preparation institutions? As we examined that question, sub-questions for the planned framework emerged: How can we use technology as the catalyst for change in urban teacher preparation? How can such a framework incorporate transformation of teacher preparation through collaboration among teacher preparation institutions, urban K-12 schools, and state education departments? How can we prepare teachers today for the urban classroom we envision for the 21st century?

These are the questions that are guiding the three-year study of urban teacher preparation in technology use by the New York State Education Department; The University at Buffalo, State University of New York; Teachers College, Columbia University; and Syracuse University.

The major purpose of this article is to discuss the first-year implementation of this three-year project funded by the U.S. Department of Education under its initiative for Preparing Tomorrow's Teachers to Use Technology (PT3). The general purpose of the PT3 Catalyst grants is to support national, regional, or state consortia with the expertise to provide leadership for large-scale teacher preparation improvements and systemic reforms. The goal of the New York State PT3 Catalyst grant is to develop a replicable, research-based framework for systems change that will institutionalize those "promising practices" identified in teacher preparation programs and to support a strong partnership among higher education institutions, urban K-12 schools, and the New York State Education Department. In the first phase of the project the partners have used a grounded theory method of developing a framework for improving urban teacher preparation programs. Ultimately this framework will inform policy-makers in New York State and technology outcomes for pre-service teacher education in the state.

In this article, we will provide background on the project, including (1) the grounded theory process of building a learning organization and a systems-change framework for teacher preparation with technology use as the catalyst for change; and (2) a summary of data reflecting the needs assessment of five "stakeholders"—pre-service teachers, early career in-service teachers in the "big five" cities of New York State, K-12 school administrators, college/university teacher preparation faculty, and New York State Education Department staff. Finally, we will provide the framework as it has been developed and tested thus far.

Overview of Framework-Building: A Grounded Theory Approach

Emerged in the process of the New York PT3 Catalyst research team meetings was a grounded theory approach to building the framework. Grounded theory (Glaser & Strauss, 1967) is a "general methodology for developing theory that is grounded in data systematically gathered and analyzed" (Strauss & Corbin, 1994, p. 273); it is a broad research method that allows for "much latitude," including theory generated from data and/or elaborating and modifying existing grounded theories through a constant comparative method among data sources (p. 273). Insofar as the developing PT3 Catalyst framework is grounded in multiple sources of data from the field in New York State and beyond—data collected and analyzed to generate a theory/framework about integrating technology into urban teacher education—the overall research method is based in the grounded theory tradition of qualitative research (Creswell, 1998).

Initially the research approach developed by the three universities involved both quantitative and qualitative methodologies. .. Our perspective was informed by our collaboration with the New York State Education Department, a former assistant superintendent of a large urban school, and the Evaluation Consortium at the University at Albany (SUNY).

In order to examine how diverse stakeholders perceive and react to integrating technology into higher education and school classrooms, the Catalyst research team collected interview and survey data; explored existing relevant research; developed and interrelated patterns of emerging themes; sought verification and disconfirmation of those patterns through expert panel reviews; and formed theoretical propositions that we then presented as a visual picture of the theory/framework. These propositions and the framework emerging from them have been periodically taken to the Advisory Group representing New York State stakeholders and to the PT3 Implementation Grantees to test face validity. There are 17 PT3 Implementation Grants in New York State. They encompass all regions of the state and cover all five of the Big Five urban cities of the state: New York City, Buffalo, Syracuse, Rochester, and Yonkers. They also touch upon smaller urban areas, urban/suburban areas, and rural areas. Throughout the development of this framework, we have continued to meet with and share our findings with these other grantees in the state and with national grantees at the PT3 conferences.

An overview of the research approaches used by the PT3 Catalyst team are outlined in Figure 1 and Table 1 below.

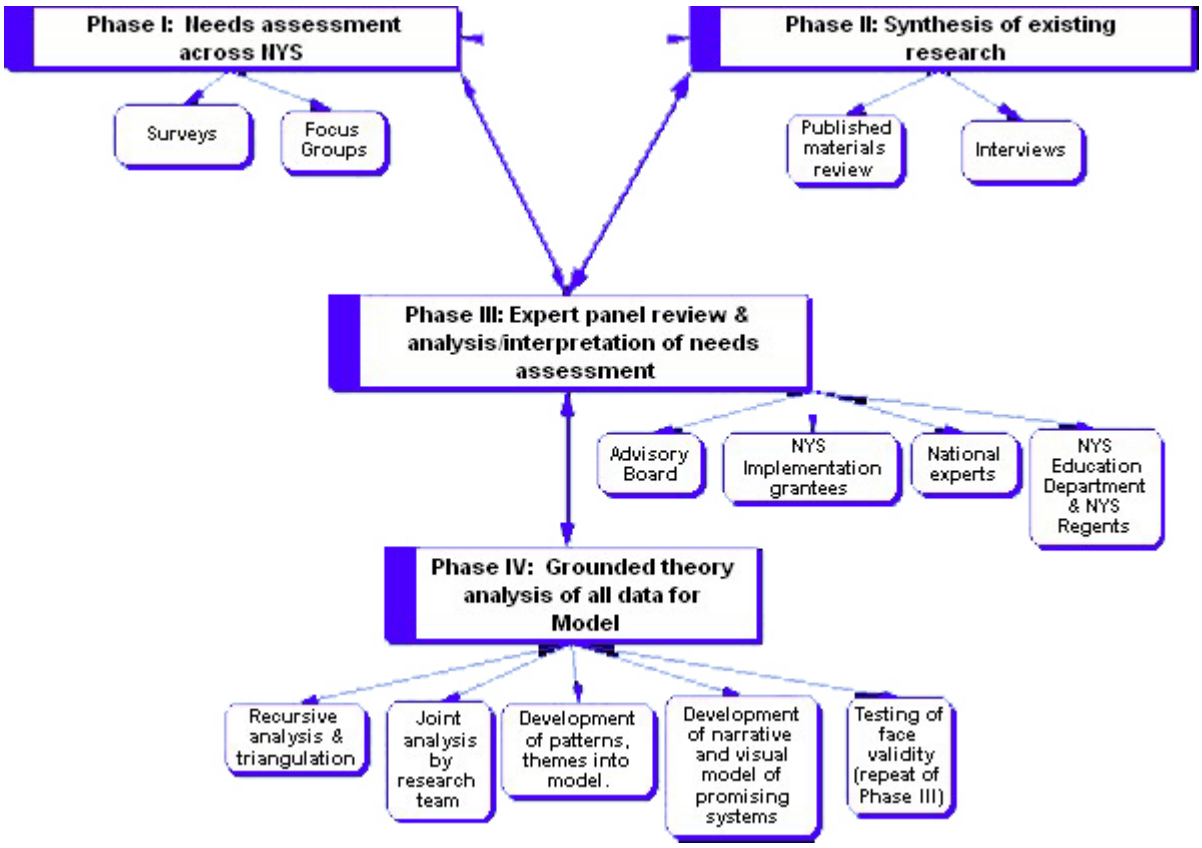

Figure 1. Grounded theory methodology.

