SECTION IV: K-12 Networking — Models and Benefits

PART I: The K-12 Schooling and Networking Model

Teachers, administrators and school reformers need to clearly see the purposes and implications of K-12 Networking in relation to the overall learning ecology in which schooling occurs, to decide what to adopt and what to reject.

Schooling is a serious responsibility among all involved. Teaching is a respected art form. A good teacher is recognized by students and colleagues. By a good teacher, we mean one that brings a coherent learning process or pedagogy to his/her teaching, inspires learning, and encourages discipline among students.

These three goals of schooling are also the goals of school networking. Networking, like good teaching, is about communication and corrective feedback (the process that makes communitication in teaching and learning a success). (Komoski, 1988).

The following graphic guides our discussion. We present the three goals of schooling and school networking (learning source, inspiration, and discipline) along three axes of the graphic.

Along the Learning Sources continuum schooling ranges from instructional to explorational. Since the Internet is a source of exploration and teachers are sources of instruction, this dimension will aid us in sorting out the respective roles of teachers and networked resources.

Along the Inspiration continuum each student experiences motivation or inspiration from external sources and from internal sources. Psychologists have long recognized that extrinsic and intrinsic motivation distinguishes among personalities and learning style. In building networks we must both respect these learning styles and provide students with whatever external inspiration they require to assimilate learning into their patterns of behavior.

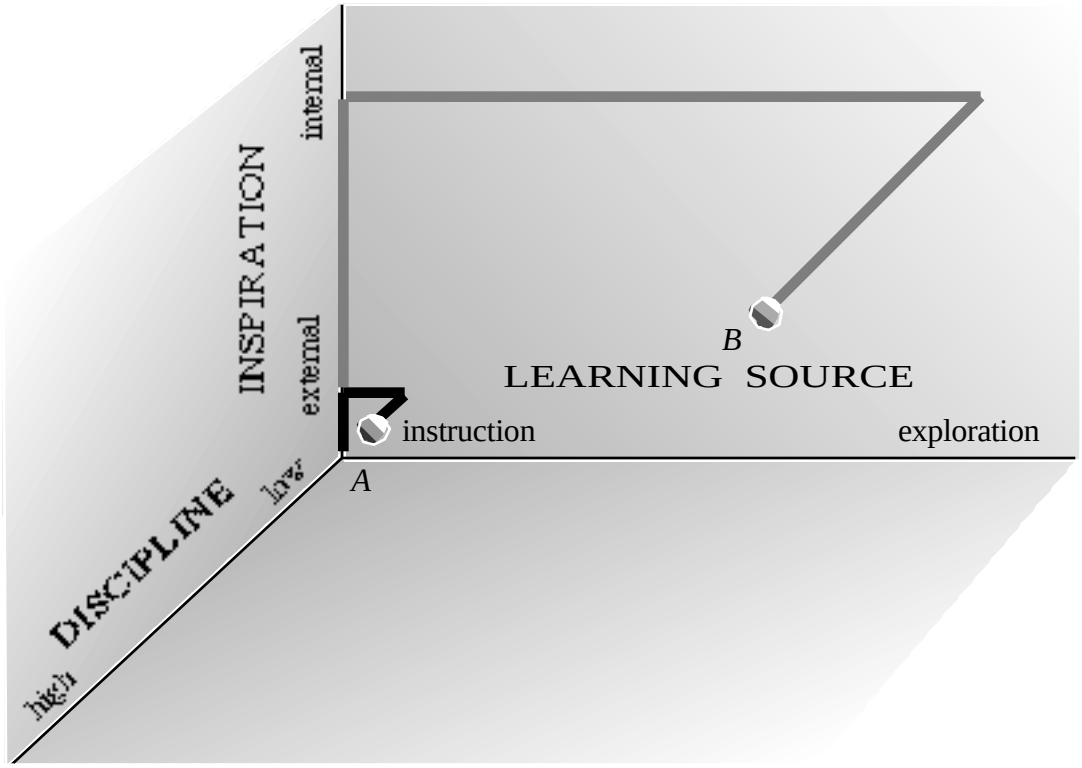
Along the Discipline continuum we have behavior that ranges from highly disciplined to low discipline. The subject of discipline occurs regularly in parents, teachers, and administrator's concerns about the success of schooling. Can networking provide improved discipline?

As an educator knows, these three dimensions interrelate and certainly do not capture everything we care about in schooling. Regardless, we need a model that reaches beyond the machines and wires of the network.

Let us look at two points in the space of the graphic. Points A and B can be thought in terms of two different kinds of students, or in terms of two different goals and outcomes of the arrangement of schools and networks.

Learner A receives his/her information about the world almost entirely through instruction. Since student A is externally motivated, the student pays close attention to the cues of the classroom. The discipline of the student, as illustrated, is low. While the student may be caught up in the moment of the class, the extrinsic orientation of the student will cause the student to be easily diverted from paying close attention to tasks outside the classroom or in self-study.

A teacher finds Learner A problematic but rewarding. Due to poor discipline homework assignments are sketchy, yet the learner listens attentively in class, asks questions both to clarify instructional points and to establish rapport with the teacher.



Source: EPIE Institute / Center for Information, Technology & Society, 1996

Learner B is a complete contrast to Learner A. Learner B is intrinsically motivated. While Learner B identifies role models among teachers, a parent or other adults who communicate that they are always learning, he/she quickly internalizes the values that accompany the role model's personality and operates from this internal set of values. Learner B is exploratory. It is this kind of learner that resists or is bored by routine instruction. This is the learner that Weir (1992, p. 19) identifies as appreciating learning that is "not canned" and wishes to "learn on one's own." Further, we have given Learner B a high level of discipline. Learner B will persevere on his/her own out of the high level of discipline and the learner's intrinsic drive.

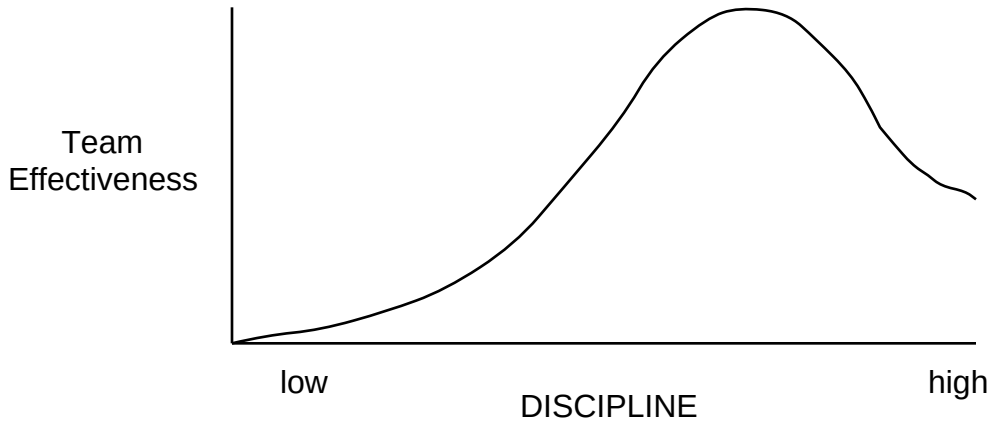
Is Learner A or B Better?

This is a silly question intended to sharpen the focus. Let's examine why. Discipline is perhaps the easiest to approach.

This graphic suggests that a learner's effectiveness in a team rises with better discipline to a point, then further discipline causes the learner's team effectiveness to taper off. The cooperation among other learners diminish when one learner becomes so focused on the task that "it's not fun any more," for other team members.

Also personality traits tend to cluster and high levels of discipline can come at the expense of missing social skills.

What about sources of inspiration? Someone who remains highly extrinsically motivated is said to lack skills to "work on his/her own." High intrinsically motivated learners can become pre-occupied by their own interests and miss a learning opportunity that a more extrinsic orientation might produce.



Source: EPIE Institute / Center for Information, Technology & Society, 1996

And what about the prefered sources of learning? Exploration is fine if the learner has the sense of what and how to explore. But many skills are not gained and mastered through exploration. We would much rather have a "trained doctor" than one that "explored his/her way through medical school."

