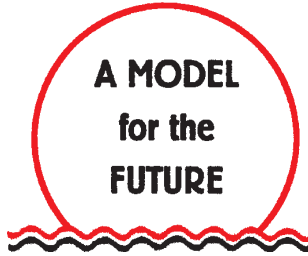


HANAU SCHOOLS



Hanau Model Schools Partnership Research Report

Technology Infusion: A Systemic Proposition

Learning from the Hanau Model Schools Partnership

by

Judith Davidson Wasser

February 1998



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T E R C

2067 Massachusetts Avenue
Cambridge, MA 02140
(617) 547-0430

The Hanau Model Schools
Partnership Project

Principal Investigator

Alan Feldman

Project Director

Elizabeth McNamara

Scientist

Judith Davidson Wasser

Senior Research Associate

Cathy Miles Grant

Project Coordinator

Valda Grinbergs

Administrative Assistant

Beth Lish



T E R C

2067 Massachusetts Avenue
Cambridge, MA 02140
(617) 547-0430
fax: (617) 349-3535

*Funded by the
National Science Foundation
Grant REC-9612905*

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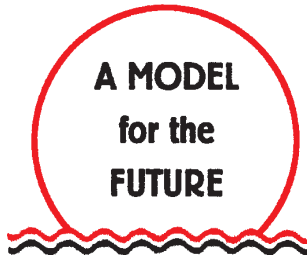
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Technology Infusion: Today's Educational Challenge

Educators and educational organizations are caught at the banks of two intersecting streams of change: technology integration in the form of widespread technological change and innovation in computing and telecommunications; and a rushing torrent of reforms in educational practice, curricula, and organization (President's Committee of Advisors on Science and Technology: Panel on Educational Technology 1997; Sheingold and Tucker 1990; Wasser 1996). A few brave ones have made the jump and seem to have cleared the barrier; others simply took the plunge and are still struggling in the current; the majority, however, watch from the banks while they estimate the distance and best means of approach.

What will technologically enriched schools of the future look like? How will we integrate educational reforms in such schools?

What will schools of the future look like? What will it mean to learn and teach in schools that are technologically enriched? How will we integrate educational reforms in curriculum, instruction, school organization, and assessment into classrooms that make daily use of computers and the Internet?

These are perplexing questions that touch on every aspect of school life. Teachers who entered the teaching force, even as few as 10 years ago, face a teaching future that in no way resembles the one in which they have been trained to work. Parents, too, find themselves sending their children off to schools that seem to have little congruity with their own school experiences. Teachers and parents wonder: Is this good for young people? What guarantees do I have that this will really help them learn better? Small wonder that many are cautious before they enter these waters.

Luckily, those who have gone before are now turning around to share their experiences with others. One of these early

leapers is the Hanau Model Schools Partnership, a vanguard project sponsored by the National Science Foundation and the Department of Defense Educational Activity in partnership with TERC, a private research firm. This project aims to explore the effects of widespread technology integration in a cluster of K—12 schools in tandem with strong efforts to enrich curriculum, strengthen thoughtful instructional approaches, and develop an infrastructure and capacity to sustain change and innovation. Throughout this discussion, we refer to this convergence of technology integration and educational reform by the term *technology infusion*.

This article is an attempt to share the experience of this project and what has been learned here about this new phenomena of technology infusion. My discussion draws from the qualitative research study conducted over the three-year course of project implementation. In this article I (1) describe the mission, history, and activities of the project; (2) provide readers with a brief armchair visit to Hanau in the second implementation year; and (3) provide a framework for understanding the multiple dimensions of systemic initiatives such as these.

Technology infusion refers to the convergence of widespread technology integration with systemic educational reform.

The report is structured so that you will find the description of the project on the left-hand pages and the armchair visit to the project on the right-hand pages. In the third section, these two strands merge in the concluding discussion of the four arenas of change in systemic propositions.

The Hanau Model Schools Partnership

The National Science Foundation (NSF) selected TERC in September 1995 to spearhead a three-year action-research project to create a technologically enriched cluster of K—12 schools. The project had three goals:

- to infuse technology into a cluster of K—12 schools so that learning with technology becomes a deeply accepted part of daily school life for all members of the school community;
- to actively support the development of exemplary teaching approaches that complement the aims of the district and nation’s educational reform goals and make good use of technology;
- to develop research-based knowledge of technology infusion—needed supports, suggested processes, and

In the Classroom

It's a busy day, as are all days, in Dick Evanson's fifth-grade classroom. Students work alone or in small groups on multiple projects. There are five computers in the classroom, scattered around the edges of the room, and they are connected to a color printer that sits next to the teacher's desk—an island that juts into the room. Besides these technological resources, Evanson's students have a classroom scanner available to them.

Today there are also some other technologies in the room—an LCD display, a video camera and SCSI attachment, and five Alpha Smart Boards (portable keyboards with memory)—borrowed from the media center. Indeed, the media center itself feels like an extension of the classroom. The classroom door is open and students, as they need, make trips down the halls for research and pleasure reading materials as Evanson thinks appropriate. Books and technology are complementary, not adversarial, resources.

Several students are working on the last stages of a social studies project about the Oregon Trail. They've used many resources over the last several weeks to learn about this period of American history—starting with their textbooks, but also including the well-known software program "The Oregon Trail," an e-mail correspondence project with a school in Portland, Oregon, and related math projects to figure distance and time pioneers traveled along the trail. Now students are trying to weave everything they've learned about the time into one piece—a diary of a young person who is on the trail. Using authentic historical details, each has to pick a character to describe. Evanson assigns two computers for this project. Those who are not at the computer may compose on Alpha Smart Boards to prepare for final formatting.

Evanson assigns two other computers for students who want to work on the science project about hurricanes. This project developed directly from student interest in strong winds—the tail end of a hurricane that had recently passed through their area. Evanson and students sought information on the hurricane at the National Weather and Atmospheric Science Web site. They were intrigued by the resources at the site and begin to track weather regularly. Today, students will locate and read Internet resources and download meaningful text and photos for a bulletin board they are creating about hurricanes. The text at the Internet sites can be difficult for fifth-grade readers, but the students are interested and not daunted by the effort. One young man skips back and forth between what he is reading on screen and a dictionary stored on a CD-ROM. In this way he is able to navigate the difficult vocabulary with relative ease.

Evanson calls students up one by one to his desk. He is teaching each student how to "capture" a still photograph of themselves from a short video clip and export it to a document. They will use these photographs for their personal Web pages. Linked to the class Web page, Evanson's students post various assignments here. Most recently students posted an essay on prejudice, written as part of a special project with the school counselor. Although Evanson is not a technology teacher, per se, he acknowledges that students must have training in the technology tools of the classroom if these tools are to serve their learning.