Note: Phases I and II were pursued simultaneously by subgroups within the research team and then integrated into Phases III and IV.

Table 1. Grounded Theory Methodology

Phase I—Needs Assessment across NYS	Phase II—Synthesis of existing research/based on topics relevant to the emerging framework	Phase III—Expert panel review and analysis/interpretation of needs assessment findings and emerging framework	Phase IV—Grounded theory analysis of all data by research team to develop final framework

Surveys Higher education and urban schools (partners in 5 NYS urban centres) • College faculty • Pre-service Teachers • Urban school administrators • New urban school teachers ***Focus Groups*** higher education and urban schools • College faculty • Pre-service Teachers • Urban School administrators • New Urban School teachers	***Published material review*** • Beliefs about technology • Promising materials • Promising approaches • Institutional contexts/urban settings • Leadership • Learning standards • Effects of technology on learning ***Interviews*** PT3Implementation grantees • face-to-face and telephone interviews with NYS PT3 directors and coordinators	• Advisory board of stakeholders retreat • NYS implementation Grantees retreat • National experts on specific needs (e.g., integrating technology in classrooms, framework-building, urban school reform with technology) • State Education Department officials and NYS regents response	***Framework building*** • Recursive analysis of emerging themes triangulated across data types and perspectives • Joint analysis by research team of those emerging themes and their evidence base • Development of pattern explanations linking warranted themes into a grounded theory framework • Development of narrative/visual framework of promising systems for integrating technology into urban teacher preparation • Testing of face validity of framework with stakeholders (repeat of phase III above)

This overview is provided as a blueprint of the multiple data types and perspectives that formed the basis of our grounded theory analysis. The resulting framework for change is anchored in this empirical data. The details of each research phase appear in subsequent sections. Themes identified through recursive analysis of these various data sources through the research phases, taken together, strongly suggested the importance of leadership, commitment, and ongoing dynamic change. Our data thus mapped onto a general framework for change developed by Fullan (2001). The research team analyzed the connections and linked technology infusion themes from our data with Fullan's more generic approach. In what follows we first explain the review of research, including the Fullan framework, and then turn to our empirical research data. Finally, we describe our promising systems leadership framework for transforming urban teacher preparation through technology use.

Theoretical Framework/Review of Research

Framework development among the higher education institutional partners, the New York State Education Department, and our evaluators began with a philosophy and belief system about the integration of technology into preservice education and beliefs about the change process.

As we prepared to build a framework for preparing urban teachers to use technology, we identified several areas that were essential to our investigation: an overall framework for teacher preparation, distinguishing characteristics of urban school settings, approaches to educational change, and the adaptive process of infusing technology into classroom practice. Our summary of the vital scholarship in those areas follows.

Professionalism Framework

We are constructing our framework at the beginning of the 21st century, at a time when teacher education institutions are being pressured to produce teacher graduates who can deliver improved test scores—part of the so-called "outcomes framework" often associated with the movement to deregulate teacher education. In this context we felt it important to align ourselves with those who argue for the need for increased teacher professionalism, that is, creating teachers who are reflective and knowledgeable, and who are sensitive to issues of social justice (Cochran-Smith, 2001). Darling-Hammond (1997) explains that in order to construct "a more complex form of teaching practice in classrooms and schools," educators must know "a great deal about learning and teaching, school organizations, and education change (pp. 35–36). This, simply put, is a key to what our framework sets out to do.

There appears to be a growing consensus among education professionals about the alignment of three things: standards, assessments for students and teachers, and new frameworks of teacher education. Despite this, Cochran-Smith (2001) writes that "just below the surface of common language and very general agreement, there are deep differences rather than consensus" (p. 30)

about these issues. Her essay on educational policy and practice critiques four outcome frameworks, and concludes that the different frameworks have similarities, but there are also some distinct differences. Some of the notable areas of difference include varying emphases on teacher learning, student learning, and the relationship between teacher and student learning. These differences correspond to differences in underlying beliefs and assumptions about professional knowledge and practice. In the end, she argues for programs that create professional teachers who are "knowledgeable, reflective and collaborative," who "construct pedagogy that is culturally relevant and responsive," and who provide a perspective focused on social justice (p. 37). Zeichner (1999), in his extensive review of teacher education research over the last 20 years, identifies teacher learning as one of the major growing areas of teacher education scholarship, and explains that although scholarship concerning the role of teacher education programs was largely missing 20 years ago, the current focus on the process of teacher education and teacher learning is both innovative and exciting.

Urban School Research

At the same time as Zeichner, Cochran-Smith, and Darling-Hammond have focused more broadly on teacher education programs throughout the United States, Weiner (2000) has researched a "number of disciplines within education …to analyze the implications for *urban* teacher preparation" (p. 369, emphasis added). Recognizing the bureaucratic environment of the urban school as its most critical characteristic, Weiner notes other defining factors: large diverse populations, centralized decision-making, chronic underfunding, cultural disconnections between school and students, and limited definitions of intelligence, with tests that reflect bureaucratic instruction and curriculum (p. 370). These factors, she concludes, can discourage innovation by new teachers who arrive fresh from thoughtful teacher preparation programs.

Programs of urban teacher preparation might, for instance, apply research about teacher thinking by stressing meta-cognition rather than mastery of technical skills. Theirgraduates, however, may be hired to work in urban schools that give them little opportunity to exercise decision-making because of curricular mandates and high-stakes testing of students—whose aggregate scores are in turn used to evaluate teachers and teaching. The program of teacher preparation may emphasize the nested contexts of learning and the need to respect and elicit parent and community knowledge, but if the power to decide how and what is taught becomes more closely controlled by centralized authorities, the value that urban teachers give to parent opinions may seem irrelevant to instruction. Well-prepared urban teachers who can apply research about teaching a culturally diverse student population may leave city schools to teach in suburbs where they will have higher salaries and smaller classes and endure less bureaucratic treatment (Weiner, 2000, pp. 396–397).