Stepping Back

A resounding "benefit" to networking and Internet-based projects relate to all of these dimensions. The word exploration is used again and again to emphasize the attraction of the Internet. Kids say it's "not boring."

In terms of our model, this benefit is, in effect, a challenge to teachers and administration to change how learners should be distributed in the K-12 Schooling & Networking Model, above. As any teacher knows, a classroom is comprised of learners that all have a unique position in the Model's "space." Many proponents of networks want to move the "cohort" of learners toward more exploratory experiences along the learning source continuum and toward more intrinsically motivated learners who like to "learn on their own."

And what about discipline? Some proponents equate intrinsic motivation with discipline, but is that necessarily true? In fact, out of the over six hundred references reviewed in this study, not one mentioned discipline, per se. What was mentioned were discipline-related monitoring systems (and these were only present in the telephone monitoring networks and the management functions of ILS's). In the features of the telephone network systems described in Sections II & III, we find attendance monitoring and reporting. We have frequent reporting of a learner's progress or lack of progress to parents, and the opportunity for parents to respond. So to understand the success of telephone network systems we need to pay close attention to how these "closed-loop, feedback systems" aid in both enhancing discipline and in providing extrinsic motivation.

Summary

Networks are systems of communication that relate to three continua of schooling: learning sources, inspiration, and discipline. Only when networks are gauged as to their abilities to meet the goals of schools and educators for students can the actual benefits of networks be judged and appreciated.

Further, a school's first step in establishing a Technology Plan is to assess what kind of learning approach(es) and learner(s) they wish to encourage. They may decide there are a plurality of goals — some which certain forms of networking aids and some which they actually work against.

Anything short of such an assessment will leave unstated conflicts embedded in the school's plan. These unstated conflicts will arise again and again, causing disturbance, until their underlying causes — the consonance of networking strategies with both teachers', students', administrators', and parents' objectives for schooling — are recognized and treated.

An Alternate Scale for Learning Sources

"There is now widespread agreement among educators and psychologists (Collins, Brown and Newman, 1989; Resnick, 1987) that the advanced skills of comprehension, composition, reasoning, and experimentation are developed not by passive reception of facts but by the active processing of information. This constructivist view of learning, with its call for teaching basic skills within authentic contexts (hence more complex problems), for modeling expert thought processes, and for providing collaboration and external supports to permit students to achieve intellectual accomplishments they could not do on their own, provides the conceptual underpinnings for, .. technology's role in education reform. (Means, 1995, p. 3)"

"Although variously described, the student-level outcome goals of most reform efforts are to increase learning, especially of advanced or higher-level skills, and to enhance student motivation and self-concept. In our view, the catalyst for this transformation is centering instruction around *authentic, challenging tasks*. (Means, 1995, p. 3)"

Thus, there is another scale required to more fully identify the K-12 Schooling & Networking Model:

Source: EPIE Institute / Center for Information, Technology & Society, 1996

In Barbara Means' introduction to authentic learning it is useful to observe that she refers to the "centering of instruction" and "to enhance student motivation." Both instruction and motivation relate to the prior graphic.

Focussing on a specific example, *From afar, Kids Do Science on the Net* (Chandler, 1995), we begin to appreciate the contrast between authentic learning and, more simple, exploration. "In early October, thousands of students across the nation and around the world will have a chance to go — virtually at least — where no young student has gone before: Eight miles up in a flying astronomical observatory." "Linking students to computer networks, in addition to giving them access to research in remote places, also allows scientists to use students as a data-gathering resource. A project initiated by Vice President Al Gore, called GLOBE (Global Learning and Observation to Benefit the Environment), enables thousands of students in the United States and other countries to catalog local daily weather conditions and plant species and sizes on a plot chosen from a satellite picture, and then enter the information into a worldwide database. (p. 28)"

Yet the author of the article mixes up aspects of the K-12 Schooling & Networking model when he says, "In many cases, the students can design their own research projects to be carried out in those distant locations." How many learners can actually design their own research projects?

We need to carefully separate out the complex instruction made possible through networking from the dimensions of motivation and the facet of exploration. Furthermore, a "reality check" requires us to consider the extent to which learners can and should be part of real scientific research, for example, versus "rehearsed scientific research."

A teacher may wish to provide authentic instruction but provide extrinsic motivation such as encouragement and test scores to ensure that each step is followed. That teacher may be pleased there is an exploratory sense to the project but the exploration is "contrived."

Learners know the difference. Weir (1992) notes that some students prefer activities where the "answers are not known beforehand. (p. 19)" Weir surveyed students and found that 80% of the students in one class

preferred to tackle the known to the unknown. But also found that after a term of experiences provided in a school setting, the number of students expressing interest in tackling the known dropped to 64%.

The reality check required revolves around the ability of schools and teachers to provide "real-life" learning situations. Hunter and Goldberg (1995) involve learners in a scenario in the year 2004 called the "Big Dig" (based on the Boston "central artery" roadway project). This very instructive view of authentic learning experiences suggests a world, however, where learners have access to preparing a "Tunnel Team" exhibit at the Boston Museum of Science, and to Bechtel employees regarding tunnel simulations. Such authentic learning stories might be improved by describing access to people that are more typical for the average student.

Running throughout the authentic learning and networking literature is a phenomenon that we label "expert myth." This is the myth that every student across the country will have access to experts and facilities via networking. (In Section II we suggest that librarians and others can play some role in this regard, but that the "real scientist" doesn't have time for but one student in a million.) Data collected by students will be interesting but flawed many more times than not. For example, just remember how hard it is just to measure something in a graduated cylinder. Do you measure to the top of the miniscus, or to the bottom? What if there is a very small residue of soap in the cylinder? Now multiply these problems by a few thousand and you have the degree of difficulty associated with good data collection.

Furthermore, while we admire the learning involved in project GLOBE (above) and agree that current collecting data on the environment is a very important learning exercise, we do wonder whether a project involving kids collecting data on international trade might avoid alienating some people on local school boards less and advance the cause for authentic learning in schools more.

In summary, we note that authentic learning is a fourth dimension to the K-12 model and one that will challenge teachers in the development of learning tasks. While authentic learning can involve exploration, it is not synonymous with exploration. And while students can design their own experiments, at times, good instruction involves providing students with pre-designed, thought-out, and well tested, appropriate tasks.

<u>And Relating Learning Source to Learning Resource</u>

This further modification of the K-12 Schooling & Networking model helps direct our focus to the materials that aid both the teacher and the learner in meeting learning goals:

Source: EPIE Institute / Center for Information, Technology & Society, 1996

Recall a time when, as a learner, you looked at the *Encylopedia Britannica*, in contrast, to say, *Compton's Encylopedia*. For the same subject, the world looked much simpler, and easier to comprehend, in *Compton*'s. Does this make one resource better than the other? Again, we ask the question to help focus the discussion — as a learner approaches a subject, field or concept, the learner brings a perspective — one that may be limited or broad. The objective, then, in providing resources is to provide a resource that permits the learner to extend his/her knowledge without that "drowning feeling" they get when a resource is "beyond them."

For teachers, networks will serve their need for resources as networks provide a level and kind of material that enhances what they have to teach and does so within the same framework of thinking. There are many ways to present knowledge and a networked resource must correspond to the way the particular teacher presents knowledge. (Indeed, many teachers form their presentation of knowledge around a "key textbook" — making this textbook the central resource. In the era of the "presentation computer" discussed in Section II, the teacher may be able to depend on CD-ROM based materials and/or Internet linked materials.)

Learners need access to materials for the performance of homework assignments and in performing on projects. While simple encyclopedic sources suffice at first, more advanced learners, in advanced grades need greater access to online databases, library catalogues, and access to knowledge creation software whether a simple word processor or a hypertext engine to build a linked database.

Furthermore, there is another important resource that networks provide: peer-to-peer interaction. Teachers talk a lot about isolation in their profession and how networks with other teachers greatly reduces this isolation. And learners talk about the excitement of working with other learners, collaboratively, over the Internet. These "resources" go beyond being sources of knowledge but they affect the "inspiration" dimension as well.

