

**Electronic Networks and Systemic School Reform: Understanding the  
Diverse Roles and Functions of Telecommunications in Changing School  
Environments**

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The Virtual Geography of Networked Schools

Networked schools, that is, schools in which there are a plenitude of high capacity networked computers, available in every classroom, as well as in central locations like labs and libraries AND a teaching force that is knowledgeable and experienced in using such tools--are a very new phenomena. In 1996 only 9% of schools in the United States were connected to the Internet, and of those schools that were connected, only a handful offered more than minimal access (US Dept of Education, 6/29/96).

In most schools, digital educational technology has been entering the scene gradually--initially as stand-alone computers with limited capacity accompanied by a small range of software tools, and, more recently, electronic networks have made possible the use of email and following that access to the Internet. Even today, although the rate of schools that can access electronic networks is growing phenomenally, the majority of these schools are not what we would consider "networked schools:" too few networked computers available to teachers and students and too few staff with the requisite skills to work effectively in such environments. A 1996 Rand Corporation study found "[E]xamples of schoolwide use of technology are comparatively rare and isolated. Use of technology instruction tends to be by individual teachers. Few schools as a whole have

embraced technology and used it to transform the content and mode of instruction (Glennan & Melmed, 1996, 1-2).” Those few schools that would qualify as “networked schools” have not been in place for enough time to sort out the impact of technology on school culture.

Not surprisingly, studies of educational technologies tend to approach the technologies and their functions as separate and discrete occurrences within limited contexts. Thus, we have studies of students using particular kinds of software, teachers or students using email, the use of the Web as a teaching tool or electronic networking as a tool for professional development. Such studies provide us with important information about the parts, but do little to help us conceive of the whole. The result is that our

conceptualization of any one school's virtual geography<sup>1</sup> has been partial and uneven, driven by the prevalent hardware or software entering the school in different streams.

Truly networked schools, however, possess a unique virtual geography that is composed of three major features:

1. Networked work space combined with a defined set of common software tools and peripherals
2. Electronic mail for internal electronic communications
3. Internet (email to the outside and Web activities)

The co-presence of these three components offer school members possibilities that unfold in an integrated fashion not possible in schools where these strands exist in separate domains. Thus, the virtual geography of a networked school must be seen as more than the sum of these three parts. While this formulation may not seem strange to computer engineers, for most educators it is a distinctly different way of thinking about a school's technology. As more and more schools enter this realm, more and more educators will have to come to grips with their schools' changing virtual terrain and the issues it poses for their practice.

In this article, we argue that the virtual geography of networked schools is qualitatively different than the virtual geography of schools in earlier stages of electronic access. Making the shift from being a non-networked (albeit with digital technology) to becoming a networked school requires a significant reorganization across schools' practice, culture, structure, and activities. It is critical that we understand the differences between pre- and post-networked schools and the ways electronic networks affect school life.

Piaget's notion of accommodation and assimilation offers a good model for thinking about the ways we need to shift our thinking. As new technologies came into the school, we accommodated: to understanding software, to learning about email, and to beginning to use the web. Now we have to assimilate those possibilities into a wider

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<sup>1</sup> By virtual geography we are referring to the growing number of metaphors that imply a geographic reality

framework of educational purposes and practices--shifting our thinking so that we no longer see various technologies and their functions as separate items, but rather as part of a larger networked whole (a cohesive virtual geography) that has complimentary parts. Understanding the new virtual geography of schools has profound implications for conceptualizing school--its culture, structure, and content.

The development of networked schools occurs in an atmosphere of intense interest about the problems and possibilities of our educational system. The primary goal for educational reform is to engage ALL students in deeper, richer curriculum and to realign school structures and resources to meet this goal (McNamara, Grant & Wasser, 1998). Technology could contribute much to this drive for systemic educational reform, just as it has the potential to detract from this work. For this reason, we must carefully consider the development of networked schools in light of our goals for educational reform.

If we are to truly understand the scope and implications of the networked school as it is coming of age in an era of systemic education reform, there are several questions that we must answer. These are: *How do teachers develop a notion of the networked school and its components? How does it affect their practice to teach in such schools? How are the changes that come about as a result of learning to work in a networked school related to systemic reform goals? What are the implications of the development of networked schools for technology integration and systemic education reform?*

In this article we will describe one school district's development as a networked school, examining the process by which teachers came to grips with their schools' "virtual geography" and the impact that these changes had on their practice in light of educational reform goals and expectations for systemic change. We conclude with a discussion of the implications of what we have learned for large-scale technology integration in schools and to the educational reform movement. Our discussion and findings are based on the work of the Hanau Model School Partnership--a wide-scale technology integration project in a K-12

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for computers and what we do with them.

cluster of four schools on the American army base in Hanau Germany. We are in the third year of working with this district.

In opening this discussion, we must admit that hind-sight is 20-20. The path that has led us to what we are presenting today has been a long and arduous one. We have also been guilty of not seeing the forest (the networked school) for the trees (the component parts) until we reached a certain distance and vantage point. Like many in this field, we individually held strong assumptions about what aspect of technology was most important and would have the most impact on educational life, and we have had to reassess those views in different ways.