The interactions between schools of education and urban schools are a focus of Weiner's analysis. She discusses professional development schools (PDS) as one strategy to promote collaboration, lamenting the marginal influence of teacher research on urban teacher preparation programs, and suggests that educators look for ways to act on research in our urban teacher preparation programs by reducing the contradictions between new research and school policy. Our emerging framework for preparing urban teachers to use technology appropriately addresses

this issue by connecting research with recommendations for policy and by promoting the joint production of knowledge by faculty in urban schools and higher education.

Educational Change

Any educational framework must consider implications for change. Michael Fullan (2001b) has written extensively and persuasively about changing educational institutions. The New York Catalyst team was aided by Fullan's identification of three primary elements fundamental to substantive change:

Innovation is multidimensional. There are at least three components or dimensions at stake in implementing any new program or policy: 1) the possible use of new or revised materials (direct instructional resources such as curriculum materials or technologies), 2) the possible use of new teaching approaches (i.e., new teaching strategies or activities), and 3) the possible alteration of beliefs (e.g., pedagogical assumptions and theories underlying particular new policies or programs). All three aspects of change are necessary because together they represent the means of achieving a particular educational goal or set of goals. (p. 39)

These three dimensions have served our PT3 collaboration well in framing the aspects of change needed for urban teachers. To date, we have explored two of the three dimensions in extensive literature reviews that synthesize key educational literatures related to materials, teaching approaches, and beliefs.

The question that guided our review of the literature on teacher beliefs and technology was: How do teacher beliefs about the use of technology affect technology infusion? The largest area of literature was focused on the alignment of pedagogical orientation or beliefs about learning and computer use. Studies have found that teachers use technology in ways that are consistent with their pedagogical beliefs (Dwyer, Ringstaff, & Sandholtz, 1990; MacArthur & Malouf, 1991; Niederhauser & Stoddart, 1994; Robblee, Garik, Abegg, Faux, & Horwitz, 2000), particularly their beliefs about how children learn (Olech, 1999). A second finding from this research literature is that teachers' beliefs about their own ability to use computers is a significant variable in predicting computer use or frequency of use. Third, teachers' beliefs about the perceived value of computers for instructional purposes are a predictor of computer use. Finally, discrepancies in beliefs and the real world—such as discrepancies between classroom events and teachers' prior beliefs—can be a catalyst for changing teacher beliefs and behaviors (Dwyer et al., 1990).

The two questions explored in the review of the research literature on approaches were: How is technology affecting approaches to teaching in the classroom? and What are the assumptions about how pedagogical theory is impacted by technology? The literature was much more limited in this area; there were few empirical studies (Herman, 1992; Tobias, 1992), and many of the existing articles were weak theoretically (Dick, 1992; Dimock & Boethel, 1999; Means, Blando, Middleton, Morocco, Remz, & Zorfass, 1993; Means & Olson, 1995). The literature indicated that the emphasis has been on technology driving the changes in the classroom (Dick, 1992) rather than pedagogy driving uses of technology. However, the limited research that exists in this area is in agreement: merely providing the technology does not lead to changes in instructional approaches (Sandholtz, Ringstaff, & Dwyer, 1997). Finally, where change does occur, it occurs

slowly, over a period of years (Sheingold & Hadley, 1990). Studies of effects of technology infusion include reports on changing the teaching environment, classroom roles and relationships, instruction, and teacher knowledge.

Technology Integration Is a Process

The Apple Classroom of Tomorrow (ACOT) study (Sandholtz et al., 1997) remains one of the classic explorations of the challenges teachers and administrators face as they attempt to integrate computers into the classroom. This study, building on the work of Hall and Loucks (1977), emphasizes the developmental nature of technology infusion into the classroom and outlines a five-step process. The process begins with "entry" and ends with "invention," and chronicles teachers' journeys through the adoption, adaptation, and appropriation of technology in their classroom. Similar frameworks have been constructed over the intervening years as more researchers worked with teachers to implement technology. Most of the frameworks share the assumption that technology integration is a process requiring extensive time (three to five years according to many studies, such as the ACOT study). The PT3 partners selected one framework that was used extensively in research done by Soloway and Norris (1999), which adapted the earlier work of Christensen and Knezek (1998). Soloway and Norris include six stages of adoption, but these stages perform the same function as earlier frameworks—putting on a continuum the time-intensive process of integrating technology into the classroom.

Through our review of these various literatures and our attempt to cull from them essential elements that could form the basis for our framework, we began to assemble a more complete picture of how institutions of higher education could better address the issue of preparing teachers to integrate technology in urban classrooms. In light of these reviews of scholarship and our monthly working meetings, a key facet of our collaboration developed: we agreed on what we later referred to as the moral purpose (Fullan, 2001) of the New York Catalyst partners work. Our collaborating group became committed to the proposition that the integration of technology has the potential to transform teaching and learning, putting students at the centre of the learning process—if institutions commit to systemic, not piecemeal, approaches to change. The systems approach is a crucial one because it requires identification of dynamics between, among, and within institutions, and forces deep views of structures and cultures of all components; it thus enables sustainability.

At the same time that we summarized the vital scholarship in key areas, the research team collected and analyzed needs assessment data. A summary of that work follows.

Findings

Surveys and Focus Groups

Two preliminary frameworks outlined above shaped the needs assessment surveys and focus group protocols. These were, first, informed by the work of Michael Fullan (2001b) regarding the change process. Our review of research and theory led us to postulate that the change process for institutions of higher learning to infuse technology into preservice education would

necessitate a process for a change in beliefs, materials, and approaches. Questions about these issues were central in the needs assessment instruments. At the same time we recognized that this change process is manifest in stages of adoption. Based on work by Christensen and Knezek (1998) and Soloway & Norris (1999), we asked our respondents to determine their level of technology comfort and use both today and in the future, across six stages of adoption: Stage 1, Awareness; Stage 2, Learning the process; Stage 3, Understanding and application of the process; Stage 4, Familiarity and confidence; State 5, Adaptation to other contexts; and Stage 6, Creative application to new contexts.