In summary, while the dimensions of the K-12 Schooling & Networking model relate to value-ladden aspects of schooling, we have endeavored to present these dimensions without judgement. It is the teacher's and school's role to judge, in cooperation with parents and learners, what kind of schooling they wish to provide and how varied the schooling should be with respect to the varying characteristics of their learners.

PART II: Causal Modelling of School and School/Home Activities and Processes

The model in Part I is suggestive of key elements of a school and school/home activity and process model. Clauset and Gaynor (Clauset, 1982, 1992; Gaynor, 1984, 1985) studied improving school effectiveness using a relatively recent tool of causal diagramming.

Causal diagrams are graphical aids for thinking, planning and designing processes and associated networks. These tools are in regular use for "business process reengineering" and could receive wider recognition in the design of school Technology Plans.

A causal diagram contains three common parts. There are boxes in which things can accumulate — such as knowledge, or such as self-esteem.

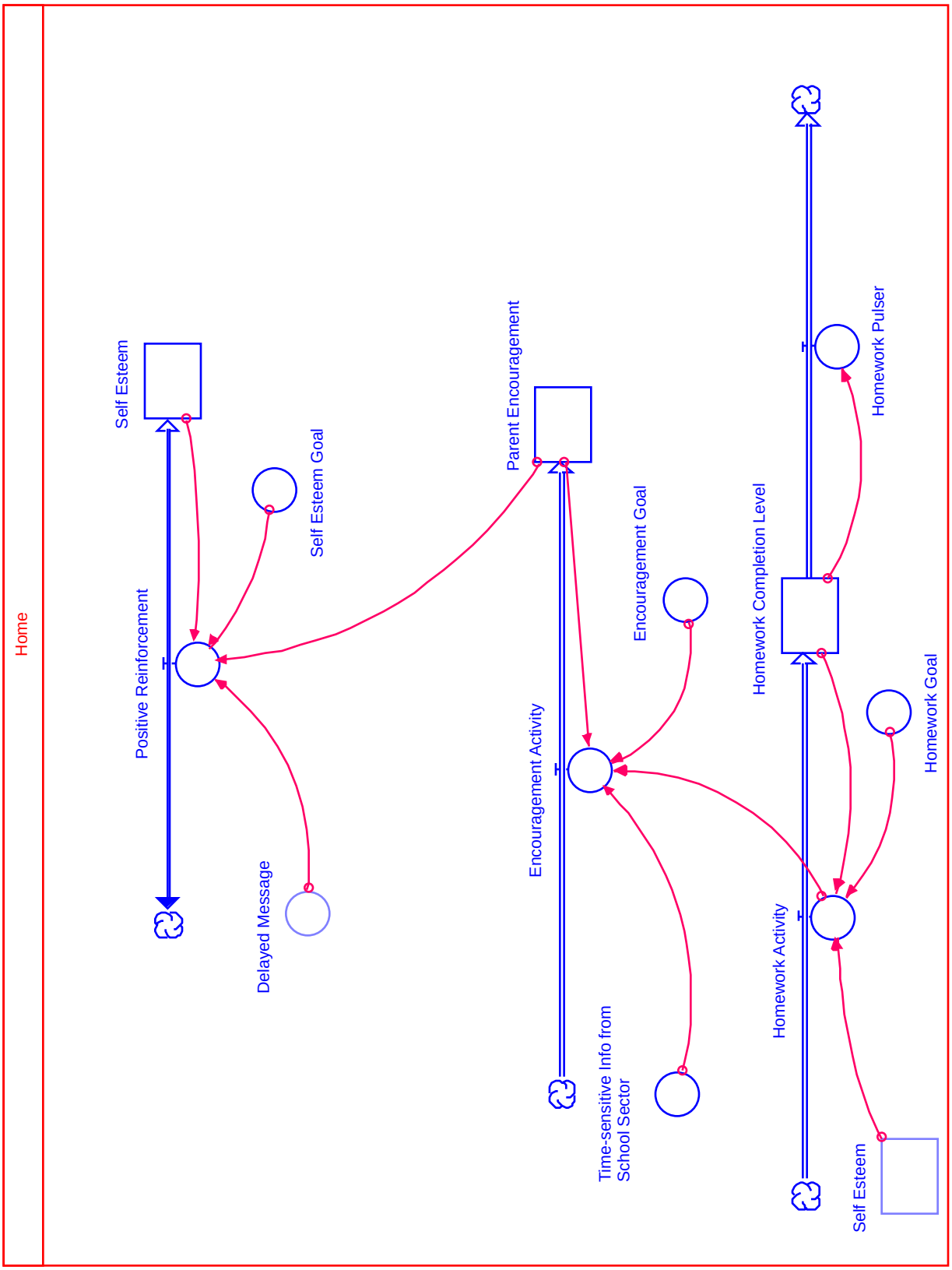
There are sources of causes of these accumulations — such as sources of knowledge, or such as encouragement.

There are processes that increase or decrease the effect of the cause on the outcome, such as the length of a learning period (sometimes called time-on-task), or such as encouragement by parents or teachers.

Taking these basic concepts, the graphic on the next page shows relationships between parental encouragement, homework completion, and student self-esteem:

Follow some of the paths. In the lower right we see student self-esteem contributing to the accomplishment of homework. We see homework completion levels contributing to the encouragement activity that both leads to parental encouragement and causes more encouragement activity. Near the top we see the build-up of self-esteem, itself, out of positive reinforcement, one of these which comes from parent encouragement.

If we now add a school model and a communications model to this process, we can begin to "simulate" home/school dynamics related to K-12 schooling and learning discussed in Section III.


Home
Self Esteem
Self Esteem Goal
Positive Reinforcement
Delayed Message
Parent Encouragement
Encouragement Goal
Encouragement Activity
Time-sensitive Info from School Sector
Homework Pulser
Homework Completion Level
Homework Goal
Homework Activity
Self Esteem

In the school model (see next page) the final goal, achievement, is shown in the upper right. The learning rate is determined by aptitude, grade standards, and student motivation. (Of course there are other influences on the learning rate, including the teacher's abilities, but we are focussing on the "inspiration" part of the K-12 Schooling and Networking model. Thus there is a cloud shown to the left of learning rate, indicating that there are other parts of the causal process that are outside of the diagram.)

Teacher effort, from the lower left, leads to a level of facilitation in the student, and contributes to motivation buildup (to the right). Existing self-esteem, teacher facilitation, motivational goals, and student motivation level all contribute to determine the increase in the student's motivation level, and this increase in motivation level leads into the process described in the last paragraph.

Let's now couple these processes. A further causal diagram was created to indicate the communication of encouraging messages from the school model to the home model (see further Priest & Risley, 1995). This resulted in the following overall model (see the next graphic).

The composite graphic shows the screen of a Macintosh computer running Stella, a causal modelling language and simulator. The Creative Learning Exchange in Acton, MA promotes the use of Stella in K-12 education as a way for students to better grasp processes in school, whether biological processes or business processes.

Here we use the same tool to better grasp the dynamics of the school/home connection.

When correctly programmed and calibrated, the causal model takes on the behavior of real-world situations. For example, the rectangles in the causal diagrams which represent levels of achievement or motivation can be observed to "fill" when the model is run.

A Result of Running the Model:

Our intent was to use causal modelling to introduce elements of schooling and home that relate to learning. Causal models are a discussion vehicle.