Instruction and Curriculum Changing K—12

Evanson is unique in the number of technological strands that he has woven into his curriculum, but across both elementary schools you see evidence of many kinds of technology in use. Using the Amazing Writing Machine, a word processing software program, the preschool special education teacher produces a daily language experience letter for students to bring home and share with their parents. Kindergarten and first-grade teachers extend student's writing opportunities with Smart Boards and software like the Amazing Writing Machine. Second-grade teachers are extending the math curriculum with a project that incorporates graphing with "the Graph Club," whereas third-grade teachers do the same using Excel with their students. Fourth-grade students use the Internet to investigate science topics and present their findings to classmates in Powerpoint presentations. Fifth-graders compose in Hyperstudio. Across the school in every classroom, students turn daily to the Internet as a combination encyclopedia-resource center. In this school, technology tools have come to figure prominently in the ways children learn.

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potential outcomes—to share broadly as recommendations or models.

The host sponsor of this project is the Department of Defense Educational Activity (DoDEA), a school system serving about 82,000 students, whose parents work in the armed services. DoDEA named a K–12 cluster of schools at the Hanau Army Base outside Frankfurt, Germany, as TERC’s implementation and research partners. This was the genesis of the Hanau Model Schools Partnership.

In initiating this work, NSF’s overall concern was to understand what the technologically enriched learning environments of the future will look and feel like, how we can ensure that they will be developmentally and educationally sound places for young people, and, of great importance, how we can see to it that the benefits of technology extend to all teachers and students in a system, not just a select group. NSF’s model schoolwork is an attempt to begin to answer these questions.

DoDEA schools are quintessentially American in character, tone, and content.

The DoDEA system exists to serve military families. Most schools are located on bases, and most students live in military housing. Students regularly cycle in and out of DoDEA schools, seldom staying more than three years, as they follow their parents’ duty rotations. Military regulations and customs are a regular part of school life. Parents in military uniform are seen daily in the halls of DoDEA schools.

It was the United States Congress that made the selection of the DoDEA system as a place to explore this question, and this was not an unthoughtful choice. The DoDEA schools are quintessentially American in character, tone, and content, despite that the school system, operated from Washington, D.C., spans the world. Military parents want to make sure their children receive an education that will be commensurate to what they would receive if they attended a school stateside, that is, that they will not be penalized by their time abroad. For this reason, DoDEA schools represent the epitome of our expectations for American schools—from the bulletin boards in the halls to the activities and textbooks in the classroom to the nature and pace of response to educational change. Thus, lessons learned in DoDEA schools about educational reform have as much relevance to school systems stateside as they do to systems actually located in the continental United States.

Like the elementary grades, students in the upper grades also have new opportunities to learn with technology as a result of the project. They use the same basic tool kit as the elementary grades with substitutions appropriate for their age level. In the high school, students in classes on psychology, English, and social studies present findings from research topics in Powerpoint. While in an algebra class, students work in collaborative groups to develop hyperstacks of math problems to demonstrate their learning. Other teachers develop Web pages where they can share resources and information on assignments with each other and students. At the middle school, science classes explore temperature and climate using MBL probes, while English classes compose poetry and science fiction on Alpha Smart Boards or use the Internet to investigate Elizabethan life as part of a study of Shakespeare's plays.

In some cases, technology is a new tool to teach a familiar topic but in better ways. In other cases, technology permits teachers to explore new topics with students in ways that were not previously possible.

As teachers at Hanau become more proficient with technology, they find themselves asking harder questions about technology and the ways it contributes to students' learning. Some of these questions include What makes a good multimedia product? How do you evaluate student work created on computers? What's the best way to teach students how to research on the Internet? How is technology helping those students with the lowest reading levels? Are they becoming more or less turned on to learning?

The deeper the Hanau teachers move into the realm of educational technology, their questions change in focus and tone. Although there are still many questions about the technology and how it works, there are increasing questions about the integration of technology in classroom work, the quality of that work, and its impact on students. In the beginning of the project, Hanau teachers tended to expect outside experts to give them immediate answers to their questions. As they ask more questions that probe more deeply, however, they are also taking greater responsibility for organizing the search for answers.

In the Teacher's Room

At 11 a.m., the elementary teachers for the younger grades gather for their 30-minute lunch break. Most eschew the cafeteria lunch for their own brown bags and leftovers. It's a precious moment to consult with colleagues.

This year, in this elementary school, unlike years past, lunchtime conversation is often about technology. As teachers munch sandwiches they talk about how to save to a drive, use a spreadsheet, or manage classroom use of the technology. In so doing, they are also sharing information about their classroom, the substance of their curriculum, and the instructional issues foremost in their mind.

As teachers talk, they frequently mention the ways students serve as resources—helping teachers and each other as they learn to make use of computers. This is in contrast to teachers' feelings at the beginning of the project, when, as they will admit, they felt they had to be the expert before they could begin to teach a student to use the computer. Now, they sometimes learn side by side with students. "You can't know everything about every piece of software," they are quick to state today. "The students are great resources. I really rely on them." Learning together is now commonplace across the four partnership schools.

Lunchroom conversations often end with the statement: "I'll e-mail you," which is tossed over the shoulder as a teacher rushes out to pick up her or his class. E-mail has become a way of life. Teachers like it because it saves time and effort. Messages fly across the day, coordinating meetings, announcing class trips, sharing personal news, and suggesting helpful Internet sites that others might want to explore. In fact, in this school, the official school bulletin is now officially dead—e-mail messages have taken its place.

There are at least two networked computers in every classroom in this school and at the other three schools in the project. Some classrooms, such as Evanson's, have even more computers available. Teachers and principals claim that having easy access to a networked computer on one's desk made the difference in helping

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The Hanau Schools

The four Hanau schools—Hanau American High School, Hanau American Middle School, Argonner Elementary, and Sportfield Elementary—are much like other schools for military dependents. Located on the Hanau Army Base, they are a 20-minute drive south of Frankfurt, Germany. The base is on the outskirts of Hanau, a medium-sized town. It is an American enclave of military housing and other army facilities. The high school and middle school sit back to back in a big parklike area. About a half mile from them, in an area surrounded by apartments, is Argonner Elementary. Farther down the road, in a neighborhood entirely for the enlisted soldier, is Sportfield Elementary. The four schools together form the Hanau schools. The Hanau schools are part of the Hessen district, which is a part of the European division of DoDEA schools.

Student Information

	Argonner Elementary	Sportfield Elementary	Hanau Middle School	Hanau High School	Total
Students enrolled	410	308	380	292	1,390
Student mobility	60%	59%	41%	40%	—

Adults in Hanau Schools

	Argonner Elementary	Sportfield Elementary	Hanau Middle School	Hanau High School	Total across the four schools
Classroom teachers	18.5	14.5	20.5	24.5	78
Specialists, administrators, and others	15	8.5	8	8	39.5
Total adults	33.5	23	28.5	32.5	117.5

(These data reflect enrollments and faculty numbers from the 1995—1996 academic year.)