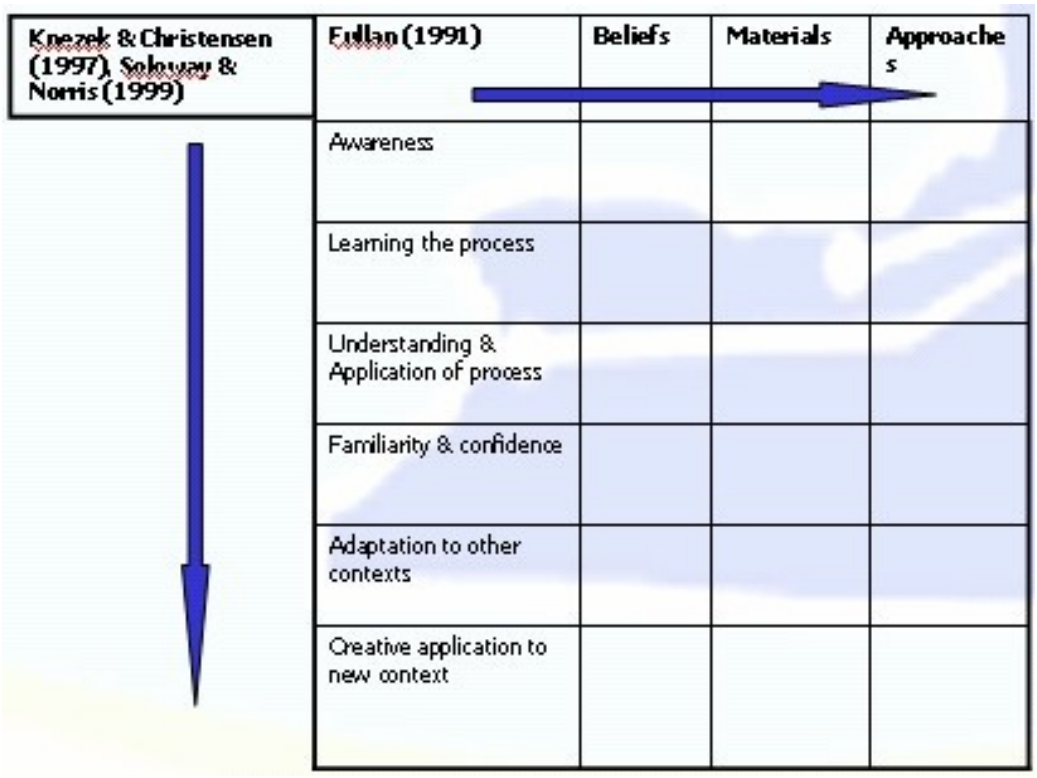

Figure 2. Framework: process of change.

Using these frameworks, the Catalyst partners developed paper-and-pencil surveys and focus group protocols. The initial questionnaire was administered to 48 college faculty; 151 pre-service teachers; 373 in-service teachers in their first three years of urban teaching in New York City, Buffalo, Rochester, Yonkers, and Syracuse; and 50 urban P-12 administrators in these city school districts.

Further, in-depth questions and reflections were gathered through focus groups and interviews with a subset of these same stakeholders. Data were analyzed both in the aggregate and by individual teacher preparation institutions. In addition, a search of other needs assessments and their results was carried out to determine whether the results of this needs assessment paralleled results in other localities. The use of multiple methods was designed to triangulate the research perspectives and increase the understanding of the participants' perspectives and response to the issues (Lincoln & Guba, 1985; Miles & Huberman, 1984). All interviews, individual and group,

were coded by researchers to compare and discuss the findings and their meanings. As themes emerged from data, these formed the basis of identifying "promising practices" contextualized in promising systems.

The focus of the present report is on the developing framework, rather than a complete report on the findings of the survey and focus groups needs assessments. (A more complete report of the findings presented in August 2001 in Washington at the PT3 National Grantees Meetingcan be found at www.pt3ny.org under Framework Research.)

A brief overview of findings suggest the themes that informed the developing framework. The goal of the PT3 program is to influence positively the preparation of tomorrow's teachers in their uses of technology. Key needs assessment findings for pre-service teacher surveys include:

- Three-quarters of the pre-service teachers support a general belief in the value of integrating technology into the curriculum and expect to transform instructional goals through use of technology.
- A lesser percentage (60%) see themselves as likely to use technology to support the learning standards, and only half understand what software to use for specific content. Only 40% believe that technology will enhance their teaching strategies by allowing them more options.

- Pre-service teachers were comfortable learning and teaching tool-based software (e.g., word processing, spreadsheets, etc.) but were not as confident in their ability to select or utilize software, and in particular, problem-solving software.
- At the current time, the majority of pre-service students indicated that they are generally learning computer skills in informal, autonomous modes. Only 43% gained computer knowledge in a structured classroom setting

These findings suggest important areas for attention in these students' teacher-education programs.

Further, comparing pre-service teachers and their higher education faculty illustrates that p*re-service teachers' use and expectations mirror faculty's use and expectations:*

- Both generally believe technology-rich environments to be positive experiences for students and teachers, enabling expansion of instructional practices.
- Both generally felt computers allowed for meeting needs of diverse students.

Yet focus group findings among higher education faculty and pre-service teachers revealed mixed beliefs about using technology and concerns about its inherent complexities. Currently some faculty and students advocate a critical/reflective stance towards technology use and careful assessment of materials and approaches.

Regarding their levels of adoption of technology use:

- Half of both pre-service teachers and higher education faculty are at Level 4 or below (See Figure 2 for the six-stage scale).
- In five years, almost all expect to be at Level 5 or above.

In its framework, the Catalyst team addresses how the system of teacher education programs might aid this move, within five years, to higher levels of adoption and wise use of technology by more than half of students and faculty. The greatest facilitator to achieving these new stages, as perceived by higher education faculty, is that pre-service teachers, as students, already have technological skills and abilities. Perceived barriers by higher education faculty include:

- time to learn technological skills;
- time to plan the integration;
- availability of trainers in both skill and integration; and
- lack of personnel and equipment to support the effort.

These are recurring barriers to technology integration in the research literature. Focus groups also identified institutional barriers, including a concern about finding time for technology when it does not "count" towards tenure, and solutions including institutional commitment to provide opportunities, incentives, support, and recognition of collaborative work.

Finally, the importance of influencing the use of technology in public schools was exhibited in the great variability of use of technology in those schools. Most striking was the finding that 37% of pre-service teachers had been exposed to use of technology in their student teaching; 39% had not. Similar bi-polar findings were evident in the new-teacher (first one to two years) focus groups. New teachers with limited experiences in technology integration perceived technology as an add-on (e.g., teaching computer skills, not content). These teachers used technology for low-level activities (e.g., multiple choice tests, drill and practice). New teachers who reported more extensive technology experience in their teacher education programs felt confident in their abilities to integrate technology, focused on student learning, and expected students to produce meaningful work using technology. In these K-12 contexts facilitators included time to collaborate, department or school support for integrating technology, and professional development for technology integration (not just software) that was ongoing, site based, and not on teachers' own time.