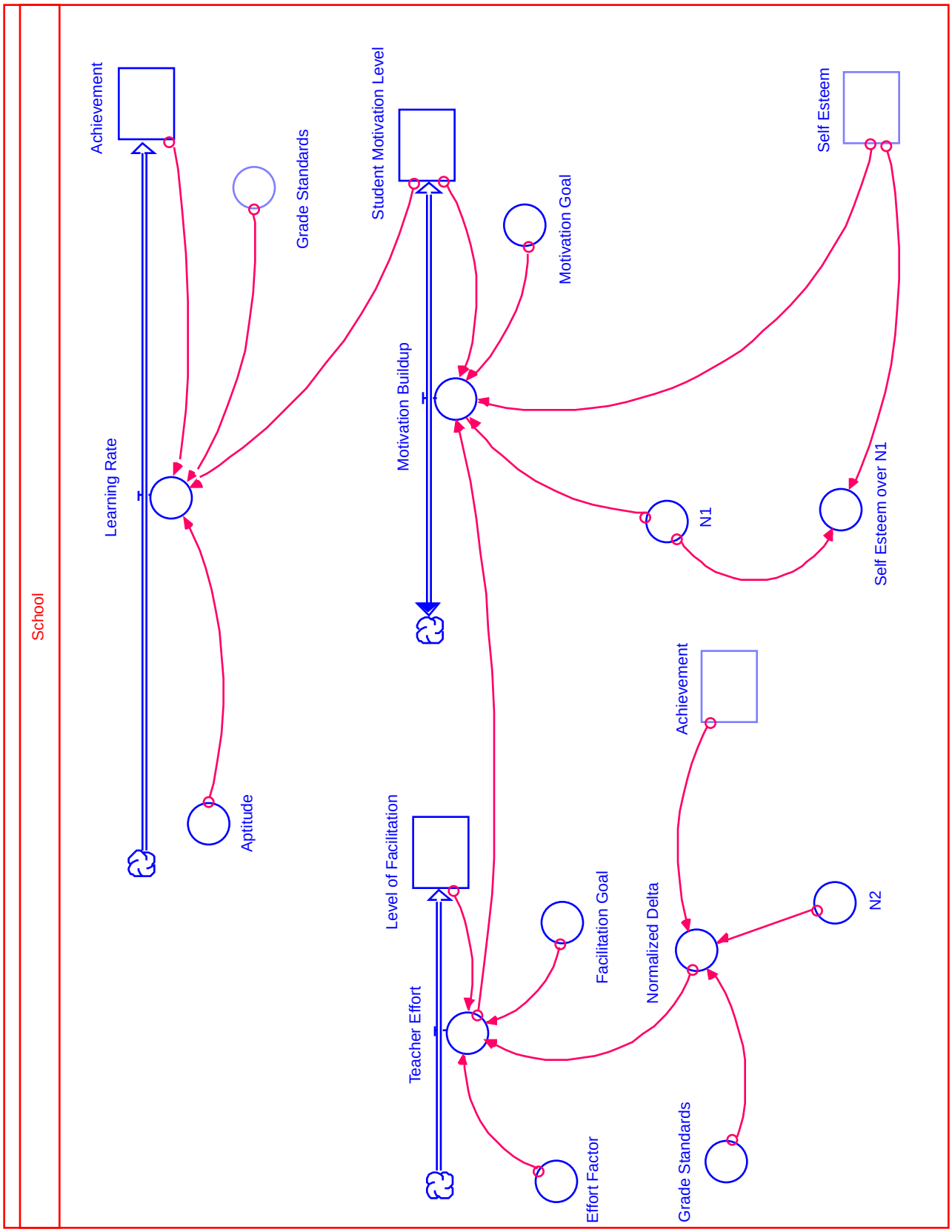
Nonetheless, Priest and Risley (1995) developed the integrated school/home model to the extent that some preliminary simulations were "run."

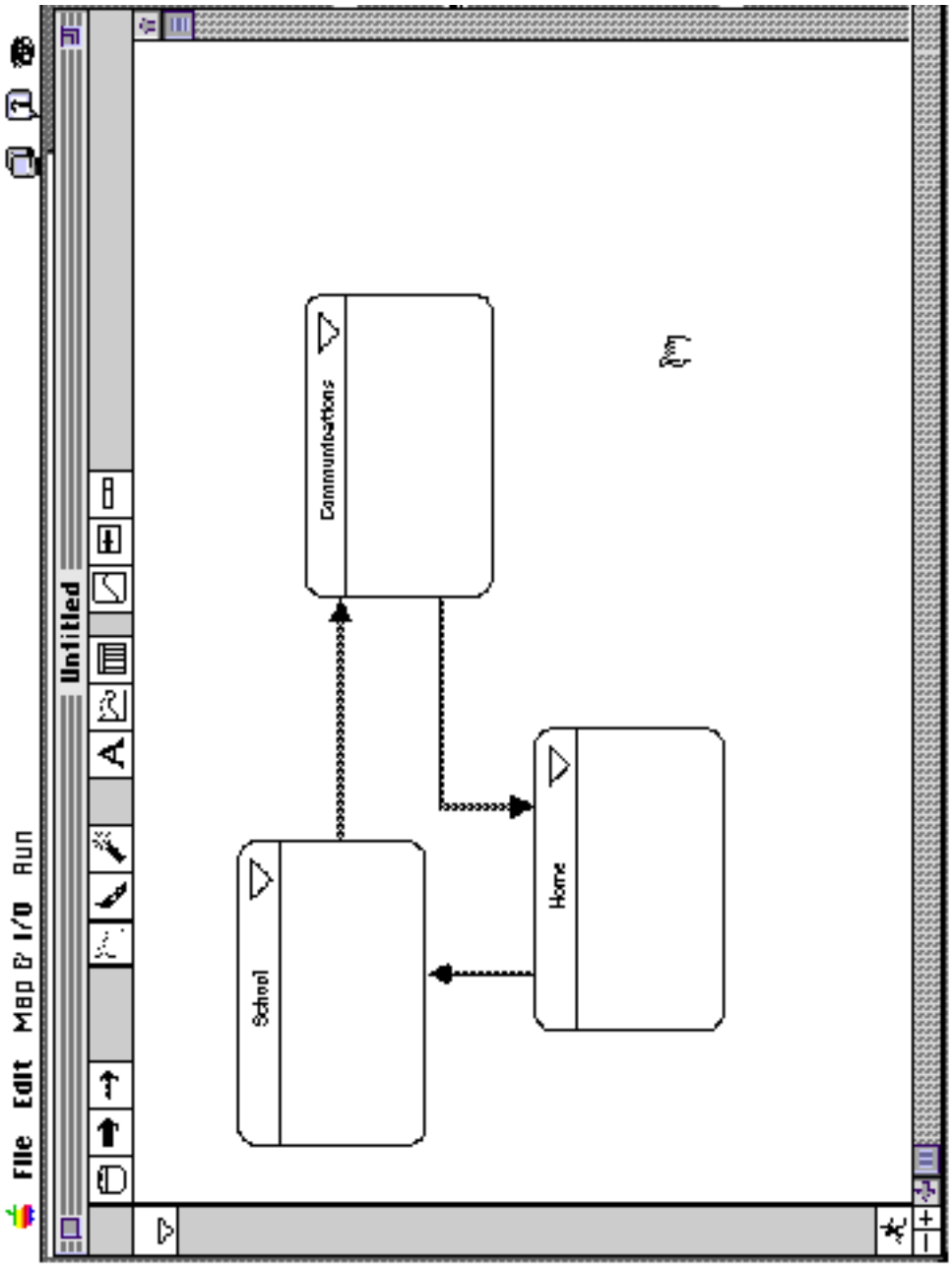
Turning to the home causal diagram, there is a small circle labeled "Time Sensitive Information from School Sector." This is the point in the model where teacher messages from school to home were (first) introduced into the home model. A message flowed from the teacher to the home every week.

When the message was introduced into the "encouragement activity" of the student at home, the final impact on achievement (shown in the school diagram) via the increase in self-esteem was "washed out." There were too many "integrators" between this flow of messages and any visible result on achievement. (Is this a fault in the model or a true result? Only further testing will tell us.)

To provide a more direct result, the teacher message flow was connected directly to the "positive reinforcement" flow leading to self-esteem. This produced rises in self-esteem, leading to improved achievement.

Running the model with this "adjustment" (moving the impact of teacher-home messages closer to the self-esteem box) the following result appeared: the level of achievement came out about the same but with more frequent messages from teacher to home there is a distinctly earlier peaking of self-esteem in the student. (Perhaps this means student confidence is improved even if the learning remained the same.)