The Hanau schools, like the American army, are diverse in racial and ethnic membership. Class, or economic differences, are also present. Although every child attending a DoDEA school has at least one employed parent, this does not mean

them to go beyond using computers as expensive bookends, as they had been in years past. Indeed, they tell and retell, with great relish, the stories of nonusers who were converted over the last year—often with the sheepish convert looking on and nodding in amusement at her own folly.

Teacher's reactions to all the technological changes are mixed. Many note that the major change the project has wrought is not about technology, but can be summed up in the one word "collegiality." Others mention that they are more excited about their work. "We'd been doing the same thing in the same way for a long time," commented one teacher. "When you're more excited about teaching, it rubs off on students."

Technology carries with it a cachet of modernity, progress, and being on the cutting edge—an image that we may not readily associate with schools today. And, truthfully, through this project we found that technology had passed by teachers and their schools in many significant ways. Whereas most people who worked in modern offices would have had extensive experience by 1995 working with computers and software for word processing, spreadsheets, and other functions, many teachers had scarcely learned to turn on the computers in their classrooms. This project, by virtue of the presence of technology, brought with it the opportunity to catch up with the world, and even surpass its current expectations for teachers.

At the same time that they praise the positive changes accompanying technology, Hanau teachers are equally positive about the difficulty of moving into this new era of schooling. "I won't kid you. It's been real hard. It's not easy to teach this way, but I would never go back. You can't."

In making the shift to integrating technology into their teaching, one of the greatest difficulties for teachers has been the issue of time—time to learn new technologies, time to think about them in relationship to the curriculum and the classes they teach, time to plan with others for the use of technology across the school. The more time teachers had to learn, collaborate, implement, and reflect, the more progress each school made: the less time—the more frustrated individuals felt about the project.

The Techies Team

Kevin McGillivray's office is on the second floor of the high school. McGillivray, the educational technologist for the four schools, is meeting with his techie colleagues—Oren Eddie, communications specialist; Mike Houser, the district computer specialist assigned to the four Hanau schools; and Barbara Schultz, the systems specialist. Although each one is located in a different school—McGillivray at the high school, Eddie at the middle school, Houser and Schultz in the elementary schools—all four take responsibility for the whole. Besides being in frequent e-mail, phone, and personal contact, they take time each week to meet and talk through the increasingly complex issues that arise when you must support four schools of networked computers.

Each one brings special skills to the task and they have found that diversity is their strength. Critical to their success with teachers has been that all three charged with classroom curricular support (McGillivray, Eddie, and Houser) are experienced teachers with strong instructional skills and thoughtful knowledge of how technology can support curriculum. McGillivray and Houser are former music teachers and Eddie has worked in business education and special education classrooms.

Meeting as a team provides them with the opportunity to identify emerging technical and policy issues and to brainstorm solutions to what are sometimes very complex technical questions. These issues range from how to upgrade a set of computers at one school and why a bank of Internet drops at another are not working, to how to get all students online with accounts on the server and how to route the daily technical questions.

The techies meeting is also a place to discuss the diverse continuum of professional development supports the group provides the four schools. These include one-to-one sessions, coteaching a technology tool or curriculum unit, training "technology wizards" for a grade-level, after-school training for teachers and/or parents and professional development day activities. Searching out new curricular resources on the Internet or elsewhere is also an important function of this group.

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that all families have adequate means to meet their needs. The salaries of enlisted persons, even with housing and other assistance, may not be sufficient to cover a family's costs, particularly the salaries of those just entering the service. There are many children in Hanau receiving free or reduced lunch.

Educators in the DoDEA system are attentive to the calls for educational reform within the United States. They have a Strategic Implementation Plan (SIP) that incorporates DoDEA goals and concerns with the federal government's Goals 2000. Each school develops an individual plan to address these goals, and these plans are submitted and reviewed annually. In addition, disciplinary standards are developed for each subject area.

The adopted curricula are the driving force in the Hanau schools, as in all schools in the DoDEA system. These adoptions occur in regular, staggered cycles. Teachers in the DoDEA system are deeply aware of their responsibility to cover the curriculum in the adopted package, as they are deeply aware of the year-end standardized tests. To parents, the adopted curriculum and the standardized tests provide critical checks and balances required for learning in such a mobile system.

The adopted curricula are the driving force in DoDEA schools.

These curricular packages, coupled with the professional development opportunities that accompany them, which are offered by both publishers and district offices, are the path by which new educational ideas are most likely to make their way into daily classroom life. New adoptions typically seek to incorporate the newest waves of educational theory and subject area developments. For DoDEA teachers, as for many teachers in the United States, the adopted curricula will be their primary instructional resource.

When we came to this school system in 1995, there were few computers in the classrooms, few of those were in daily use and none were networked. To access e-mail, teachers had to go to a designated computer within the school. In the middle school and the high school, students could take special computer classes, but other than that there were few opportunities for students to use computers.

Because there was little use of technology, there was little talk by teachers about technology. Although Hanau teachers were well aware of the growing importance of technology in the world around them, there was little mention or thought given

The techies group works closely with TERC staff back in Cambridge in planning professional development opportunities by communicating daily through e-mail, electronic logs, telephone, and fax. In providing professional development, this joint TERC-Hanau professional team seeks to honor the district's commitments to the adopted curriculum, provide teachers with critical support for integrating technology in their daily work, and assist teachers to become more aware of innovative practice through the lens of technology integration. They do this through building a continuum of informal and formal learning opportunities for teachers, administrators, and other adults concerned with the schools. In this way they enrich the professional culture of each school, making it a resource sustainable within the cluster.

After School at the Middle School: School Technology Committees

The middle school technology committee is meeting after school in the library media center. Each school has a technology committee that has grown in increasing importance as the project continues.

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to it in their daily classroom life.

It would not be unfair to say that in 1995 in Hanau, pen and pencil, paper, and the textbook were the critical items in the school day. Technology was, as yet, located outside the powerful circle of curricular adoptions, and, thus, had little impact on the day-to-day life of learning and teaching in Hanau.

What Is the Hanau Model Schools Partnership?

Creating the Implementation Plan (1995—1996)

In the fall of 1995 TERC began its partnership with the Hanau schools. With the help of the district superintendent's office (DSO) and the school principals, TERC formed an implementation team composed of a principal, teacher, and parent from each school, plus district and union representation. This team was the backbone of the community-based planning process that distinguished the Model Schools process.