These findings provide a glimpse of the needs of each of the key stakeholder groups in their current use of technology in teacher preparation programs and in the K-12 urban classroom. They also provide a crosswalk that enables us to view this *change* framework from different, key perspectives. Taken together, all of the data point to areas of agreement and disagreement between and among the respondents. These consistencies and gaps support a systems change framework that institutionalizes the infusion of technology into pre-service education *and* that involves the inter-relationship between the pre-service training institution, the K-12 urban school system, and the State Education Department. Further, it is clear that the system developed must be flexible to accommodate different urban contexts and the needs of different teacher preparation institutions

Expert Panel Review

As the Catalyst team completed the literature review and needs assessment, we shared our findings with stakeholders to elicit their perspectives on the validity of the findings, additional issues, and questions. At day-long retreats stakeholders responded to emerging findings within institutional groups (urban schools, higher education, State Education Department, community/business) and through mixed-institutional group discussion. After the groups reviewed the findings of the needs assessments, they discussed these questions:

- What would influence effectiveness of teachers infusing technology into teaching and learning in urban classrooms?
- What, then, do we need to include in the framework—for example, what processes could achieve these outcomes?

Retreats included the advisory board, NYS implementation grantees, and State education Department officials. As needed, the research team elicited advice from national experts on specific needs (e.g., integrating technology in classrooms, model building, urban school reform with technology); these consultants spoke to the group at its monthly face-to-face meetings.

Through these discussions with various implementers, it became clear that change exists within a context of a single institution itself *and* in relation to other institutions. The analysis of the discussion during the advisory board and PT3 implementation grantees retreats, developed through a recursive analysis of themes, led to identification of recurring patterns in the large- and small-group discussions. The themes include leadership, professional development, curriculum content, teaching approaches, institutional partnerships, and the role of SED (see Appendix A for more details). These statements represent the key findings:

- Leadership must create commitment to a culture of change to support wise integration of technology through financial, technical, reward, and learning structures.
- Systemic professional development is essential to initiate change—*if* it is ongoing, collaborative, focuses on changing teacher beliefs and practices, and aims to help students meet subject-area learning standards using technology as a tool.
- Promising teacher education programs focus on student-centred learning; wise uses of technology as a tool to meet learning standards; urban education issues/contexts; and experiences in and opportunities for using technology in a variety of situations.
- Faculty and pre-service teachers should use a range of teaching approaches, styles, and strategies in using technology; should be able to evaluate, select, and use technology to meet curriculum goals and state learning standards; should be able to troubleshoot problems; should be familiar with a range of software; and should be aware of promising practices in integrating technology.
- Higher education and urban school partnerships and relations should be used to initiate and sustain change (e.g., through collaborating to create technology-rich environments in urban classrooms, jointly creating new knowledge about wise uses of technology for content-area teachers).

- The State Education Department must encourage such collaborations to promote wise technology integration with material support and attention to the coherence of SED initiatives.

The keen interest of all stakeholders in *leadership* for sustained change through urban school–higher education partnerships as an impetus for professional development and urban reform emerged as central to all of the findings. Given opportunities to talk across contexts, these participants also viewed the State Education Department as responsible for prompting such collaboration and for creating coherence in state initiatives.

As a result, the research team began discussions that moved away from promising practices and towards a new notion of "promising systems" for integrating technology into pre-service teacher education. Such promising systems seemed to require relationships among the institution of higher education, the K-12 urban schools working with the higher education institutions, and the State Education Department. The building of these relationships became crucial to development of our framework for technology infusion in preservice teacher education programs. We saw these as dynamic relationships in which the K-12 schools and higher education mutually influence each other's programs and both inform the State Education Department, which in turn determines those standards and accountability measures for both K-12 and higher education institutions.

Once we identified these major framework components, we realized that there remained gaps in our understanding of the change process. The research literature findings indicated that we needed to study the very reason for this change in preservice education; the elements of the institution itself that would facilitate or hamper the change; the leadership factors; the impact of the standards movement in education; and the focus on teaching and learning and accountability monitored by the State Education Department in both higher education institutions and K-12 schools. We saw these interrelated aspects not as separate factors but as dynamically related aspects of a total change process.

In an effort to make sense of this as a dynamic process of change, we turned to the newer work of Fullan (2001a), in which he focuses on *leading in a culture of change.* Our findings about technology infusion into teacher preparation programs mapped onto this general leadership framework. Through a critical examination of these linkages, we adapted components of Fullan's broad change framework to the change required of higher education to infuse technology into preservice education programs. Fullan himself provides an explanation of this theoretical "fit": he notes a "remarkable convergence of theories, knowledge bases, ideas, and strategies that help us confront complex problems that do not have easy answers. This convergence creates a new mind-set—a framework for thinking about and leading complex change more powerfully than ever before" (p. 3). He indicates that "five components of leadership represent independent but mutually reinforcing forces for positive change". These components are: (1) *moral purpose,* which he defines as "acting with the intention of making a positive difference in the lives of employees, customers, and society as a whole"; (2) *understanding of the change process,* which must be combined with moral purpose to be effective; (3) *improvement of relationships,* the "single factor common to every successful change initiative"; (4) *knowledge creation:* "Leaders commit themselves to constantly generating and increasing knowledge inside and outside the

organization"; and (5) *coherence*: "Effective leaders tolerate enough ambiguity to keep the creative juices flowing, but along the way ... they seek coherence. Along this path the leader of change seeks commitment, both internal and external" (p. 3).

A careful integration of this work on leadership and change with our findings enabled our group to see the system of relationships among the factors that we already had in place. We jointly drafted a framework of change for integrating technology that would be dynamic and multidimensional. The overview of that framework follows (see Figure 3).