To give you an example, Liz thought the significant impact would be from the Internet and the opportunity to communicate with educators and others in distanced places and the possibility of collaboration with other classrooms. For Cathy, it was going to be specific software tools introduced in ways that deepen processes of inquiry and reflection that would impact teacher thinking and practice. Judy was more interested in the communication that teachers were going to be having throughout the school as they organized and implemented work with computers. To be perfectly honest, Cathy and Judy still find themselves mentally separating out work with software applications from the notion of the electronic network as a concept, even though they know intellectually that it is part of the same package--and growing ever more so with each reiteration of the software. The ways these electronic pieces were connected through servers was such a "natural" notion to Liz that, for some time, she did not even realize that Cathy and Judy saw the issue differently from herself.

Our views about the electronic network and our conceptualization of its constituent parts and their importance to the school had implications for what we thought would work and why. Each of us has at various times tried to impose our views on the others and shape the work based on our assumptions. It has only been over time, and through much

dialogue, that we have begun to emerge from the trees and have begun to perceive the forest within which we had been standing. This paper is a result of that process.

## The Hanau Model School Partnership

### Context and methodology

Initiated in 1995, The Hanau Model Schools Partnership is a *technology infusion*<sup>2</sup> project located in a K-12 complex of four schools (two elementary, one middle, and one high school). The four schools serve a total student population of about 1,400 students (the children of both officer and enlisted people) and almost 120 teachers, administrators, and other specialists. The members of the partnership are TERC, a private educational research firm located in Cambridge, Massachusetts (and our employer); the Hanau schools and the Hessen District Superintendent's office; DoDEA--the central office of this school system that spans the world; and the National Science Foundation (NSF).

The project has two specific aims: 1) to infuse technology throughout the four schools so that learning with technology becomes a deeply accepted part of daily school life for all members of the school community; and, 2) to actively support the development of exemplary teaching approaches consistent with local and national educational reform goals and that make good use of new technologies.

From the initiation of the project, we have been studying the planning and implementation efforts of this cluster of four schools using qualitative research methodology (Wasser, 1998). In addition to classroom observations, surveys, and interviews with teachers, administrators, and students, we have also developed an extensive bank of photographs of work-in-action as well as an inventory of drawings by elementary students depicting their computer use in action. Since December 1996, we have been collecting and analyzing daily electronic journals from the Educational Technologist, a key individual detailed to support teachers to work with the school

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<sup>2</sup> Technology infusion is a trade-marked term from this project. We use it specifically to refer to the intersection of wide-scale technology integration with educational reform goals, as they are manifested within schools and districts in standards-based curricula, school improvement plans or other forms.

technologies. Since August 1997, we have been collecting and analyzing daily journals from his counter-part, the communications specialist.

As is standard ethnographic procedure, we analyzed our data simultaneously with the conduct of the study and have developed a series of interpretive memos and intermediate reports as we have moved through the various implementation phases. We are now using NUD.IST software for organizing and re-coding the stacks of data as we move into the third and final year of the study. Understanding the diverse roles and functions of electronic networks in this changing school environment has been an important component of the research effort.

The work we have undertaken is systemic in nature, and for that reason, it was critical that we find a way to identify the various spaces within the system where we should look for evidence of systemic change. The four interlocking arenas in which we have looked consistently for evidence of such change are: 1) educational practice; 2) professional culture; 3) technology leadership and management; and 4) community involvement and family participation. In discussing the impact of the electronic networks in Hanau we will be returning frequently to these four categories. For that reason, they are important terms to define:

<b>Educational Practice</b>	The composition and conduct of classroom learning activities and the growth of students' knowledge, skill, and experience as it evolves over the school year from engagement in these activities.
<b>Professional Culture</b>	The social medium in which adults in the schools interact, grow, and develop as knowledgeable educational professions. This includes the composition and conduct of educators' formal and informal learning activities and the growth of their knowledge, skill, and experience as it evolves over the school year and across their careers as educators.
<b>Technology Leadership and Management</b>	The matrix of formal administrative structures and policies through which learning experiences and resources are organized within and across schools
<b>School-Community and Family</b>	The school-community comprises services that support and extend young people's educational experiences outside of the normal school day...and the family members and friends who support the learner and are concerned about his or her educational development and learning opportunities

### Becoming a Networked School

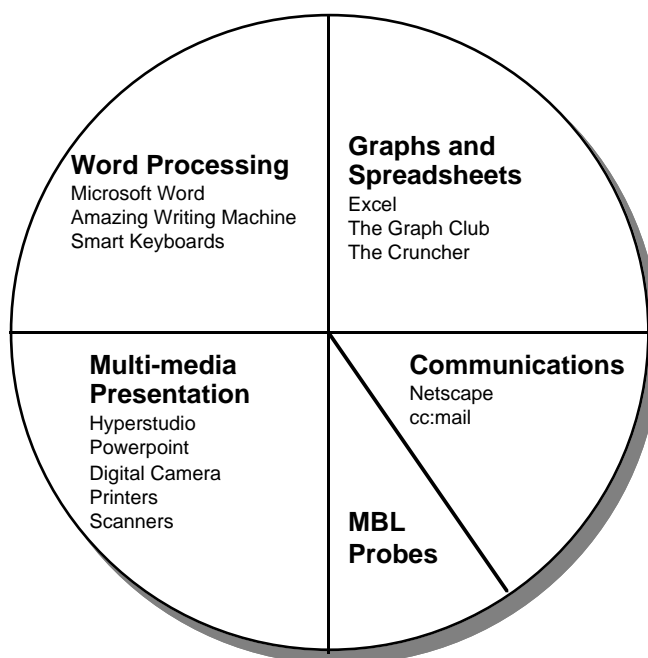
We began this project in Fall, 1995. The four schools were each in the process of cabling network access into every classroom. A concurrent DoDEA initiative provided support for Internet access as well as applications access and provided about 100 new computers across the four schools. However, these changes had only affected classroom practice in about three to five classrooms in each school. For most teachers, Internet access was provided by a single computer with modem in a central location that teachers could use for personal and professional purposes and one for the principal for his or her administrative work. There were a lot of stand alone computers in the schools, Apple IIGS's in the elementary schools and IBM 386's in the Middle School and a few in the high school. Each school had a computer lab, and each school had a teacher who earned a little extra pay to help others with computer problems. The Middle School and High School each had a computer lab teacher who taught students (who opted for the computer