The development of the planning team went hand in hand with TERC's ground-level assessment of the schools conducted during the first year as the initial step in the comprehensive ethnographic study of the project. In addition, TERC staff devoted thoughtful time to researching the literature and writing about a selected set of critical issues pertinent to the project: (1) the relationship between systemic reform, restructuring, and technology integration; (2) professional development in a technological age; (3) frameworks for understanding the functions of educational technology; and (4) the role of the community in supporting technology infusion (TERC 1996).

Over the first year TERC staff and the Hanau planning team developed a two-year implementation plan to guide the purchases of equipment, professional development activities, and support for community-building activities. The key features of the implementation plan were

1. an ongoing community-based planning component that includes planning team meetings and full-school community days;
2. a comprehensive professional development plan that would be anchored by an on-site educational technologist and would include individual commitments from each faculty member in the form of Technology Action Plans (TAP);

The structure and purpose of the middle school technology committee, like those at the other three schools, has changed considerably over the last year. Previously, this group was chaired by the principal, met in reaction to emerging issues, and dealt with a limited range of concerns—such as where to place the school’s stand-alone computers. Today, it is chaired by a teacher, meets regularly, shares its minutes with all faculty, and deals proactively with a range of critical issues that affect all members of the school. The change in this committee is a response to the increasing importance of technology as a resource needing management within the school.

Chaired by the computer technology teacher this year, the committee includes the library media specialist and a range of teachers—classroom teachers and specialists, some who love technology and others who see it as a necessary evil. The principal, Robert Sennett, is an important member of the committee, but no longer the sole owner of technology concerns, which are shifting to ownership by the whole school.

Topics of concern to the committee this year are the implementation of the Acceptable Use Policy—how to monitor and implement and what sanctions to employ; a check-out policy for the Alpha Smart Boards, the schedule for setting up the new computer lab, and how to support teachers to use technology in their upcoming cross-curricular study of Mars.

Today two members of the techie team, McGillivray and Eddie, sit in on the school meeting. This helps them stay aware of schools needs and concerns and provide information on various issues of immediate concern.

From the Principal’s Chair

Technology infusion has had a strong impact on principals, and high school principal Sandy Matthys is no exception. Downstairs from McGillivray’s office where the techies are meeting, she is hard at work in her office completing a Powerpoint presentation on her computer about the school’s technology progress that she will present that evening to a meeting of the Parent Teacher Association.

As Matthys works, the vice president of that organization pops her head in to ask a question. The PTA vice president is on her way to the high school media center to use the Internet facilities to find and download information for the upcoming “College Night.” On College Night, Matthys and the PTA also plan to have a computer lab open so that parents and their high school age children can surf the Web together for college resources.

Earlier that day, Matthys had conducted several formal teacher observations, an important part of her supervisory activities as principal. In watching teachers teach this year, she is surprised by how much instructional styles are changing in response to the special issues and opportunities the new technologies present. There is much more small collaborative group work now than a year ago. Matthys notes that teachers seem to be talking less, as they facilitate more. All in all, students appear to be more active as learners compared with a year ago.

For Matthys, however, the good things that technology has brought have not come without a price. She has had to gain quick mastery of new domains of technical knowledge. Indeed, at times she feels more like an engineer than an educator. To make the technology happen for students and teachers, there is much background work on the electrical system, the network, and the installation of hardware and software. Sometimes this has meant getting in and getting dirty, as when she had to learn to make computer upgrades, struggling to get her hands into the tight corners of the inner sanctum of the computer as she changed cards. Even when others carry out the work she has to be able to understand the decisions that have been made and to ensure these decisions meet the long-range needs of the school.

As technology infusion has proceeded, she has also had to deal with a problem new to the school—“technoenvy.” Two years ago, few teachers paid attention to the computers others might have in their rooms. Many teachers would have gladly passed on their computer to others, in swap for something more desirable. Today, the entire staff is intensely aware of who has what and how they use it. For instance, they know that the upgraded 486s are slower than the new Pentiums—and those with upgrades are jealous of those with

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3. access to networked computers in each classroom and a standardized software tool kit on every school computer;
4. a comprehensive qualitative research study that would provide formative data for project improvement as well as summative findings.

The creation of the implementation plan was a full-year process that began with a communitywide “visioning meeting” of faculty, some parents, and district staff December 8, 1995. In what we have since been told was a first, the three schools (the fourth school, Springfield Elementary joined the project in the second project year) met together to talk about the future of the schools. What were the educational challenges they saw emerging? What impact would technology make on their responses?

Working cross-school K—12, involving everyone in decision making, drawing all teachers into the use of technology—these were innovations for the Hanau schools. As one teacher noted in the next school year: “I talked for hours that night with another teacher about the meeting. It was so unusual for us to meet that way.” Another said, “I wasn’t really sure where you were going with all this. Truthfully, I never really thought it would happen. I’m surprised at how much we are doing now that we begin to talk about that meeting.”

The planning team, formed shortly after this meeting, followed up rapidly on the “visioning meeting” discussions with a three-day meeting in early January 1996 at TERC offices in Cambridge. It was at this meeting that the framework of the implementation plan with its emphasis on access to appropriate technologies, comprehensive site-based professional development, and community-based planning was created.

It was also at the Cambridge meetings that Hanau and TERC began to learn in-depth about what it means to be both leaders and followers in educational change. Hanau staff had deep knowledge of the students and the schools. TERC staff were knowledgeable about technologies, networked systems, and curriculum implications of technology. Over three days both parties had to learn how to trust each other, structure their interactions, share decision-making power, and develop appreciation for the different kinds of knowledge they possessed.

Pentiums. The presence of technoenvy, however irritating at times, is strong evidence to Matthys that the partnership's work has had an impact on the majority of faculty.

To keep the machines up and running, Matthys works closely with McGillivray, based in her building, and repair contractors. A broad-based school technology committee assists her with various policy issues. Besides the professional development support her teachers receive from McGillivray and others of the "techies team," Matthys has been proactive herself in finding extra professional development time in the schedule so that teachers can further hone their skills on teacher workdays. Teachers appreciate that she's kept them in charge of planning these workdays to meet their needs.

Matthys is an important link between her school and the other schools in the project. She and the other three principals are members of the implementation team, and she, like the other principals, are in frequent email contact with TERC staff about project issues.

The roles and duties the principal's job now entails are not what Matthys' original principal training prepared her for. It's not always easy to be on the cutting edge of change, and the project has tried to support her and the other principals as they work through these areas of change. TERC staff meet individually and en masse with the four principals when they visit Hanau. The principals have also had opportunities for special training during summer sessions.

The Hanau Implementation Team

The Hanau Implementation Team is assembling in the high school media center at 3:15 pm, shortly after school dismisses. The implementation team is the cross-school group that developed the implementation plan for and oversees the progress of the Hanau Model Schools Partnership. As new technology initiatives come into the schools, they are folded under the implementation team mantle.