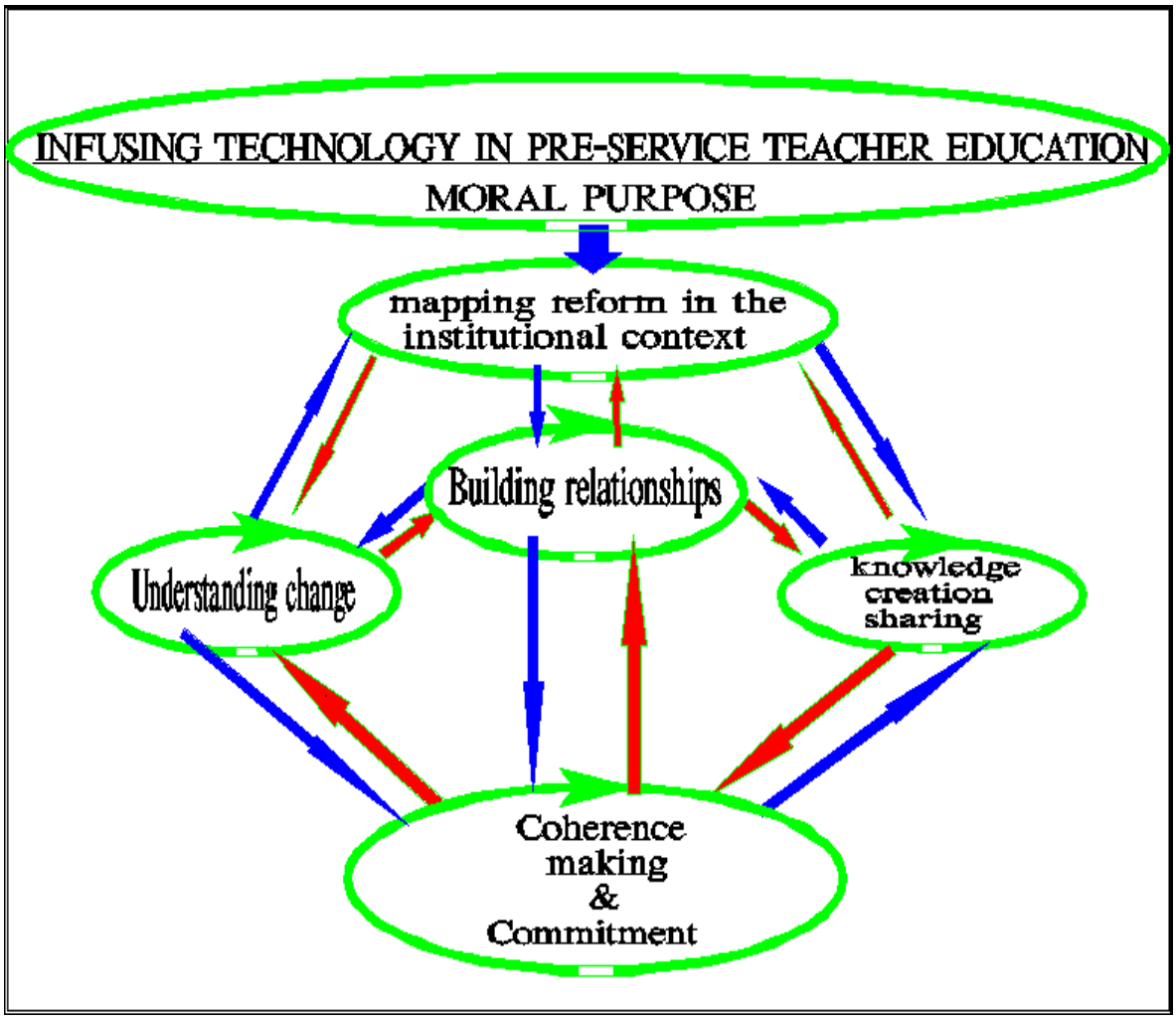

Figure 3. The promising systems framework (adapted from Fullan [2001]).

Moral Purpose

Adapting Fullan's framework, a moral purpose for technology infusion must be constructed by leadership in the system so that the change is guided by "the need to make a positive difference in society." Such a purpose would guide the infusion of technology into teaching and learning at both the higher education institution and the K-12 school. A considerable amount of current

research examines the impact of technology on classrooms, schools, and districts. Results of a number of these studies (e.g., Chang, Henriquez, Honey, Light, Moeller & Ross, 1998; Hawkins, Spielvogel & Panush, 1996) suggest that, over time, technology can serve as a catalyst for change at the classroom, school, and district level. Glennan and Melmad indicate that "introducing information technology into the schools may provide the catalyst that enables and forces the restructuring necessary to meet our national goals" (1996). The reasoning behind this vision is that technology provides powerful tools for retrieving, organizing, and presenting information and ideas. These tools, when used by educators interested in helping students build knowledge, have the potential to move education beyond traditional notions of "covering curriculum" in didactic classroom situations to creating authentic learning environments for students and teachers.

For example, Sandholtz et al. (1997, pp. 47-8)) argue:

Technology is a catalyst for change in classroom processes because it provides a distinct departure, a change in context that suggests alternative ways of operating. It can drive a shift from a traditional instructional approach toward a more eclectic set of learning activities that include knowledge-building situations for students.

Although the research cited relates to K-12 schools, several trends in higher education that are similar to those of K-12 schools are described in the literature:

- the integration of technology into instruction, as current students have embraced technology;
- emphasis on interdisciplinary teaching and learning, as students, having been introduced to it during much of their K-12 education, are familiar with the concept;
- active learning, which engages students in the learning process; and
- outcomes and "quality," as students (especially older students) and parents appreciate understanding the outcomes of learning.

There is evidence that the use of technology is growing and simultaneously changing the learning process, the structure of knowledge, and the nature of instruction, including curriculum development and assessment (Alley & Repp, 1996). Through his 1995 survey on campus computing, Kenneth Green (1997) illustrates that major gains have been made in the proportion of colleges and universities using informational technology as an instructional resource. Trent Batson and Randy Bass (1996) describe how the growth in information technology is bringing hybrid forms of teaching and learning, a blurring of boundaries, different literacies, and changes in the way knowledge is constructed. Robert Dufresne et al. (1996) illustrate how using technology for instruction engages students in active learning and enhances overall communication in the classroom. Technology infusion in pre-service education can address the moral purpose of improving the nature of teaching and learning in both the institution of higher education and K-12 schools. The New York Catalyst grant partnership is committed to providing leadership for institutions aiming for these kinds of teaching and learning reforms.

Understanding Change: Key Aspects of Implementation

The leaders of this change need to understand the nature of the change process and the way change would manifest itself over time. To depict our understanding of this process, we have created a subsection of this framework that describes the changes in beliefs, materials, and approaches and the stages of change in technology infusion (see Figure 4). These primary components or dimensions are central in implementing any new program or policy, but seem especially significant to our topic of integrating technology. The use of new digital technologies provides new resources. The use of new teaching strategies may be necessary to make best use of these resources. And these changes prompt the need to reflect on and possibly alter assumptions about teaching and learning.

These three aspects of change provide leverage points for achieving the goal of technology integration, yet all three must work together to create sustainable change. As our findings suggest, faculty and pre-service teachers may have changed beliefs, but not approaches; they may have new materials, but no supporting beliefs about using them wisely. Promising systems have leaders with a clear moral purpose who seek out the means of supporting changes in materials, beliefs, and approaches. Such leaders understand, however, that such change takes time and may not happen simultaneously. Monitoring and responding to these three primary components can produce deep and substantive change.