class) how to use basic software packages, and, in the High School, beginning programming skills. Technology had little relevance to the central work of the schools: the core curricula.

The Hanau Model School Partnership provided planning mechanisms for the schools to think about using these resources very differently. With the addition of another 100 multi-media computers, and upgrades for the 160 existing computers in labs and media centers, and district investment in another 100 computers, the schools found themselves with almost 500 networked computers. During the first year of the project, the TERC team worked with the district office and the principals to create a planning team, which came to be known as the Hanau Implementation Team, or HIT. The HIT included representatives from all four schools, parents, the community; and the district office. It began to grapple with decisions on computer placement and access and on ways of using technology to meet the district education reform goals. Using a shared decision based model, which was also suggested by TERC, the group made recommendations that resulted in every administrator, specialist, and classroom teacher having access to a networked computer in his or her classroom or office. Classrooms all possess at least two networked computers, and may have up to five. There are updated labs filled with networked computers in each school and more networked computers in the libraries.

Each of these computers is capable of accessing the Internet, supports DoDEA electronic mail software, and has software applications for: word processing, presentation, communications, graphing and spread sheets, and other peripherals and computer packages.

## The Model Schools Tool Kit



The application software in the toolkit is actively available from any computer and much of it is housed centrally on in-school servers. Each adult and child in the four schools possesses 20 mgs of work space on those servers. This means that the networked workspace now has many purposes--both a public and private work space, a blackboard, or storage space. All the items in this work space can be mixed and matched (text, visual, and auditory) in ways that are unthinkable in the non-digital space.

Peripherals such as separate keyboards with limited memory (there are 50 in each school) extend the numbers of machines available for basic word processing functions even further. In addition, teachers have learned to mix and match new and old technologies, and, in many classrooms teachers have repurposed older machines using them for word processing or other simple computing functions.

One of the toolkit items is the email package--cc:mail. Every adult in the system has an email address and addresses are being built for students, either individually or as classroom addresses.

In Hanau, four positions support the networked system. The project educational technologist, the communication specialist, a district educational technologist, and the administrative technologist. Individuals in the first three jobs focus primarily on professional support for the four schools, providing a range of informal and formal learning opportunities for teachers, administrators, parents, and community members in regard to technology integration in the service of school learning. The fourth in that list--the administrative technologist--has sole responsibility for support of the network and servers. The four, known as "the techies" work closely together, providing each other with collegial support for the myriad of tasks that arise in a networked school. Although all of the techies provide services to all of the schools, each one has his/her office in a different school, ensuring that there is at least one person with special technical expertise located in each building.

#### Professional Development Activities

Teachers began to learn about the toolkit applications (including email and Netscape for Internet access) during the summer of 1996 at two two-week workshops that were attended by about 70% of the professionals in three of the four schools (the fourth school entered the project the next fall). We were struck by how little the teachers knew about computing--much less than most people who worked in offices. Those two weeks were devoted for the most part to very basic questions like what is hardware and software, what are the pieces of the toolkit, and to beginning to think about how the applications could be applied to classroom work (Wasser, 1996).

Much of the first year was devoted to exploration--teachers and students exploring what the software looked like and how it worked--and teachers exploring how they would apply it to classroom work. Teachers' explorations were guided by the individual

Technology Action Plans (TAPs) that they authored at the summer workshop or at the beginning of the school year. The their TAPs, each and every adult working in a professional capacity within the schools made some level of commitment to learning new technology skills and were guided to reflect on the meaning of their work.

The "techies" provided individual and group and school support. Two community days--fall and spring--brought the teachers from all four schools together to continue to learn with and from each other. Increasingly, teachers found themselves talking to their colleagues, during and out of school, about their issues with technology and how they were incorporating it into their curriculum.

In the second project year, teachers again had options to attend different summer trainings sponsored by ours and other projects, and almost every teacher in the four schools elected to attend some form of TERC or DoDEA technology workshops during the summer months. These sessions ranged from review of the basic toolkit to advanced work on selected technologies to making technology links related to a subject area or a particular role (example: media specialists).

In the second year, we also expanded our professional development offerings with the extension of the "co-teaching model" which Cathy Miles Grant had explored in the first year in the area of elementary mathematics and technology integration (Grant, 1998 & 1998). In the second year, we brought in consultants to work in this way in the science and language arts curriculum. In that year several Hanau teachers also began to work with each other as "co-teaching partners". Across the second year, the "techies" continued to support professional development through a range of formal and informal means.