Each school is represented at the meetings by the principal, a faculty member, and a parent. Teachers and parents are appointed annually by a process decided within the school. Four representatives of the teachers union are present as a complement to the four administrators. The assistant superintendent in charge of technology is a member of the committee as is the district technology officer for the four schools. McGillivray, the educational technologist and Eddie, the communications specialist, are de facto members of the

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The First Implementation Year (1996—1997)

The first implementation year began in August 1996 with two 2-week workshops for Hanau faculty and administrators held at Endicott College in Beverly, Massachusetts. These workshops attracted 70 percent of three school faculties, creating, by the beginning of the school year, a sizable mass of teachers with basic knowledge of the project software tool kit and individual plans for curriculum/technology integration (TAP) (Wasser 1996).

The **software tool kit** for the schools contains: *telecommunications tools* (Netscape and cc:mail); *word processing tools* (Microsoft Word, The Amazing Writing Machine, and the Student Writing Center); *spreadsheets and graphing tools* (Excel, Cruncher, Graph Club); and, *presentation and multimedia tools* (Powerpoint and Hyperstudio). In addition, there were also important peripherals included as part of this kit: MBL set-ups, in-focus projectors, scanners, and printers. Having a representative, but finite, set of tools that could be applied to most sorts of school tasks, classroom and administrative, helped teachers quickly develop skills across a range of tools. Working from this foundation, each can then customize the tool kit to suit his individual needs.

A standardized technology tool kit for all school machines: telecommunications, spreadsheets and graphing, presentation and multimedia, and supportive peripherals.

With knowledge of the tool kit under their belts, teachers were ready to develop their individual plans for technology integration. These ranged from implementing the use of Micro-based Computer Lab probes in the middle-school science curriculum to using e-mail at the first-grade or using spreadsheets and graphs as tools for elementary mathematics. Each plan was highly individual, representing a specific teacher's desires and concerns. TERC staff organized the plans in a single document that then helped teachers see the commonalities and differences across schools.

Besides classroom teachers, attending specialists also developed plans for technology integration in the areas of physical education, special education, health, home economics, art, and music. Interestingly, their involvement led to one of the strongest findings about the impact of the project (as reported by a focus group of specialists), namely, the opportunities and invitations it has provided to specialists working in the classroom with regular teachers. For instance, at the middle school the school nurse and the home economics teacher joined forces to teach an Internet-based health unit. At one of the elemen-

committee—serving as unofficial staff and counselors to the group. Besides the parents, the community is represented by the Hanau Army Base educational liaison.

This assortment of some 20 individuals is the first group of its sort working across all four schools, and, as such, it has had to forge much new ground. Members have had to be thoughtful, creative, and patient in learning how to bridge their various divisions, developing common goals, and sharing resources. For instance, there is no single chair for the group: leadership rotates from school to school for each monthly meeting. The new ways of doing business open new opportunities. For instance, parent members comment that the implementation team offers them a unique chance to work shoulder to shoulder with teachers and administrators on the hard issues of education.

There is a guest at today's meeting: Liz McNamara, TERC's project director for the Hanau Model School Partnership. Although McNamara was pivotal in initiating this group, she, like group members, maintains that the implementation team must be owned and operated by the schools.

McNamara is at the meeting to discuss the year's future activities and TERC's support for that work. Some of these activities were laid out in the original implementation plan that the TERC team hammered out with the implementation team. For this year, these include a full-day planning retreat for the implementation team that TERC will coordinate, professional development opportunities for teachers to work with curriculum area specialists to better integrate technology in their classrooms, and updates on a new technology project recently awarded to the district.

The implementation team is where it all comes together—this is the place where the classroom developments and activities, the emerging policies, new structures, and system concerns are knit together into one whole. Concerns percolate up to this group from the schools and issues broached in this group are funneled back to teachers, parents, and school technology committees. It has been a long time in the evolution, but this group has come to play a critical role in the management of widespread, interconnected technologies within the school.

Family and Community Participation

Classrooms that make extensive use of technology, in the ways that one sees in the Hanau schools, do not look and feel like the traditional education many parents and community members expect. Rightfully, they wonder if the new ways really are better and if children really are learning more with these tools. From the beginning, the Hanau Model Schools Partnership recognized that the project would fail without support from families and the community. Here are some of the ways they participate:

Base Command and community participation includes

- Base educational liaison serves on the implementation committee
- Base commander receives regular briefings on the progress of the project
- Base command honors teachers for their participation in this work with a breakfast the morning of the May 1997 four-school community day
- Base liaison arranges publicity to the military community
- Base librarian attends 1996 summer training with Hanau teachers
- Base librarian has software tool kit installed on all library computers for student and parent use
- PX stocks software tool kit items

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tary schools, the PE teacher worked with third-grade classes to measure heart rates and chart them using the Excel spreadsheet program.

Teachers implemented their plans across the school year with support from the newly hired educational technologist, Kevin McGillivray, who left his job as high school music director in December 1996 to serve in this role. McGillivray and Mike Houser (who was already located as a technology person in the Hanau schools) began the collaboration that led in the second implementation year with the addition of Barbara Schultz, administrative technologist, and Oren Eddie, communications specialist, to the “techies team.” At the beginning of the year their energies were focused on installing the equipment and stabilizing the system; as the year progressed, they branched out in multiple directions with professional development activities.

Iterations of the December 1995 Visioning Day continued in the first implementation year with the fall and spring community days that, again, brought together all school faculty members and administrators. Sportfield Elementary School joined the cluster in September 1996, and community days also served to integrate them into the larger group.

The Hanau Implementation Team, a group representing all four schools, community, and parents, coordinates and oversees technology infusion efforts.

The fall of the first implementation year, the cross-school team passed from the temporary status of a planning group to the more substantive role as an implementation team, now dubbed the Hanau Implementation Team (HIT). Then, key decisions were made about membership and representation, and leadership. Meetings became a monthly affair. A full-day retreat in the winter of 1997 provided further opportunities for group members to congeal as a team.

Part of the congealing process entailed the group’s response, initiated at the retreat, to a Request for Proposal (RFP) from a new technology program in the DoDEA system—the President’s Technology Initiative (PTI). The implementation team’s proposal to the PTI became an opportunity for the group to declare who they were and what they believed. The plan they presented to the PTI became an important historical document and reference point in the project’s life. The guiding notion in their proposal was that *all* teachers and students in the four schools must be included in any technology initiative. The four schools and the district superintendent’s office had come to see themselves as allies with a shared educational goal.