School
Achievement
Grade Standards
Learning Rate
Aptitude
Student Motivation Level
Motivation Goal
Motivation Buildup
Self Esteem
N1
Self Esteem over N1
Achievement
Level of Facilitation
Facilitation Goal
Normalized Delta
N2
Teacher Effort
Effort Factor
Grade Standards



Summary: This is the **first** school/home dynamic model using causal modelling. The result of such a fledgling model is therefore less important than using the model to view school/home network relationships. The model focusses on self-esteem. This is only one of many factors effecting learning that school/home networks can influence. Another would be causal loops involving the regular performance of homework and the involvement of parents in those dynamics.

We strongly urge further development of these guidance tools. If an extended model combined the "Transparent School Model" of Jerry Bauch (Bauch, 1995) with the work of Priest & Risley, schools would have much more solid guidance about what school/home networks to construct and what aspects of the communications loops are most important to establish. Further, such work cannot be done in "the lab." These models must be continually calibrated and informed by real-life applications of such networks.

PART III: The Benefits of K-12 School and School/Home Networking

Parts I and II of this Section contain the EPIE/CITS K-12 Schooling and Networking Model. It is within, and only within, the context of this model that benefits can be ascribed.

To illustrate this, we consider one of the most commonly ascribed benefits to networking — "excitement."

"I've seen kids who I know have been turned off by school in general become excited about learning for the first time in year. (Larry Geni, High school teacher, Evanston Township, IL, in Chandler, 1995)"

"There is also a strong motivational aspect to network use: kids bring an energy and enthusiasm to it that's often missing in traditional classrooms, and teachers are thrilled to be able to share ideas, problems and solutions with colleagues across the country as easily as if they were next door. (Eisenberg, 1992)"

In terms of "intrinsic" factors encouraging high school teachers to continue using the Internet, "Only one included term surfaced under the domain of influences that was intrinsic in nature — exciting. This term represented the aggregate of the many words or phrases the participants used to describe their feelings. These included "exciting," "thrilling," "fun," "envy," and curiosity." Julia said that the Internet 'opened up a whole new world to me. It's very exciting with lots of possibilities and I'm thrilled to be on it. It's the most exciting thing. (Gallo, p. 33)"

"Nobody knows the full potential of the Internet as a resource for K-12 education because it is still an emerging, rapidly growing, and largely unmanaged library of information, but educators nationwide are excited about the prospects. Already, teachers are using the Internet to share lesson plans, software and curriculum ideas; to connect students from different cultures in order to let them share their views and concerns about the world; and to download current information useful in the classroom from any number of free resource centers along the vast super highway. (Wilson, 1995, p. 77)"

In terms of the EPIE/CITS model we can see that excitement extends across a number of the dimensions. For example, the last speaker was excited about the "Learning Resources" possibilities, while the Gallo reference talks about the "Inspiration" dimension. The first quotation was from a piece that described "Authentic Learning" and the excitement described there was derived from this change.

Reflecting on this, excitement, itself, is a hazy benefit. It is great to say one of the benefits of networking is excitement but what excitement? Some of these include:

- Excitement gained from accessing resources "Learning Resource" dimension
- Excitement gained from shifts to authentic learning "Authentic Learning" dimension
- Excitement gained from teacher-to-teacher sharing "Learning Resource" dimension -- peer-to-peer
- Excitement gained from exploration "Learning Source" dimension - exploration versus instruction
- Excitement gained out of sense of magic probably related to the exploration dimension
- Excitement gained from collaborative projects "Learning Resource" dimension -- peer-to-peer

Networking, per se, is not exciting, but causing any one of these networked activities to occur, is exciting.

And it is important to ensure that the perceived benefit is a derived benefit. Consider the benefit of networking to access resources (as exciting). After a period of confusion, a teacher accessing the Internet perceives what appears to be an almost unlimited set of resources.

- Perceived benefit — almost unlimited resources on the Internet

What exists on the Internet (for free) at any given moment is one of the oddest assortment of materials imaginable. Priest (1995, Primer) describes the reasons for this assortment. Copyright restricts many valuable materials from free Internet access. Academic online databases are not free on the Internet.

Perhaps the three most touted resources on the Internet are 1.) The CIA World Factbook (http://www.odci.gov/, 2.) NASA photographes (http://www.gsfc.nasa.gov/ and 3.) the Weather map (http://www.mit.edu:8001/usa.html). Williams (1995) provides a useful catalog of these and similar sites. At this moment we have connected to the CIA World Factbook, and, choosing Afganistan, we note that most of what we find here is in a typical atlas of the world except that life expectancies are presented with two significant digits to the right of the decimal point — the male life expectancy is 44.72 years — a level of detail the not found in the atlas. Also, we note that the connection to the CIA site has about a 30 second delay (probably due to its popularity) making it somewhat slower than using a paper atlas. It is interesting to note the number of miles of paved and unpaved runways in Afghanistan but we are at a loss about what to do with that information, at the moment.

One can love the Internet, its conferences and resources are interesting, but its resources for K-12 teaching are very limited. So while some teachers' **perceived** benefit from Internet connectivity is high:

- the current **derived** benefit to K-12 teachers from access to curriculum resources is likely to be extremely low.

The "netnik's" response to this qualification of the benefit of the Internet is to say it is too early to judge the benefit of free resources on the Internet. Our response is that much of what is, and will be, available for free is, in fact, already on the Internet.

[Note: The hype and excitement about the Internet makes almost any kind of judgement about it offensive to someone. Many technology-based school reformers see sufficient leverage due to Internet interest among the population that disparaging the Internet, as in Clifford Stoll's *Silcon Snake Oil*, is cause for immediate ostracism. But this report is designed to be a "practical" guide to K-12 networking, and as part of practicality we are obliged to attempt some perspective. Part of that perspective is to identify the existence of "netniks:"

- Netnik — a person dedicated to promoting the value of networks without fully acknowledging the limitations that may be derived from networks as they exist in practice.]

In contrast, there is considerable evidence that peer-to-peer networking among teachers using e-mail and lists has both high perceived benefit and high derived benefit. Eisenberg notes this benefit (1992) and Gallo (1994) found the reduction of teacher isolation through contacts on the Internet to be far more important than the teacher's use of the Internet in the classroom.

<u>Practical Benefits of Networking</u>

The above discussions on excitement and reduced teacher isolation relates a good deal about the derived benefits of networking.

Further benefits are:

- (Internet is) A Puzzle (Gallo, 1994)

Relation to Model: Learning Source — exploratory

- (Students are) Able to Explore Current Issues (California Guide, 1994)

Relation to Model: Learning Resources

- (Students have) Access to Electronic Networks (Eisenberg, 1992)

Relation to Model: Learning Resources

⇨ (Networking) Allowed Students to Share with Greater Group (Teles, 1991)

Relation to Model: Learning Resources — peer-to-peer

⇨ (Networking is the Basis to) Alter Roles of Student Teacher (Peha, 1995)

Relation to Model: From instruction to exploration

⇨ (Networking Projects helps Students) Appreciate Science as a Collective Enterprise (Weir, 1992)

Relation to Model: Learning Source — toward authentic learning

⇨ (Networking) As an Interactive Communications Medium (California Guide, 1994)

Relation to Model: Generally

⇨ (Networking leads to) Authentic Learning (Kozma, 1995; Chandler, 1995; Newman; 1992; etc.)

Relation to Model: Learning Source — toward authentic learning

⇨ (Networking leads to) Awareness of Global Community (Peha, 1995)

Relation to Model: Learning Resources

⇨ (Networking) Brings Real World Relevance to Classroom (Teles, 1991)

Relation to Model: Learning Source — toward authentic learning

⇨ (Networking is a) Catalyst for Paradigm Shift (California Guide, 1994)

Relation to Model: Networking encourages shifts along multiple dimensions of the model (as described above)

⇨ (Networking produces) Change Teacher Role (Means, 1995)

Relation to Model: Various shifts from instruction to exploration and varied use of resources

⇨ (Exploring Internet produces) Character Building Against Threat of Drowning (Honey, 1993)
This benefit requires clarification. Margaret Honey presents the Internet as a journey into the unknown, akin to a "frontier expedition." The vastness of the journey poses a "threat of drowning" — as a sea journey poses a threat of drowning. Nonetheless, the challenge of such an expedition helps build personal character strengths.