#### Conceptualizing the networked space of the schools

Within and across the four schools, electronic networks combine to compose three interconnected virtual domains: 1) the **networked work space** provided by the servers, which houses the common toolkit applications and individual and classroom workspaces; 2) **electronic communications** (email) as it is used for communication within the

schools and cluster; and 3) the "**Internet**", email communication outside of the cluster and the use of the Web for teaching and other purposes.

Teachers come to understand the parts and the whole of the schools new virtual geography over time and through experience with the system. Developing an understanding of a networked school and the possibilities of its components involves more than learning how to use an operation.

What is important about a networked school, as we have defined it here, is that EVERYONE is engaged in this process of coming to grips with the notion of the network and its organization. In pre-networked schools, it is typical that only a few teachers are engaged in this process, meaning that there are far fewer opportunities for discussion about the network and experience with technology to pervade the environment. In networked schools, the new virtual geography may not be apparent to all immediately, but all are simultaneously engaged with the various parts or in contact with others who are.

Teaching in a networked school entails changes in classroom management procedures and instructional practices, a reworking of teachers' notions of professional self as well as changes in beliefs about the role of technology in schools. The technical, the social, and the pedagogical notions grow in relationship to each other.

In developing an understanding of the networked school, teachers start from different points and are motivated or attracted by different aspects of the technology. Our experience in Hanau demonstrates that the electronic network, as it is conceptualized within networked schools, can, have a profound effect on movement toward educational reform goals. In this article, we trace the movement toward education reform goals based on teachers' changing conceptualization of both the parts and the whole of the electronic network now present in their schools.

#### The networked work space and the common toolkit applications

Much as industry has been struggling to create a common workspace through the use of the Intranet--web space allocated for internal company use in which you can find all

the tools and documents needed for work activities--the networked work space and the toolkit served this function in Hanau. Developing an understanding of the networked work space and the common toolkit applications was a process that unfolded over time, and, as noted before, understanding this notion was more than a matter of grasping technical issues. We found great differences between the beginning understandings of teachers with no or little knowledge of networks and applications and the later understandings of teachers who had gained experience in these domains. These differences were in terms of technical knowledge AND pedagogical knowledge, strategies, and beliefs.

Initially, most Hanau teachers, inexperienced with technology, viewed the hardware and software as separate and discrete items--each with a fixed physical location. They had difficulty with the idea of the server as a public and private work space, preferring to keep work on their own machine. They were not sure how to work across machines within or across rooms, even with the use of computer disks--much less within the networked space. They viewed the computer lab and its computers as a separate work space from the stations in their own rooms. The computer lab was seen more as a place to instruct or practice software applications than a place to do real school work other than typing up written assignments.

Another aspect of this lack of a concept of networked space was that each teacher wanted his or her own printer in the room, as opposed to using the schools' several networked computers. This was both a function of their concerns about the possession of the things, but even more so it was an issue of school etiquette and classroom management strategies. They were concerned about unescorted young people wandering in the halls or entering another teacher's classroom. They did not have procedures for young people to be up and moving around, leaving the room, or frequently entering other spaces. They were worried about offending colleagues or being seen as an ineffective teacher by their principal. Networked printers were troublesome in this way and there was much complaining early on as these issues had to be sorted out. In addition, learning to use a

networked printer was more difficult than simply pressing “print” and having it appear at the same location each time. Learning how the networked computers were set up and how to print to locations across the building, however, probably reinforced the notion of the school network.

It was not only the machines that were seen as separate items, the network applications were also pictured in this way. Many teachers were unaware that software applications had interfaces with common features, making it conceptually easy to work with new packages based on your knowledge of the old. It was yet another step to learn that digital means you can mix and match across programs--capturing pictures from a web page and dropping them in Powerpoint; writing a message in Word and cutting and pasting it into a cc:mail message, or creating a chart in Excel and adding it to a Word document. Working across applications more flexibly and working in networked space flexibly were notions that moved forward in tandem in Hanau.

Teachers’ stance toward technology and their beliefs about its place in the curriculum provided critical guiding assumptions about the ways they would employ it. Teachers who were inexperienced with technology believed they had to know everything possible about technology before they could use a tool with children. In other words, they had to be in charge of the tool, able to answer any question, and impervious to doubt. A corollary belief was the technology-inexperienced teacher’s belief that young people needed “exposure” to technology. This led to tensions as they struggled to teach the assigned curriculum and technology as separate elements in the day.

A number of things began to change as teachers’ notion of the networked workspace and the toolkit applications began to coalesce. Teachers soon began to catch on ways to use the networked space as demonstrated by their ability to use the server spaces and to work with students across machines--in the classroom and the lab. Less and less was it necessary to have everything on your own machine, and, indeed, storing on the server made it easier to work across these spaces.

With increased experience with technology came an accompanying readiness on the part of teachers to learn new software--both individually and in group settings. In particular, they became increasingly comfortable with learning alongside of students. Students became important technology resources that teachers now turn to readily for assistance. Changes in teacher and student roles happened quickly in the project and were a dramatic indicator of the ways that the technology was changing classroom practice.