Parent involvement includes

- A parent representative from each school serves on the implementation committee
- Parents participate in computer training workshops
- Parent members of the implementation committee help develop a brochure just for parents
- Parents participate in school “upgrade parties”
- Parents volunteer in classrooms, helping students with technology tasks
- Students demonstrate technology uses to parents at Technology Day and Open House
- Parents receive frequent information in parent newsletters and teacher conferences and through their child’s homework and comments



While there were many successes in the first year, there were also frustrations. Shipments of equipment met mishaps and were mislaid in transit. Upgrading old machines and integrating them with the new caused its share of headaches. And there were moments of doubt, as participants became frustrated with the scale and pace of the changes that technology infusion required from them.

Yet, by the time the school year drew to a close in June 1997, principal and teacher interviews indicated that expectations for individual and project goals had been met, and, indeed, had been exceeded by most. As important, there was almost 100 percent participation on the part of faculty across four schools, which meant that the majority of students in the four schools were gaining benefit from the technology already. All four principals reported “technoenvy” on the increase among staff—another sign that technology was fast becoming a coveted, rather than an ignored, item.

By the end of the first implementation year, almost 100 percent of the four school faculties were using some form of the new technologies in the schools.

Why, we asked ourselves, had this project been successful in gaining such widespread participation, when others we had read about or visited, ended up, ultimately, involving smaller numbers? It appeared that our tactic of involving all school adults from the beginning (as opposed to selected groups of torchbearers) had much to do with our success. The success of technology infusion, we learned, has much to do with opening up new space for schoolwide change in professional culture. By involving everyone, we ensured that everyone could be included in the conversation, and this created a critical mass that was moving in the same direction at the same time across the first implementation year.

The Second Implementation Year (1997—1998)

The second implementation year also began with a round of summer training. This time Hanau teachers gathered at the air force base in Aviano, Italy, with teachers from schools across the DoDEA system. The Aviano summer workshop mixed Model Schools training with opportunities offered by the President’s Technology Initiative. The larger offerings allowed the 47 Hanau teachers who came to Aviano to mix and match professional development opportunities to fit their needs. Some elected to continue with projects and tools begun in the first year. Others chose to learn new tools or focus on new initiatives available to them.

Those who were not able to attend the training in Aviano had the opportunity for two days of training in Hanau just before the start of school. Fifty-eight teachers availed themselves of this opportunity to learn about classroom management of technology and to refresh their memories of the basic software tool kit.

With the Model Schools training sessions, week-long district training sessions offered after the end of the school year, and various DoDEA sponsored trainings during the summer months, almost every Hanau teacher participated in one, and some participated in several, technology learning opportunity above and beyond the usual professional development days during the school year.

For this and other reasons, the second implementation year presented different issues and challenges from the first year. Issues about initial setup and installation are behind us. The breadth of supports now available to teachers, compared with October 1995 is staggering. Besides the four-member techies team, teachers' and students' expertise have grown considerably. The school technology committees have been reshaped and are linked in substantive ways to the implementation team. Increasingly, district office curriculum specialists and leaders of special initiatives are connecting to technology and project goals in more thoughtful ways, providing greater support from this arena.

In the second year of the project, a number of new professional development opportunities are available to teachers that represent their growing sophistication as users and consumers of technology-integrated professional development experiences. Across the year, curriculum specialists in selected subject areas (all of whom have worked with Hanau in earlier training situations) will return to Hanau to work with teachers who would like more hands-on help integrating technology into specific subject areas. Each consultant has been picked for her understanding of appropriate technologies, her knowledge of teaching, and her ability to demonstrate innovative curriculum and instruction that attends to pertinent directions of educational reform. The consultants will spend at least a week in Hanau, coteaching with teachers, meeting individually and in groups to discuss cotaught lessons, and training teachers at more advanced levels on the technology tools they have elected to use with their subject areas. These curriculum experts seek to build on the adopted curricula provided by the DoDEA system.

During the summer of 1997, almost every single Hanau teacher participated in one, and some participated in several, technology learning opportunity above and beyond the usual professional development days.

Cathy Miles Grant, TERC's professional development specialist, worked closely with TERC colleagues and consultants to develop this model, and she has led the way to implementing it with elementary teachers seeking to integrate technology into their math curricula. She began this process in the planning year, meeting with DoDEA math specialists and studying the adopted elementary mathematics curriculum (Mathlands) in great depth. From that study she developed model lessons that demonstrated the link between the goals of the adopted curriculum and graphing and spreadsheet software tools. In the first summer training workshop, she conducted training workshops in these software tools that introduced teachers to the model lessons. Then, across the first implementation year she had e-mail communications with the same group of teachers, providing them with support as they began to make use of the new technology in their classrooms. McGillivray, the educational technologist, also served as a bridge between Grant and this group, providing extra support to them in her absence.

In the second implementation year, TERC developed a coteaching model that deepened the impact of technology on specific curriculum areas.

Spring 1996, Grant returned to Hanau and spent intense days coteaching with elementary teachers and meeting and talking with them about the lessons. At a Saturday workshop, teachers from both elementary schools gathered together to review the student-made products and to talk about the ways that technology had, or had not, contributed to students' understanding of data representation.

Fall 1997, Grant returned again to Hanau to continue this intensive hands-on work with a growing circle of elementary teachers. Over time, as the teachers have developed a deeper relationship with Grant, their e-mail correspondence with her has also increased. Now that the teachers share vocabulary, concepts, and experiences on the issue of students' understanding of data representation with Grant, they find it easier to talk with her in person and through electronic channels—and the correspondence grows in volume and thoughtfulness.

In the second implementation year, Grant will help TERC's subject-area consultants understand the principles of this model, implement it, and review it to consider how best to improve it. The principles of this model include the following: start from the learner and his curriculum requirements, make professional development an ongoing dialogue between mentor and teacher, show people what you mean (don't just tell them), keep in mind the aim toward more challenging

curriculum that requires more active learners, make student products and the thinking behind them a focal point of discussions with teachers, provide multiple opportunities in different forms and frameworks for teachers to work with the ideas and tools—deepening the conversation each time you circle back (Grant 1998a/b).

In tandem with Grant's professional development work, Project Director Liz McNamara continues to work a parallel strand of activity around the development of technical support, policy, and leadership at the cluster. Specifically, this work includes supporting the techies, principals, and district office as they strengthen and expand the work of school technology committees and the implementation team.

The Hanau Model Schools Partnership has begun to exercise strong pull on DoDEA's Hessen district in which it resides. Based on the Hanau experience, the Hessen district office made extensive technology purchases to be able to place a computer on the desk of each teacher in the district. Many of these computers will be networked. All will be configured with the basic software tool kit found on the computers of the partnership schools. McGillivray, the educational technologist, has already begun to assist other district schools in their training needs. Fall 1997, district administrators were introduced to the model of the Hanau Model Schools Partnership, touring the schools and meeting later to discuss the critical components of technology infusion.