Relation to Model: Learning Source — toward exploration

⇨ Classes Finish Units of Study Faster (ACOT study in Brown,1995)
(attributed to networks and other Apple Classroom of Tomorrow technology)

Relation to Model: Various, including Learning Resources

⇨ (Students) Communicated more Effectively About Complex Issues (ACOT study in Brown, 1995)
(attributed to networks and other Apple Classroom of Tomorrow technology)

Relation to Model: Learning Sources - toward authentic learning

⇨ (networking) Communication Leads to the Respect of Other Cultures (California Guide, 1994)

Relation to Model: Learning Resources — peer-to-peer

⇨ (The) Computer Inspired More Active Learning (ACOT study in Brown, 1995)
(attributed to networks and other Apple Classroom of Tomorrow technology)

Relation to Model: Learning Sources — both exploration and authentic learning

⇨ (Networking enables) Computer Mediated Communication (Teles, 1991)

Relation to Model: Generally

⇨ Computers Inspired more Collaboration (ACOT study in Brown, 1995)
(attributed to networks and other Apple Classroom of Tomorrow technology)

Relation to Model: Learning Resources — peer-to-peer

⇨ (Students) Develop Skills for Questioning, Researching, etc. (California Guide, 1994)

Relation to Model: Learning Sources — toward authentic learning

⇨ (Networking leads to) Discovery (Honey, 1993)

Relation to Model: Learning Sources — toward exploration

⇨ E-mail Encourages Writing (Kuttner, 1995)

Relation to Model: Learning Resources — peer-to-peer

⇨ (Networking Technologies) Encourage Student Leadership (Weir, 1992)

This benefit is reported as part of the TERC Star schools networking project. Teachers reported "that the open-ended nature of the activities encouraged them to adapt or modify their teaching methods; that their students carried out more group work than usual; and that collaborative work in their classes resulted in a positive experience for them and their students. (pp. 8-9)" A survey of 184 teachers reported on how the program was "encouraging students to take leadership roles." From a regular curriculum to the Star School Activities the following increases were reported: Male students - from 31% to 61%; Female students 28% to 55%; minority students - 20% to 44%; those with poor academic performance - 12% to 38% (p. 11).

Relation to Model: Learning Resources — shift to peer-to-peer, collaborative learning

⇨ (Networking leads to the) Energy and Joy of Collaborative Learning (California, Guide)

Relation to Model: Learning Resource — shift to peer-to-peer, collaborative learning

⇨ (Networking leads to) Enthusiasm or Excitement or Exploration (addressed above in text)

⇨ (Networking) Fosters Interpersonal "Intelligence" (Eichleay, 1993)

A pervasive way of recognizing learning styles has resulted from Howard Gardner's theory of "seven intelligences" (*Frames of Mind*, 1983, 1995). Eichleay presents a "map" showing the relationships of

various kinds of software and networking to the List of Seven Intelligences. We briefly summarize this list:

- Linguistic - Magic Slate, Bank Street Writer, etc.
- Logical-Mathematical - Reader Rabbit, Oregon Train, Bank Street Filer, etc.
- Spatial - Kid Pix, SuperPrint, Muppet Slate, etc.
- Musical - Magic Music Maker, Music Theory, Joshua's Reading Machine, etc.
- Bodily-Kinesthetic - Lego LOGO, Stickybear Typing, Operation Frog, etc.
- Interpersonal - telecommunications, Oregon Trail, Social Skills on the Job, etc.
- Intrapersonal - Playing to Learn, Math Blaster, 3-2-1 Contact, etc.

To the extent networks provide interconnectivity for shared software experiences (e.g. Oregon Trail), networks provide access to tools and experiences that foster all of the seven intelligences. In particular, however, the key characteristic of a communication network is interpersonal communication.

Relation to Model: Interpersonal communication relates to the full range of the model. Discipline is improved as students make commitments to others, whether in promising to e-mail a pen pal or committing to participation in a collaborative research project. There are many external rewards to communicating, fostering involvement and encouraging work on task. And interpersonal communication provides access to Learning Resources - peer-to-peer as well as student-mentor relationships.

- (Networking Enables Learning) Freed From the Limitations of Buildings (Eisenberg, 1992)

Relation to Model: Learning Resources — more transparent access from the outside

- (Networking Enables Learning) Freed From Classroom Restriction (Eisenberg, 1992)

Relation to Model: Learning Sources — shift to authentic learning

- (Networking Technologies) Frees Teacher (Teles, 1991, p. 9)

Relation to Model: Learning Sources and Learning Resources — shift away from instructional

- (Networking Brings) Gains in Content Knowledge (Weir, 1992)

In the evaluation of the NGS Kids Network, "students demonstrated gains in specific content areas: significant gains in place knowledge, and significant increases in the ability to use lattitude and longitude to identify map location. Students' understanding of the factors contributing to acid rain and their ability to reason about the impact of these factors improved significantly from pre- to post-test: For example, causal explanation of the relationship between factory emissions and wind patterns increased by 26%. (p. 16)"

Relation to Model: Learning Sources — shift to authentic learning; Learning Resources — peer-to-peer

- (Networking Brings) Gains in Data Interpretation Ability (Weir, 1992)

In the evaluation of the NGS Kids Network, "students demonstrated significant gains in their ability to organize and represent data. (p. 16)"

Relation to Model: Learning Sources — shift to authentic learning; Learning Resources — peer-to-peer

- (Networking Provides) Greater Access to Information (Teles, 1991)

Relation to Model: Learning Resources — shift to more sources

⇨ (Telephone Networking) Helps Parents to Call Every Day to Hear Teacher (Bauch, 1995)

Relation to Model: Improved Monitoring (Discipline); Extrinsic Motivation (Inspiration)

⇨ ILS Network Benefits (Sherry, EPIE Institute, 1990;Van Dusen, 1995)
(Integrated Learning Systems)

- ⇨ Access to Learning Resources
  Relation to Model: Learning Resources
- ⇨ Effective Assessment and Reporting
  Relation to Model: Improved Monitoring (Discipline); Extrinsic Motivation (Inspiration)
- ⇨ Guaranteed Individualized Instruction
  Relation to Model: Learning Sources — using Learning Resources such as Computer Assisted Instruction
- ⇨ Increased Time on Task
  Relation to Model: Learning Sources — using Learning Resources such as Computer Assisted Instruction
- ⇨ Teachers Not Dispensers But Guides
  Relation to Model: Learning Resources — teacher role shift from instruction source to resource

⇨ (Networking Technologies Leads to) Improved Observation Skills (Weir, 1992)

In the evaluation of the NGS Kids Network "students' skill at data interpretation also improved significantly. More students were able to make observations about the data set on the post-test (p. 16)"

Relation to Model: Learning Sources — shift to authentic learning; Learning Resources — peer-to-peer

⇨ (Networking Technologies Leads to) Improved Self-Esteem (Weir, 1992; Means, 1995)

"Teachers gave specific examples of the benefits of a hands-on, technology-based approach to teaching science to students with learning difficulties, both with regard to self-esteem and in increasing understanding of the material. (Weir, p. 10)"

"A second frequently cited rationale for introducing technology was to *stimulate motivation and self-esteem*. Through either personal experience or a review of the literature, many innovators perceived the dramatic effects that technology can have on students' interest in class activities and their sense of their own capabilities. Although these benefits are perceived as occurring across the board, our case study sites, most of which serve student bodies coming predominantly from low-income homes, felt that these benefits would be particularly important for their students. Thus, a related reason for using technology was the *promotion of equity*. In the case of the teacher network, the districts recognized the wide disparity in the resources available to them and felt that a unifying network could promote a more equitable use of those resources. In the case of several schools serving students from low-income homes, technology innovators stressed the importance of giving these students the technology tools that would equip them with a needed edge to compete with children coming from more affluent homes, where technology is commonplace. (Means, p. 103)"