Over time, teachers came to see classroom and lab computers less as places to learn a specific application, and more as places to conduct various kinds of school work. While this was one of the central goals of our professional development program, we needed to respond initially to many teachers' needs to focus on the tools themselves and to gradually provide them with opportunities to deepen their understanding of the potential links of each tool to the curriculum. We were purposeful in connecting the learning of the toolkit applications to specific topics or concerns of the adopted curriculum. A good example are the several elementary teachers with whom Cathy Miles Grant worked. They learned how to use the spreadsheet program "Cruncher" and the graphing tool "Graph Club" in the context of investigations of data representation adapted from their mandated Mathlands curriculum. Over time they've begun to build from that experience to use these tools to explore data representation projects of their own design (Grant, 1998 & 1998).

While most teachers were eager initially to use the technology resources with students, they quickly became aware that they were valuable tools for their administrative work. They could store tests, assignments, form letters, lists, inventories, etc. electronically and re-use them across the year. This saves much time and effort. Gradually teachers begin using specific software tools for administrative tasks--electronic grade books, spreadsheets, word processing, and presentation software. Again, the network was important here--in the notion of storage and working across applications.

Increasingly today, teachers in Hanau tell us that they cannot imagine teaching without these tools. The majority now use the networked space and selected toolkit items

with ease. They are comfortable with drives and storage space. It's as natural to them now as taking attendance or grading papers.

Because the electronic facilities are continually growing and expanding, teachers are frequently asked to change procedures in regard to network practices. They easily incorporate these new changes and assume responsibility for learning them. This was not true early on, where some would react with anguish even at the thought of having to find an extension cord--much less change passwords or procedures.

Learning to work in networked space required new procedures for working in the real geographic space of the school. Over time, teachers have revised school etiquette to allow for more multi-tasking within the classroom, young people in the halls on errands related to technology tasks, project work that spans the computer lab and the classroom, and the acceptance of various kinds of classroom visitors.

Teachers are now likely to incorporate one or more technology tools as a part of their curriculum studies, whether or not that tool is suggested by the adopted curriculum. Students may use the textbook and the Internet to investigate a topic and then produce a paper--drafting it on the Smartboard, finalizing it on the computer. Classroom presentations are often made with Powerpoint or Hyperstudio.

Teachers now include technology mini-lessons, much like the mini-lessons of writing process workshops, within the school day. Whatever technology is needed for a project, they teach the skills along with the topic.

As teachers become more experienced and proficient with technology they expand students' access to technology in ways we had not imagined. Teachers who are technology beginners tend to focus on "exposure" of all students to technology, which is a sort of universal access. Rapidly, however, students who like or are experienced with technology start getting more time with the technology as they are called upon to help others. These technology-inexperienced teachers shy away from calling upon technology-inexperienced students for work with tasks involving technology because these teachers are uneasy about

their own skill levels and their ability to help a young person with a technology task. As teachers gain more experience and comfort with technology, we find them assisting students who are not skilled with technology--talking them through a task--with the same spirit that they would help a student figure out a math problem or struggle to read a difficult passage. Technology-experienced teachers, thus, provide broader technology access to students in a variety of ways.

The networked work space, accompanied as it was by the common toolkit of software applications, was an important agent in furthering the changes we have seen in educational practice across the four schools. Through the lever of technology, curricular content is deepening and instructional approaches are being reshaped. Teachers and students have developed a new and radically different map of their school as it exists in virtual space, and the social rules that dictate the use of this space.

#### *Electronic Mail*

The placement of a networked computer on every classroom and specialist's office, suddenly made electronic mail (email) a reality in the four schools. The use of email as an aspect of internal school communication had a sudden, stunning, and profound effect across the cluster. One small but telling example is the demise of the printed school bulletin. After a week of electronic messages, the printed school bulletins in two schools were discontinued, made obsolete by the email messages flowing back and forth all day among administrators and teachers.

Access to email on the teacher's desk computer made it infinitely easier for teachers to facilitate the diverse administrative issues of daily classroom life. Teachers' lives are bound in time and space by their classrooms. Although there are many things that they must do outside of class to facilitate classroom work (connect with other teachers, arrange to use special spaces in the school, find resources, talk to specialists, the principal, and parents, etc.), the realities of the structure of their days is that they must fly around the building during their brief time without students to accomplish these other tasks, since their

primary time commitments are in the classroom. Much time is wasted seeking others, who cannot be found, leaving messages, being sought and missed again. Suddenly with email available on the desks of all adults in the schools--all of that process was simplified. "I could never give it up." "I can't live without it." were statements that we heard frequently after email was installed on teachers' desks.

I like the cc:mail in the sense that...I like the ability to contact other teachers without trying to run around and catch them. It's really good. But on the downside is that it takes me, I would say, a good half an hour to 45 minutes every day to review all my messages. They have proliferated, everybody likes it and so everybody's using it. And so it's not at all unusual to open up the computer in the morning and have 10 to 12, or if you're out for a day or something, it's just pretty overwhelming...So that's the downside of it. But I do like it. I think it helps quite a bit, especially in the school situation where it's often hard to catch people. This is a good way. And the special ed, with monitoring kids or getting messages...A teacher can write to me and say, "Ernest is making a total ass of himself. I'm going to ask him to do this and this and this in your class, and would you monitor him." It's really great for that. (A Hanau Teacher).