In the spring, the four schools will come together once again as a full body to share their progress and to celebrate their successes. These community days, which at the beginning of the project were considered suspect at best and wasteful at worst, are now deemed valuable professional development opportunities. The attitude of "I teach high school, what good will it do for me to talk to kindergarten teachers about the use of technology!" has given way to a strong collaborative ethic, which sees value in shared discussion with other teachers, recognizing the need for such time and processes among communities of educators.

Looking back over the three-year process that developed the Hanau Model Schools Partnership, most striking is the way that a few general good principles, encoded in a loosely structured framework of activities, allowed a cohesive layering process by which classroom experiences, professional development, the creation of new structures, policies, and leadership

Principles of the coteaching model include

- start from the learner and curriculum requirements;***
- make professional development an ongoing dialogue;***
- show, don't just tell;***
- keep challenging learning goals in mind;***
- make student products and thought central to the conversation;***
- provide multiple invitations to teachers.***

This is evidence that the schools and the cluster have increased their capacity in multiple ways—educationally and technologically—and that is the goal for technology infusion.

Technology infusion is a new phenomena in schools, and qualitative research, with its emphasis on description and participants' experience, would help us develop detailed illustrations of what it looks like and how participants experience the process.

forms could be implemented in linked fashion. Project leaders actively sought to connect these focus areas in a meaningful way for participants. Today, when one enters the schools, it's hard to separate the project layers and their effects, and that is a desirable outcome. It means that there are increasing pathways and links between activities and participants and that these linkages are both thick or numerous and robust. This is evidence that the schools and the cluster have increased their capacity in multiple ways—educationally and technologically—and that is the goal for technology infusion.

Researching Technology Infusion

We elected to use a qualitative research design as the basis of our formative and summative evaluation for several reasons. Technology infusion is a new phenomena in schools, and qualitative research, with its emphasis on description and participants' experience, would help us develop detailed illustrations of what it looks like and how participants experience the process. The project was an opportunity to look closely at a specific site, which qualitative research is well designed to do.

In hindsight, we realize that qualitative research had another critical implementation function that we only became more deeply aware of as we proceeded with the project. Qualitative research, with its numerous observations and interviews, conducted in this case by the research director, Wasser, provided opportunities for a continuing conversation with teachers and administrators about this work over the life of the project. Several times a year, they speak with her formally and informally: "How's it going? What have you learned? What kinds of problems are you encountering? What advice do you have for others? What are the next set of issues we should think about?" These simple, almost timeless questions about project work, asked again and again of participants over two years have had, if our informants are to be believed, an important cumulative effect. We have "grown" an expectation for reflection. This finding about the value of qualitative research—conducted in a cohesive fashion across the length of the project as opposed to in segments or in case studies—to project implementation demonstrates the importance of the kind and quality of "talk spaces" in this sort of project work and the importance of continuity in project personnel.

Each year of the project, our work has been guided by an evolving set of research questions:

Year 1:

1. What is the nature of teaching, learning, and technology use in the Hanau schools?
2. What are the opportunities for technology infusion at the site?

Year 2:

1. How does the Hanau Model Schools Partnership impact teacher, learning, and technology use in the Hanau schools?
2. How does the site develop and coalesce in response to the challenges of technology infusion?

Year 3:

1. What is the continuing impact of the project on educational practice, professional culture, technology leadership and management, and family and community participation?
2. With the influx of the President's Technology Initiative, how does the site build on the foundation laid by partnership activities to manage the new resources and deepen the work now underway?

In Year 1, we developed a “baseline” of information. In Years 2 and 3, we created “data layers” to compare against the baseline.

In Year 1, the planning year, using ethnographic methods that included interviews, observations, and photography, we developed a “baseline” of information on the Hanau schools, which we could use to compare and contrast with the work accomplished in Years 2 and 3 of the project. In that first year, we conducted five site visits and produced a lengthy report describing the site in detail and its technological readiness (Wasser 1996).

In Year 2, we built upon the baseline of data and interpretations developed in Year 1. Our Year 2 work began with the careful documentation of the summer training sessions and the subsequent analysis of participants' plans. A popular version of our findings was published in TERC's *Hands On!* (Wasser 1996). During Year 2 we also conducted five field-

work visits to Hanau. During these visits we conducted more than 300 interviews (individually and in focus groups). We also made classroom and schoolwide observations at each of the four schools, documenting special events and collecting pertinent artifacts.

From Year 3, we intend to build yet another “data layer” that can be compared against the first year of baseline data and the second year of information about impact. Besides several fieldwork visits planned for the year, we will conduct a student and parent survey in the fall of Year 3. We are concerned with developing a deeper understanding of what access to technology now means in the four-school complex, as well as seeking broader participation from parents in the technology work.

Across the three years, we have followed a fairly similar pattern for analysis of fieldwork materials. After each fieldwork visit we conduct a preliminary analysis of our materials, creating tables, logs, and memos, to describe findings and patterns emerging at the site. At the midpoint and the conclusion of the school year we conduct intermediate analyses of our data. For the intermediate analyses we review all materials for that period as a whole and develop interpretations and hypotheses from that more comprehensive review. In this, our third and final year of the project, we have begun a re-analysis process of materials using NUD.IST software as a tool for interpretation.

Besides TERC’s own use of data and analysis for formative evaluation, whenever possible we report emerging research findings to participants, a practice that allows them to learn from our research as we do.

Critical forms of data that do not spring from fieldwork visits are the educational technologist’s (McGillivray) and communication specialist’s (Eddie) logs. These documents have been invaluable for gaining a day-to-day perspective on project activity. Through ongoing analysis of their content we can see how the shape of the work in Hanau changes over time, how new priorities arise and old ones fade. E-mail, letters, and other artifacts are another part of this important, non-fieldwork documentation.

Technology Infusion: A Systemic Proposition

The Hanau Model Schools Partnership is testimony to tech-

nology infusion, the widespread integration of technology across schools and districts in tandem with changing expectations about many areas of educational performance, as a systemic proposition. Changes in the classroom are closely related to changes occurring among teachers in the ways they think about teaching and about their relationships with colleagues. Tensions about technology force changes in school structure, leading to new policies and opportunities for leadership. The technology project has been the catalyst for new forms of involvement in the schools for families and community members.

Based on our experience in Hanau, we have come to believe that if technology infusion is systemic, one should see changes occurring in four related dimensions: educational practice, professional culture, technology leadership and management, and school-community involvement and family participation.

Educational Practice

By *educational practice* we refer to the composition and conduct of classroom learning activities and the growth of students' knowledge, skill, and experience as these evolve over the school year from engagement in these activities. It is the goal of the Hanau Model Schools Partnership to promote the use of technology as a means of delivering a richer and more challenging curriculum to *all* students.