Relation to Model: Learning Sources — shift to authentic learning; Learning Resources — peer-to-peer

⇨ (Networking Technologies Leads to) Increased Citizen Participation (California Guide, 1994)

"As the social and economic issues of the information age have increased in complexity, our society has found itself lacking in tools for engaging and educating its citizenry. Declining voter registration and even greater declining voter turnouts attest to the toll the alienation of our citizenry is taking on our democracy. Though mass media is pervasive, it presents information as though there were ready answers to the complex issues. Because it is very difficult for mass media to convey significant detail about a topic in a manner

that is interesting to its broad audience, it is relegated to finding the acceptable level of detail, or lack thereof, and an engaging way to present it. By virtue of the medium's technological constraints, viewer participation is extremely limited. The Internet, with its volumes of materials, voices, points of view, and images provides educators a serious but engaging tool for fostering student curiosity and literally demands an interactive relationship between the individual and the information he/she is receiving. (p. 22)"

"Through thousands of news groups, mail lists, and e-mail dialogues, users are encouraged to participate, ask questions, dig deeper, and study more extensively. Curious lifelong learners are respected and supported, regardless of their level of expertise. The impact of this social design has for education is revolutionary in scope. (p. 22)"

 Priest (1995, NetNews Primer) did an investigation of newsgroup messages that occurred within 24 hours of the Japanese earthquake (1/16/95) for a Forum on Journalists and the Internet (Emerson College and Telecommunications Policy Roundtable - NE). What Priest found was a use of news groups to mainly provide emotional support and a way of sharing the grief. "Many American otaku are anguished and prayerful about the disasterous earthquake befalling our brothers and sisters in Japan. Some of us have friends and family over there. Perhaps it would help if we articulated and shared our wishes and prayers - just let them know that there are those who care. (mendosan@aol.com, Mendo san, Jan. 17, 1995, rec.arts.anime)

Surely this form of international communication plays a role that transcends borders and races. News groups are perhaps one of the most fascinating aspects of the Internet. Divided into over 10,000 topics, using threaded newsreaders, anyone can become part of an on-going dialog regardless of stature. While each group has regular members, with both written and unwritten rules about the expectations for the dialog, a student can track a news group to understand the purposes and limits before making a "post."

Also, it is surprising the care and time some people take, without pay, to help others in news groups. While an unstated rule of news groups is to answer questions, that you can, while asking a question and following the list for responses; there are "regulars" in each news group that contribute far more than their "share" in informing others. Whether newsgroups can sustain this level of generosity as the numbers of participants grows is a remaining question.

Relation to Model: Learning Resources — peer-to-peer

 (Networking Technologies Leads to) Increased Understanding (Weir, 1992)

In analyses of the TERC Star School networking activities, Weir found substantial increases in 'students' understanding of academic content. Comparing the regular curriculum to the Star School activities the following improvements were measured: male students - from 54% to 66%; for female students - from 52% to 64%; for minority students - from 43% to 58%; for students with poor academic performance - from 24% to 38%.

Relation to Model: Learning Sources — shift to authentic learning; Learning Resources — peer-to-peer

 Intercultural Use of Telenet and the Source Helps Bring Cultures Together (Mason, 1989)

"The Intercultural Learning Network: Faculty at the University of Illinois, the University of California, Aoyama Gakuin Women's University, Tokyo, and Hebrew University, Jerusalem, have collaborated to develop personal computer-based activities in which geographic distance and cultural differences become useful devices to focus student interest. International networking provides depth to the study of the natural and social sciences and scope to the development of written communication skills. Using public dial-up satellite links (Telenet) and a commercial information utility (The Source) to pass email messages, the Inter-cultural Network has linked classrooms in four states and three foreign countries. Students in upper elementary, middle and high schools work together on projects in which they compare observations of the different ways that local people handle problems and organise activities that are common around the world. (p. 41)"

Relation to Model: Learning Resources — peer-to-peer

⇨ (Computer Technologies Enable) Learning by Modelling (Kozma, 1995)

As students gain access to modelling tools, they are better able to understand subjects and relationships.

Relation to Model: Learning Resources

➪ (Networking Leads to) Learning to Use Rapidly Changing Information (Newman, 1992)

Relation to Model: Learning Resources

➪ (When Using Networks) Learning Disabled Did as Well (Weir, 1992)

Weir found that students classified as "learning disabled" did as well as those not disabled in some of her networking evaluation studies.

Relation to Model: The educational literature addresses how students in a typical classroom setting can be labeled as disabled, yet when these students are placed in different environments - say an authentic learning situation - these differences disappear. (Some studies have gone so far as to provide mis-information to teachers about good and poor students, to find that based on these misperceptions, the performance of the student actually mimics the false label.

➪ (Networking) Makes It Feel Real (Wilson, 1995)

Relation to Model: Learning Sources — shift to authentic learning

➪ (Internet) Not Fixed, It Changes with Arrival of Every New User (California Guide, 1994)

✎ The California Guide covers the networking landscape with an exceedingly wide sweep. It is commendable in its range and depth for both educational and technological issues. We simply point out that this "benefit" is similarly boundless. One could almost say the same for every birth in the world, and with "six degrees of separation" every birth affects everyone, some time to some extent.

Relation to Model: Boundless Learning Resources; exploration

➪ (The Internet is) Not a Benefit, but a Waste of Time (Stoll in Wald, 1995; PBS debate between Clifford Stoll and Damor Moore [Science Teacher], 1/3/96)

Stoll's presentation on PBS, while somewhat theatrical, speaks to a number of concerns critics of computers and networking voice about the technology. Stoll returned many times to the "Inspiration" dimension of our model, emphasizing the role of the teacher in raising student interest and instructing in the ambience of the classroom. Moore countered that the purpose is not to "replace the teacher" but to provide resources that extend the teacher's ability to instruct.

Relation to Model: Stoll focuses on the extent to which networks have a certain inspirational sterility; Moore focuses on Learning Resources - especially those that extend the teacher's capacity to instruct.

➪ (Networking Facilitates) Parental Involvement (Boston Globe, 1995)

The *Boston Globe* produced a special Learning Section on parental involvement in schools. A number of the articles are based on the work of Don Davies at the Center on Families, Communities, Schools & Children's Learning located in Boston.

Davies formed the Institute for Responsive Education in the early '70's (see Clasby, 1975; Davies, 1977; Institute, 1977; Zerchykov, 1984). The Institute has received foundation support to improve the process of parental involvement in schools and has published numerous parental resources.

"As education reform grips Massachusetts and the nation, parent involvement in a child's schooling needs to - and can - extend well beyond the old bake sale and annual parent-teacher conference, say education specialists."
"From building playgrounds and volunteering in classrooms to joining school-based parent councils and reading their child every night, many parents play a crucial role in trying to improve their children's education."
"'When parents and teachers develop good working relationships, teachers offer students more support in the form of higher expectations and added encouragement,' said Nancy Sconyers, senior research associate at the Center on Families, Communities, Schools & Childrens' Learning in Boston.' (p. 72)"

Parent/teacher/student communication is a high priority, especially among lower income families (Priest, 1973). "Ask the teacher for specific ways you can reinforce at home what is taught at school, be it helping with homework, reading with the child or monitoring television-watching. (Boston Globe, 1995, p. 73)"

Relation to Model: Parental Involvement provides the widest range of relationships to the K-12 Schooling & Networking model of any area of benefit. Parents can, as illustrated above in monitoring their children's TV watching or homework activities, improve student discipline. By working with teachers, they help form "higher expectations and encouragement" and thus affect the inspiration dimension of the model. And by reading to children and being actively involved in homework assignments, they provide the child to one of the most responsive "Learning Resources" - the parent.

As discussed in Sections II & III, under telephone voice mail systems and home/school web pages, the technology for making the home/school connection is flourishing in a way that prior technology could not support. As the **time** required for parents to have meaningful relationships with teachers and schools **decreases**, and as different **modes** of communication, be it e-mail or voice-message, provide more **comfortable ways** in which teachers, parents, and students can discuss learning opportunities and problems, the prospect for improved parental involvement-based learning expands.