While email served important professional functions within the school community, its personal functions were also attractive. Hanau teachers are both colleagues and friends. They have lots of news to share about personal and professional concerns. They frequently meet for social occasions outside of school. You don't have to live long in Hanau to know that Thursday night is bowling night at the Bowling Alley on the Base, to know who gets together regularly with whom for dinner or what teachers will be willing to go volksmarching on the weekend. Email greases the social as well as the scholastic skids. One principal reported hearing a conversation between two teachers in the hallway, where one said, "Email me next period and I'll email you back." In the initial stages of pervasive email there was truly a gleeful, almost childish feeling to the excitement--and that

excitement was about communicating with colleagues more than about conversations with those in the distant world beyond the school walls.

Email is now a “part of everybody’s daily routine,” as one teacher reports.

When I come in the morning, first thing I turn the computer on and I go through my cc:mail. We prepared fieldtrips...everything is done via cc:mail. And before I went to the hospital. I knew I would have some time and I printed out several messages and things and I had time to read it there. (A Hanau Teacher)

Today in Hanau we have seen teachers extending their use of email in new ways that support the further development of their community. One teacher reports that she now finds teachers using email as a means of “sending strokes” to their colleagues, that is, words of praise, congratulation, or condolence.

Email has played an increasing role in managing the growing technical system and supporting teacher’s professional growth. The “techies” plan with each other, teachers, administrators, and DSO staff through email. Consultants and teachers discuss plans prior to their co-teaching sessions. Teachers regularly send questions and requests to their school’s electronic help box that the techies check daily. Responses by email or in person are quick in coming.

The educational technologist regularly culls the Internet and other sources for technology resources that will meet the needs of different teachers, and he passes these on through email. Increasingly, we hear that teachers are doing this for each other--asking and answering technical questions of each other through email--and sharing the many resources they are discovering.

Email is a tool for the internal Hanau community. Teachers and administrators in Hanau are, like teachers and administrators in schools and districts across the United States, tuned-in first and foremost to that local community of work colleagues. As we learned in Hanau, day-to-day communication among members of this community on a

range of administrative tasks is of the utmost importance to them, an aspect of school life that is virtually unaddressed in educational literature.

Email facilitated the planning and nurturance of this immediate community. Teachers and administrators feel less isolated from their teaching colleagues than they did before. Gradually, we are seeing changes in collegiality that have been facilitated in part, we believe, by the breakdown of isolation. Email, we think, was a critical agent in this turn about of affairs. Without email, we would have had to search for other powerful means to support and nurture the professional culture that is necessary for bringing about systemic educational reform.

### *The Internet*

The Internet provides teachers with resources outside of the school community, both through conversations with colleagues in other locations, and through access to digital resources at other sites. For the teachers, this access beyond the school walls, and especially the use of the world-wide web represents cutting edge technology. It is glitzy, symbolic, and required for today's educational projects. In Hanau having Internet access in every classroom told educators, families, and community that the Hanau schools were recognized and progressive.

Having heard much about the Internet and the resources available through it, educators were eager to try it out. At the first summer workshop, teachers and administrators searched day and night for professional sites and for sites of personal interest. As with email, a combination of the two were always compelling reasons for connecting to the Internet. Teachers enjoyed sharing the results of their searches with each other. As they worked side-by-side they extended their mutual understandings of the wealth of material available on the Web.

In the early days, just after the networked computers went into the classrooms, there was an explosion of student use--much of it related to learning how to use the Internet. In the first phase of use of the Internet in classrooms, teachers and students

became excited about the materials they found there. However, the teachers had not established any criteria for the value, usefulness or veracity of that material. They discovered how time-consuming Internet searching could be. Teachers and students had not yet developed extensive skills in the best search methods. Internet information was uneven--some very good and some very poor. In addition, it was written at many different reading levels, making it difficult for many students to navigate alone. A broad research question, such as "find information about Africa" resulted in information that was not useful, yet was overwhelming in volume.

Gradually, teachers became more critical of the quality of information and began to help students sort out resources. They began to find appropriate ways to use Internet resources, through planning with students, search engines designed for students such as Yahoooligans, and more sophisticated and focused questions. In all grades, we find teachers using the Internet as an up-to-date encyclopedia. "Look it up," no longer means a trip to the library, but an investigation with the classroom computer. Starting in the middle grades, but particularly in the high school, students report that the Internet, not the library, is their preferred source of information, as library information they find is too limited and dated for their research needs. In these instances, the Internet (like word processing and presentation software) is primarily mapping onto already established patterns of school business.

The immediate availability of Internet resources seems to be a very important factor for students and teachers. In thinking about this issue, one of the authors of this paper (Grant) remembered her elementary school teaching days when she kept a running list of unanswered questions that would emerge during class. Once a week she would go to the library and find books with the answers to those questions that she would share with students the next day. This kind of tracking and resource searching requires an incredibly organized and focused teacher. Not surprisingly, many student questions that arise during the day simply disappear into the ether in most classrooms. The Internet makes it possible

for students and teachers to find resources for their questions immediately, and this is an important benefit.

One interesting quality of the Internet is the availability of digital images. Classroom practice has relied heavily on text alone as the source of information. The explosion of juvenile trade books has supplied richer visual opportunities for younger students. The Internet provides yet new photographic sources, as well as important graphics (charts, maps, pictorial representations), that teachers have found extremely helpful to their teaching in all grades, and in Hanau they have used them extensively in all content areas.