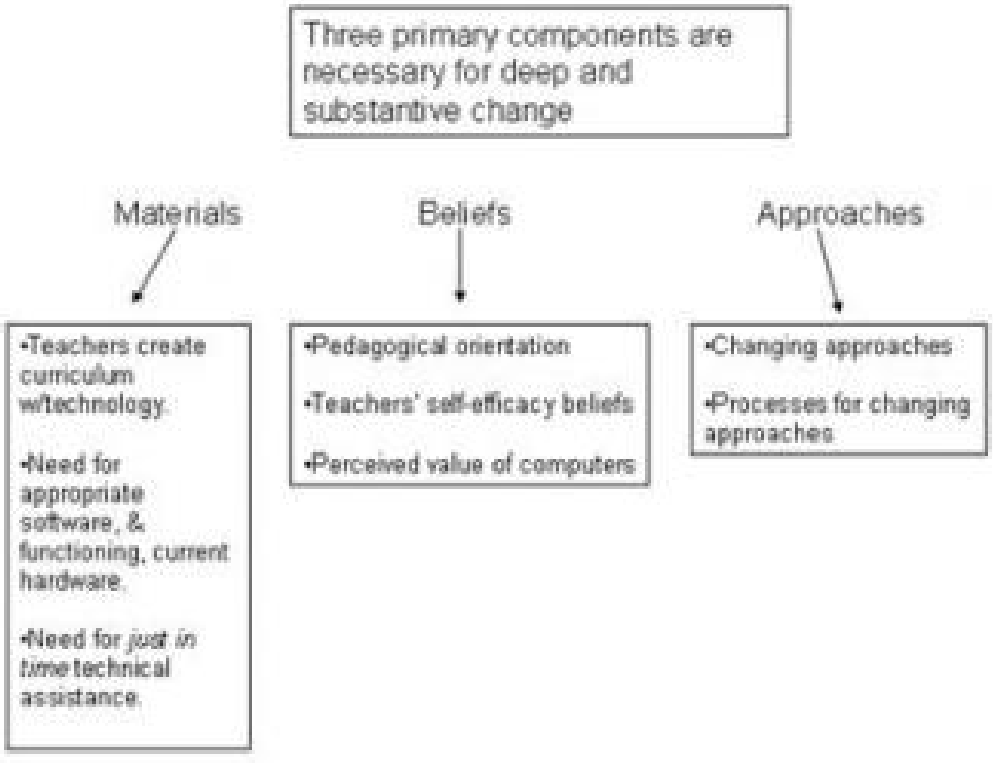

Figure 4. Key aspects of implementation.

Building Urban Relationships for Promising Systems

Working with our advisory board has given us great insight into the nature of the relationship that needs to take place between the institution of higher education and the K-12 urban schools and between these entities and the State Education Department (see Figure 5). This framework indicates the long-term commitment of higher education to transform future teacher practices through technology integration, a commitment that parallels that of the urban K-12 schools to its teachers and student teachers. Both systems initiate that change through leadership at a variety of levels, financial and other rewards, professional development, and the development of promising practices. The two systems come together through negotiated partnerships and through the development of a community of learners that will include the placement of preservice teachers in technology-rich urban classrooms. Together, higher education and the K-12 schools will create new knowledge and approaches. Out of this collaboration will develop curriculum and outcome changes for faculty, pre-service teachers, in-service teachers, and students. Out of this will also come a strong coalition that will interact with the State Education Department as they work together to develop and implement exemplary standards of practice. This relationship-building requires the commitment of time, financial support, and a coherent set of state initiatives and accreditation standards.

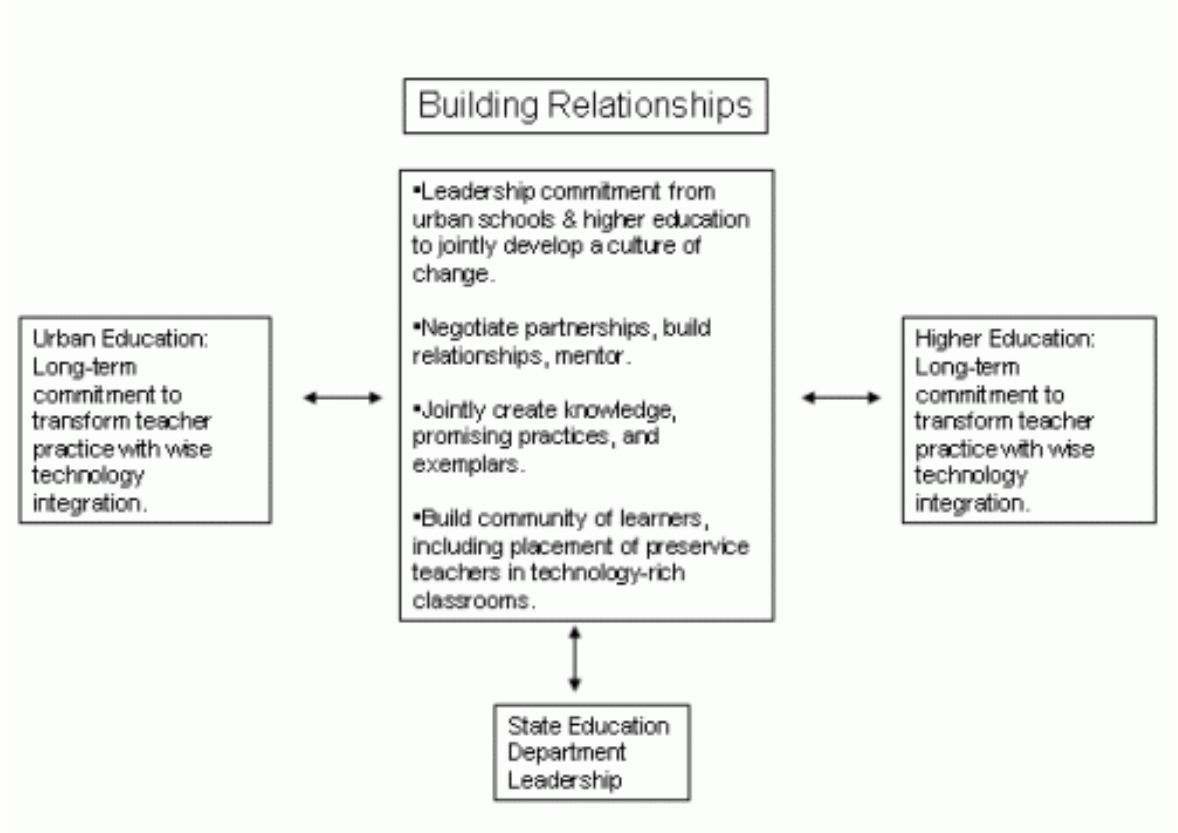

Figure 5 . Building relationships for promising systems.