In Hanau, technology infusion led to changes in teacher and student roles within the classroom, strategies for classroom management and instructional strategies, not to mention the introduction of new curricular resources that offered, themselves, new instructional possibilities. Many reports have come from students and teachers on renewed interest in classroom activities. Though in some cases the actual impact on student learning may seem slight, there is growing evidence that in many cases the impact on learning is deepening. The changes we have seen within Hanau classrooms reflect many touted goals of national reform and appear to be leading to more challenging, thoughtful learning for all students.

Professional Culture

By *professional culture* we refer to the social medium in which adults in the schools interact, grow, and develop as knowledgeable educational professionals. At the heart of a school's professional culture is the composition and conduct of edu-

If technology infusion is systemic, one should see changes occurring in four related dimensions: educational practice, professional culture, technology leadership and management, and school-community involvement and family participation.

cators' formal and informal learning activities and the growth of their knowledge, skill, and experience as these evolve over the school year and across their careers as educators. For educators, learning about technology should be a pathway to deepening their understanding of the craft of teaching.

In Hanau, there is no doubt that across the four schools, all teachers have increased their technological knowledge as well as their base of pedagogical and content knowledge. Teachers also say that the schools have become more “collegial” places in which to work. For the first time in their memories, faculty have a shared professional topic of substance in which to engage. Over the last year they have spent increasing amounts of time working together—teaching and learning together, talking about what they are doing and learning, and planning for the school and cluster.

There is much evidence that technology infusion has led to the development of a richer, more vibrant and supportive professional culture. The legacy of the project is a technologically knowledgeable faculty and staff with increased capacity for supporting each other's professional development. The educational technologist and his colleagues on the techies team have played a key role in the evolution of this new professional culture.

Teachers say that the schools have become more “collegial” places in which to work.

Technology Leadership and Management

Technology leadership and management can be defined as the matrix of formal administrative structures and policies through which learning experiences and resources are organized within and across schools. This includes the various school committee and planning processes, school leadership roles, and the activities of principal and district administrators. We hypothesized that if technology infusion were to be successful in Hanau, we would see the development of new structures, policies, roles, and resources to support learning in technologically rich environments—and this is what we have seen.

In Hanau, the changes in this dimension have occurred on multiple levels. Students and teachers share in the management of technology at the classroom level. Teachers and principals work together in reshaped technology committees to organize and support classroom uses of technology, and they participate in a clusterwide policy group—the implementation team. The techies team provides maintenance, as well as

support in the identification, formation, and implementation of the newly emerging policies.

School-Community Involvement and Family Participation

The *school community* is the collection of school and community services that support and extend young people's educational experiences beyond the boundaries of the school day. Such services may include youth groups, the public library, religious organizations, school committees, and local governmental departments. The category of *family* includes family members and friends, older and younger, who support the learner and are concerned about his or her educational development and learning opportunities. The support of the school-community and families is critical to ensuring that technology learning opportunities are maximized and that the schools' long-term technology goals can be achieved.

Probably my strongest sense that something different was happening in this realm came when I attended the Argonner Parent Open House in the Fall of 1997. With the soldiers just back from Bosnia, and parents who had long been separated and eager to take part again in their children's lives, the school was filled to overflowing. Almost every teacher had 100 percent of her students' parents visiting that evening. In the third-grade, I watched a young boy describe to his mother how to use Excel to graph information. He told her how he had gone about conducting a survey and inputting the information, and how that information was then turned into a graph—a comparable form of data representation. He showed his mother how to switch from a bar graph to a pie graph, and he explained why it would be better to use one rather than the other.

I wondered if his mother felt the same sense of awe that I did as I listened to this young social scientist; I didn't have the chance to ask her. But I do know that parents and other community members in Hanau, who are generally in favor of computers, recognizing that this is the way of the future, are beginning to understand the place technology will hold in the curriculum and the reasons they need to ensure it is used appropriately to maximize students' potential.

Thus, in Hanau, technology infusion, because it is understood to benefit learning, has increased the bonds between school, community, and families.

The support of the school community and families is critical to ensuring that technology learning opportunities are maximized and that the schools' long-term technology goals can be achieved.

Emerging Questions

That the project has been successful in the main does not mean that there are not important questions still present. There are things that could have been done better. There are also issues, only now emerging, that must be grappled with in the next round.

While the first round of analysis indicates that technology has led to improved learning, we need now to ask—What are the specific effects of technology on learning? How are children benefiting? Are all children benefiting? We have strong evidence that for some children with special needs technology has provided exceptional benefit. For example, the preschool special education teacher uses the Amazing Writing Machine to turn out a daily language experience letter to the parents of her students, helping these children build on the new language introduced in class. There are also children with serious writing problems at the middle school who have improved from the use of a Smart Board for all their notes and writing.

Although the first round of analysis indicates that technology has led to improved learning, we need now to ask—What are the specific effects of technology on learning? How are children benefiting? Are all children benefiting?

However, more and more Hanau teachers are raising concerns about those poor achievers who seem to be falling further behind with the influx of computers. Internet reading activities may be challenging, as text found on the Internet can be uneven and written at levels higher than these students can comprehend. They tend to approach technology tasks as reading tasks with a limited ability to generalize across functions and little tolerance for failure. To the teachers' surprise, computers are not the answer for everyone, and, for many who are already experiencing school failure, computers may be yet one more reason not to engage. This is a serious issue that must be dealt with as more and more schools infuse technology.

We have also found that the nature and character of technology infusion is different in each individual school culture. Technology, in and of itself, does not solve deep issues of institutional confusion. For example, e-mail supported and made possible the expansion of professional contacts within the schools. Where professional contacts and good will were below a certain base level of functioning, however, it could do little to resurrect positive feelings or nurture new professionalism. Indeed, its presence and the many demands that such an initiative made on a system could further exacerbate an already weakened culture and structure.

Technology infusion also unfolds differently within the grade-level institutions of elementary, middle, and high schools. We know little yet about what to expect in the way of technologically infused educational practice within these unique domains.

Technology infusion creates opportunities not only to think within but also across schools. As a result of our work in Hanau, many there began to look anew at the K—12 continuum. Such scrutiny raised both the strengths and the weaknesses of that continuum to view. Although the Hanau Model Schools Partnership is only one isolated case, our experience with it has made us increasingly concerned about middle schools in the K—12 spectrum of technology infusion. Lacking true agreement on who they are, who they serve, what they should be doing, and how they should be organized, the middle school, more than the elementary school and the high school, has the potential to be a weak link in the K—12 chain. For this reason, technology infusion may be an opportunity to revisit and renew support for improvement at the middle grades.

Educational technology, as it is coming to be viewed in the last decade of the twentieth century, is a systemic proposition integral to the daily practice of schools. The work of the Hanau Model Schools Partnership has provided important opportunities for exploring just what this might mean and how it might best be achieved.

Educational technology, as it is coming to be viewed in the last decade of the twentieth century, is a systemic proposition integral to the daily practice of schools.

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