The Internet provides the opportunity for the school not just to bring in information but to directly share information about themselves. It reaches far beyond the parent newsletter to the broader virtual community of schools. Going through the process of defining a school web page has helped the schools to re-emphasize teaching and learning, rather than scheduling or facilities. The school web pages were good publicity for the schools, and they received recognition and compliments from many. For most intents and purposes, however, they were vanity pages.

In the first year, an elementary teacher developed a classroom web page and began to post student work here. Early this year, two high school teachers developed web pages on which they could share classroom assignments and resources for students. Later this year, increasing numbers of teachers are signing up for workshops on making web pages. The communications technologist who led one of these workshops reports that teachers are thinking hard about ways to connect web pages to teaching activities. At present, these web pages serve mixed purposes of presentation of student work and for sharing information about classroom work. We believe that these functions will expand with time as teachers become more facile with the technology. Several teachers across the four schools have come to be noted as web development experts and other teachers turn increasingly to them as leaders in this field.

The presence of the Internet provided the schools with important opportunities for authentic problem-solving. Internet access prompted the immediate need for decisions about school Internet policy. The HIT and the school technology committees had to grapple with acceptable use rules and their implementation. For example, they raised questions such as what happens if a student is banned from the Internet, but the Internet is required for an assignment? If we don't think it's reasonable to prohibit students from using textbooks should we prohibit them from using the Internet--it is an educational tool? What if the Internet is necessary for an assignment, but the parent has said no? The first policies were rigid, but as teachers became more comfortable with the technology they began to refine their policies to reflect the internet as another resource, not a threat.

Through these various decision-making opportunities, educators in the schools began to amplify and refine their notion of the networked school and themselves as professionals working in such a setting.

#### Summarizing the evidence for systemic reform

The following chart provides a summary of the kinds of changes that have occurred as a result of the presence and use of electronic networks and the correspondence of these changes to the four areas of systemic change described earlier.

Electronic Networks and Systemic Reform: Charting the Impact in the Hanau Model School Partnership

	<b>Educational Practice</b>	<b>Professional Culture</b>	<b>Technology Leadership and Management</b>	<b>Community and Family</b>
<b>Net-work-ed space and toolkit</b>	<ul style="list-style-type: none"> <li>-changes in teacher &amp; student roles</li> <li>-changes in classrm mngt practices</li> <li>-teachers look more closely at student products</li> <li>-teachers questioning practices change</li> <li>-increase in writing across all four schools</li> <li>-tools force new curricular information and projects (MBL...)</li> </ul>	<ul style="list-style-type: none"> <li>-everyone learning and using same tools</li> <li>-you see teachers spending more time in each others' classrooms</li> <li>-teachers talk about their tech projects outside of class</li> <li>-co-teaching with outsiders &amp; insiders</li> <li>-teachers developing multiple ldrshp roles in curriculum area</li> </ul>	<ul style="list-style-type: none"> <li>-opportunities for shared decision making arise as a consequence of networking</li> <li>-the pattern of professional development begins to change...and teachers take more leadership</li> </ul>	<ul style="list-style-type: none"> <li>-parents learn from children's talk and products</li> <li>-parents attend trainings and learn to use the equipment</li> <li>-toolkit is placed in the PX, and parents begin buying for home computer</li> <li>-parents come into the school and assist with technology</li> </ul>
<b>Email</b>		<ul style="list-style-type: none"> <li>**email facilitates in-school communication</li> <li>-builds the school community</li> <li>-there is a major shift in daily patterns (have to look at email everyday)</li> </ul>	<ul style="list-style-type: none"> <li>-facilitates administrative work; but doesn't necessarily change the content of that work</li> <li>-union plans and disseminates via email</li> <li>-HIT and school tech comm ideas exchanged quickly</li> </ul>	
<b>Inter-net</b>	<ul style="list-style-type: none"> <li>-"getting information"</li> <li>-visualization (real and representational)</li> <li>-having up-to-date info available immediately</li> </ul> <p><i>emerging...</i></p> <ul style="list-style-type: none"> <li>-publication on web</li> <li>-class web page w/assignment info and links</li> <li>-1 teacher did more interactive projects</li> <li>-some teachers are beginning to review their research practices</li> </ul>	<ul style="list-style-type: none"> <li>-teachers share "good" web sites w/ each other</li> <li>-Educ Tech. frequently researchers and shares web sites w/teachers</li> <li>-several teachers are emerging as web page development specialists</li> </ul>	<ul style="list-style-type: none"> <li>-school vanity pages</li> <li>-creates opportunities for shared decision making with Internet policies</li> </ul>	<ul style="list-style-type: none"> <li>-community and parents pleased that the schools have these resources</li> <li>-HS students use heavily for college research</li> </ul>

Shrinking this summary down even further, the next chart illustrates the estimated level of impact each of the virtual functions of the electronic school has had on the four arenas of change.