Creating New Knowledge

This takes us to the creation of new knowledge within the higher education institution and its partners at the K-12 schools and the State Education Department. Through higher education and K-12 collaborations, new contextualized knowledge about how to wisely infuse technology into curriculum to meet learning standards in urban schools will develop. The active partnerships between K-12 and higher education faculty provide the opportunity to generate knowledge to address problems and issues distinct to the specific context. In these relational contexts, then, new materials and approaches can develop in higher education classes and in the K-12 classes. This knowledge-generating process will provide promising practices that can be shared throughout the state. Promising practices will grow into diverse promising systems as the work of the partnership turns to the variations of the framework that develop through different approaches to curriculum, instruction, assessments, and through the new insights and perspectives gained in collaborative inquiry (see Figure 6).

Using the developed NYS –PT3 framework described here, the NYSED Catalyst team is currently generating tools for institutional self-reflection and guidelines to assist pre-service programs, such as outcome standards, promising program indicators with sample descriptions, and gap analysis tools. Such tools for reflection will aid in higher education and school district partnerships working together to reinvent pre-service teacher preparation programs with the focus of using technology in urban settings and creating knowledge for and within specific contexts. Next steps for the NYS–PT3 team include the piloting of these new instruments in selected sites and the creation of knowledge about varying contexts for sustainable institutional change for teacher education programs throughout New York State and the State Education Department.

Figure 6. Generating new knowledge.

Creating Coherence, Commitment, and Sustainability

Throughout the process of change, we seek coherence, so that this process is not seen as distinct and separate actions but as actions that flow one from another in many directions. Thus, we have made time to reflect on the change process and seek coherence of the whole to ensure that we meet our moral purpose—commitment to urban reform through wisely infusing technology into teacher preparation and urban schools.

Validation of the framework is underway through site studies of PT3 implementation grantees to identify promising practices and processes in context and to test them against the current framework to revise it. Our ongoing process of consultation provides a test of the face validity of the promising systems framework, grounding it in the experiences of those pursuing integration of technology into diverse contexts across New York State.

Educational Importance of the Study

In the next five years it is anticipated that New York State (and many other states) may lose close to 75% of its teaching staff. The existence of well-prepared teachers in urban schools has been identified as a key factor in the survival of the urban public school. Such teachers must be comfortable with technology as a tool to engage students and enhance their learning. Much work is being carried out in the area of preparing teachers of tomorrow to use technology. Primarily, this work is being carried out at individual colleges and universities. The individual nature of this work may or may not lead to a larger change in the system of pre-service education. The Catalyst concept has the promise of developing a change in the system of pre-service teacher preparation, recognizing and using the "promising practices" identified through the implementation grants, and further developing a "promising systems" change framework. Our work so far suggests that infusing technology may indeed promote positive change in a teacher preparation program, but a broader change in the state system of urban teacher preparation should involve the catalyst of a state partnership, including the State Education Department. In our continuing work, the Catalyst partnership seeks to provide leadership for such systemic change by creating internal and external commitment of NYS teacher preparation institutions and attunement to a coherent framework for infusing technology in the state.

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Appendix A

Summary of Themes
Advisory Board & Implementation Grantees Retreats

Contextual Issues: Perceptions of Promising Programs/Systems

How institutional programs can initiate change

1. A culture of change must be developed through a leadership commitment to supporting institutional transformation with wise integration of technology as a central feature.

2. Committed leadership must support financial and reward structures to prompt wise integration of technology into teaching (e.g., promotion and tenure, incentives).

3. Financial investment to make technology available through a technology infrastructure is a necessary but not sufficient factor in promoting wise integration of technology into teaching.

4. Teachers must be seen as resources in promising programs, and be sought out as teacher leaders in the change culture. That is, developing teacher leadership to promote change among other teachers is a key goal of the institutional change. Embedded in this approach to change is recognizing the developmentally different needs of veteran and novice teachers and the possibility for teachers to be co-learners in wise technology integration.

How systemic professional development can initiate change

5. Long-term, ongoing professional development is necessary to support teacher change and should take the form of collaborative mentoring, joint creation of exemplars of promising practices, and emphasis on understanding/reflecting on teachers' beliefs and approaches.

6. Professional development of teachers is central and essential; it must emphasize the philosophy and practice of changing roles of teachers and students to that of co-learners, where students are seen as resources who can aid teachers in infusing technology as learning tools into the classroom.

7. Professional development should be seen as opportunities to learn, with rewards and incentives for faculty central to the institutional commitment. This changing of beliefs will create sustainable change where unfunded mandates will not (a caution for SED, as well).

8. Professional development at all levels should be curriculum/standards driven, not technology driven. The belief in the use of technology to meet existing subject area learning standards is essential.

Content/experiences expected in promising teacher education programs

9. The curriculum of pre-service teacher education program, then, needs to reflect these elements: student-centred learning; opportunities for pre-service teachers to see a variety of wise integrations of technology into their content areas and to do so themselves both at the university and in student-teaching contexts; urban education issues/contexts infused throughout the program; technology as a tool to meet learning standards; classroom management in different technology settings; ability to solve technology problems and curricular problems through technology.

10. Outcomes for university faculty and pre-service teachers include: use of a range of approaches to using technology (instructional styles and strategies); ability to evaluate, select, use technological tools to meet curricular goals and state standards; ability to troubleshoot technology problems and reflect on failures of using technology; familiarity with a range of major and popular software types; awareness of promising practices in integrating technology into subject matter teaching and the disposition to use them.

11. Policies to promote change must be coherent and supportive of the outcomes for faculty, pre-service teachers, and in-service teachers (who serve as cooperating teachers).

Higher education and urban school partnerships/relationships to initiate/sustain change

12. In their field placements and student teaching, pre-service teachers should be connected with cooperating teachers in promising urban school systems, where the elements above (1–10) are goals and practices.

13. Higher education institutions must negotiate and collaborate with urban schools to promote a culture of change that will allow pre-service teachers to enter technology-rich environments with knowledgeable teachers and administrators.

14. Joint creation of new knowledge about wise uses of technology in content area teaching should be a goal of teacher research and other reflective practice for faculty, pre-service teachers, and in-service urban teachers.

15. An ongoing plan for evaluation and expansion of the uses/integration of technology in pre-service teacher programs and in schools must be in place to keep up with technological advances and new outcomes/skills emerging over time.

SED promoting changes in technology integration

16. The State Education Department has a responsibility to promote ongoing communication, sharing, and collaboration through financial support for collaborative efforts. This is an essential pressure point for change in the system. SED must also address the coherence problem: coherent integration of SED initiatives so they do not (appear to) conflict (e.g., the push for test scores may be perceived as conflicting with taking time to wisely integrate technology through deep inquiry into content area problems in student-centred classrooms).

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