Electronic Networks and Systemic Reform: Synthesizing the Impact in the Hanau Model

School Partnership

	<b>Educational Practice</b>	<b>Professional Culture</b>	<b>Technology Leadership and Management</b>	<b>Community and Family</b>
<b>Networked space and toolkit</b>	<b>Very Strong</b>	<b>Strong</b>	<b>Strong</b>	<b>Moderate</b>
<b>Email</b>	<b>Weak</b>	<b>Very Strong</b>	<b>Moderate</b>	<b>Weak</b>
<b>Internet</b>	<b>Moderate</b>	<b>Weak to Moderate</b>	<b>Strong</b>	<b>Moderate</b>

Reading across the chart, we can make the following statements about the three components of electronic networks:

1. Networked space and the common tool kit applications have had the single greatest impact across all four dimensions of systemic change.
2. Email had the strongest immediate impact on the development of professional culture in comparison to other features of electronic networking, but relatively little direct impact on other areas to date.
3. The jury is out on the Internet. Overall, it seems to have had less effect on the critical areas of systemic reform than the other two components of electronic networks in the schools. However, it's presence was a critical symbolic feature for educators and

community members. The various changes and effects emerging from use of the Internet are difficult to interpret yet.

Reading down the chart, we can say that educational practice, professional culture, and technology management and leadership have all been significantly, if not profoundly, affected by the presence of electronic networks. The Community and families have been moderately affected by its presence. It's important to note that as the project continues, the evidence and the opportunities for community and family participation are steadily increasing, and for obvious reasons in the first stages of the project we have focused most intently on professionals within the schools.

Moving away from a strict interpretation of the chart, it may be helpful to think about what project features seemed more important to supporting thoughtful use of the electronic network as a tool for teaching, learning, and the organization of school life. In other words, what did we do that promoted the use of electronic networks for systemic reform? Project features that we feel are particularly important in this regard include:

1. Including 100% of the professional community within the four schools and asking everyone to making some commitment to learning technology.
2. Offering comprehensive professional development opportunities that included:
  - on-site support
  - multiple invitations over time to teachers at different levels
  - emphasis on the development of local capacity
3. Focusing on a common set of software tools that could be reasonably supported, provided teacher with immediate relief of some important sort, and allowed everyone in the schools to be thinking and talking about the same items at the same time.
4. Promoting and supporting a model of shared decision-making and building the strength and capacity of decision-making groups through collaborative work on authentic project problems.

5. On-site technical staff that focused on professional development, while linking and supporting technology management and leadership, as well as community and family involvement.
6. Including parents and community members in decision-making groups and attending to their needs for information, training, and access to resources.

#### Implications, Concerns, and Recommendations

What are the implications or questions that our findings raise for: a) those concerned with the implementation of electronic networks in schools; and b) those concerned with systemic educational change, that is, the strengthening of the curriculum and the insurance that ALL students will receive a rich educational experience?

When we began this work, we, like many others, hypothesized that the Internet and the opportunities it presented for remote communication, collaborative work, and heretofore unavailable resources would have an immense impact on educational practice and school life. We were very surprised to find that this was not at all so, at least in the initial phases of the project. Rather, networked space in tandem with a suite of simple software applications and peripherals made the largest impact on teaching and learning, as well as other critical areas of school life. Secondly, networked communication within the school (email) made a far more forceful impact on school life than did communication with those outside of the school (the Internet). We see potential impact from the Internet, but as yet we are unsure of what this will be and how it will be structured within schools.

In regard to the Internet, this is not to say “there is no there...there,” but, rather that the Internet is one feature of a school’s virtual geography, as it is formed by electronic networks. Much of the hyperbole about the Internet ignores this fact. If we really want to understand the contribution the Internet can make to teaching and learning we’ll have to understand it as an integrated aspect of contextualized educational practice. To develop this understanding will require studies of classroom practice that document the ways teachers and students use the Internet across various curricula, as a tool among other tools (digital

and non-digital). These studies need to demonstrate how this use grows and changes over time. Such studies should be undertaken in “networked schools” that are beyond the initial phases of technology infusion and in a maturing position in regard to the use of technology. Some studies that we believe point the way to understanding educational technology in richly contextualized ways include the work of Bruce and Rubin in the Quill project (Bruce & Rubin, 1993); the many studies that have come out of the ACOT work (Sandholtz, Ringstaff & Dwyer, 1997); and a remarkable and interesting study presented at the 1997 AERA meeting “Language and Technology in Students’ Everyday Lives” by Michele Knobel of Queensland University of Technology (Knobel, 1997). The kinds of thoughtful research on the Web as a tool for learning that Mark Windschitl has called for should also be taken into careful consideration (Windschitl, 1998)

To date, electronic networking and systemic reform have been growing up at the same time but separately (Wasser, 1996). In the next decade, as we create more and more networked schools, it is critical that we have a conception of the new electronic geography of the school that is being created by this medium. The three-part view of networked space presented here (workspace and applications; internal communications; the Web) may be a starting place. Much more more work needs to be done.

While we recognize that by themselves electronic networks are nothing more than inert wiring--we also recognize that through the surrounding context of activity--their presence has contributed to the systemic changes that we have documented in the Hanau educational system. When we speak of the systemic changes that have occurred in Hanau over the life of the project, we are speaking of changes that have occurred in the presence of electronic networks. Thus, it would appear to us that the potential of electronic networks lies someplace between its actual technical possibilities and the social contexts in which it is embedded (Bromley, 1994).

The Hanau Model School Partnership is an example of a networked school, plush with the technological tools that will in a very short time be considered de riguer in the

average school. Our work here demonstrates that, if approached with intentionality, the process of technology integration, can lead to significant changes of the sort that educational reformers are now seeking to implement.

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