⇨ (Students Can Learn from Others through) Peer Communication (Eisenberg, 1992)

Students and teachers can "communicate with peers and gain access to electronic resources as they wish... (p. 1)"

Relation to Model: Learning Resources — peer-to-peer

⇨ (Networking has a) Positive Impact on the Classroom (Sun, 1995)

Preliminary evaluation of networks in classrooms under the ModelNets study finds "[i]t is possible to address the issue of effective[ness of networks] by equating it with "positive" impacts and by letting these positive impacts be an indicator for effectiveness. " Specifically, one can say that effective networks create positive impacts on classroom teaching and learning. (line 43)."

Relation to Model: Generally

⇨ (Networking Technologies Leads to) Preparing Students for the Future (Means, 1995)

"The concern for equity [see self-esteem, above] is related to a fourth motivation for introducing technology - to prepare students for the future. 'I don't care what field they're in, be it factory worker, office worker, medicine or whatever. [There is not place where technology will not be used.] It's getting harder and harder to get jobs. You want your kids to get a leg up. It's becoming a necessary ingredient. -- Middle School principal' (p. 103)"

⇨ Relation to Model: Generally

⇨ (Networking Technologies Leads to) Promoting Interest (in Science) (Weir, 1992)

In evaluating the effect of the TERC Star Schools project, a survey found that the networking project promoted students' interest in science over the regular curriculum: for male students - from 51% to 73%; for female students - from 47% to 66%; for minority students - from 43% to 59%; and for students with poor academic performance - from 16% to 49%.

✎ Many of the government supported networking-based projects are susceptible to the "Hawthorne Effect." [The Hawthorne effect was noted when a study purported to uncover the positive effects of "improving" working conditions by changes in layout and lighting. When these "improvements" were made, measured productivity of the workers increased. In the Hawthorne study, the researchers then "improved" working conditions again, by putting things back the way they were. Measured productivity of the workers increased a second time. Thus, the actual cause and effect was not the impact of the surroundings but rather the attention given to the workers.] In Weir's survey there is no way to separate out the various influences that a special science project has from its relationship to networking, per se.

Relation to Model: Assuming that interest and inspiration are related, networking provided improved extrinsic motivation or inspiration for students.

⇨ (Networking Leads to) Reduced Teacher Isolation (Eisenberg, 1992; Gallo, 1994; Means, 1995)

Networking technologies have two major effects on teachers: 1.) reduced isolation through peer-to-peer networks, and 2.) increased professional development (discussed below).

"Technology has the potential to support a much greater degree of communication and collaboration between teachers and others outside the school walls.. 'I don't know of any other profession in the world that isolates themselves more from what others do than teachers. We walk into our classroom. We close the door, and there is no connection with the rest of the world. Networking is going to change that - TeacherNet teacher' (Means, p. 156)"

Bonnie Bracey (moderator of nii-teach@wais.com) plays a critical role in encouraging teachers to break out of older teaching styles and to embrace Internet resources. Terry Moore and others operate GENII — a welcoming service for teachers and students. When teachers receive an e-mail account, members of GENII are alerted, and send welcome messages to these teachers.

Relation to Model: While we have largely referred to Inspiration in terms of the student, teachers, too, need inspiration to adopt new teaching styles. Networking teachers also provides Learning Sources — peer-to-peer.

⇨ (Networking Technologies Leads to) Students as Active Learners (Internet World, 1994, Global Schoolhouse)

The Global Schoolhouse is an ongoing project that demonstrates the use of videoconferencing on personal computers over the Internet." "Cornell University's CU-SeeMe software allows students to sit down at an Apple Macintosh or MS-DOS computer and work with students in other locations. (p. 12)"

Relation to Model: Learning Resources — peer-to-peer

⇨ Students Become more Socially Aware/Confident (ACOT study in Brown, 1995)
(attributed to networks and other Apple Classroom of Tomorrow technology)

Relation to Model: Inspiration

⇨ Students become more Independent Learners and Self Starters (ACOT study in Brown, 1995)
(attributed to networks and other Apple Classroom of Tomorrow technology)

Relation to Model: Shift from extrinsic to intrinsic along Inspiration; use of Learning Resources

➪ (Networking Technologies Leads to) Teacher as a Facilitator (Peha, 1995)

"When students spend class time browsing the Internet rather than listening to a teacher's lecture, they encounter more diverse expert opinions, work more independently, and proceed at their own pace. In fact, we observed that students experiencing computer problems were more likely to consult peers than the teacher. Throughout this process, the teacher becomes more of a facilitator, helping students find information and, more, important, figure out what to do with it. (p. 21)"

Relation to Model: Learning Resources — shift to peer-to-peer and outside resources

➪ (Networking Technologies Leads to) Teachers Shifting from Dispenser of Knowledge to Coach (Newman, 1992)

"The answer to the instructional delivery paradigm can be stated quite simply. Information required for productive citizenship is changing rapidly. It is now essential to present instructional content that is live, that comes from active information sources such as weather satellites, data collected by students in other locations, and responses from working scientists. School work must include primary information sources so that students are simultaneously learning the critical content while gaining first-hand experience with information sources themselves. At the same time, information access technology is evolving rapidly and dropping in cost: Changes in the teachers' role from a dispenser of information to a coach who helps guide students' first-hand experience with the live sources of information will require support of teachers in finding and using these sources... (p. 3)"

Relation to Model: Learning Sources — from instruction to exploration; Learning Resources - diverse

✎ It is perhaps this picture of the "wandering student" with the teacher as "coach" that has frightened more educators than other networking pictures. Surely we recognize what compels Newman to describe this situation - the intrinsically motivated student, exploring and building his/her reach and knowledge. What needs to be added to this picture is the role: 1.) Extrinsic motivation plays in the classroom or in learning groups, 2.) the need for exploration to trigger in the mind of the student his/her ignorance or ineptness, compelling the student to elect a more instructional approach to a body of knowledge that requires carefully building up requisite knowledge blocks that enable exploration to begin again. Some students come from homes of scientists and other professionals, and have already had the benefit of these role models and became intrinsically motivated very early, often pre-kindergarten. But many other students must wait for the schooling process to provide structure, inspiration, and provide the instruction required to build from.

➪ (Networking Technologies Leads to) Teacher Increases in Professional Activities (Means, 1995)

"One of the major effects of the technology-supported education reform efforts for teachers was an increase in their involvement in professional activities. Project-related teacher professionalization enhancements can be roughly classified into two categories: (1) activities and change in circumstances that were part of the reform effort or technology implementation per se and (2) increased opportunities for professional activities and a state- or national-level exposure that arose as a side effect of involvement in technology innovations. (p. 157)"

Studies of the costs of implementing networking in schools (Rothstein, 1994; Hodas & Warren, 1995; McKinsey, 1995) note that the major cost of implementing networking is in "teacher training."

EPIE/CITS Note: The phrase **teacher training** is the most commonly misrepresented notion in achieving practical K-12 Networking that we come across. The phrase conveys something akin to "refresher course" or "in-service training" or getting some more credits for the next pay scale.

A common alternative for **teacher training** is **professional development** for but this phrase conveys something even worse. It sounds as though the teachers are not professionals and require development to become professionals. Teachers are, indeed, professionals at what they do — instruction. They have taken their courses, gained their degrees, performed supervised teaching, and spent years perfecting their courses,

style, and presentations. While some teachers might coast, most stay current with their field, read avidly, and are very good at what they do.

What we are talking about, in contrast, is professional redevelopment - in business it is called reengineering - and it is the shifting of skills and techniques of teachers in tandem with a shift in a school's commitment to moving the schooling of students from one cluster in the K-12 Schooling & Networking model to another cluster. (By cluster we mean if you took the current schooling objectives and placed the current students in the "model space" the points in the space would cluster in some distinct pattern. As suggested earlier, this cluster would have many students closer to the instructional form of learning sources, closer to extrinsic inspiration than intrinsic inspiration, and closer to lower discipline, than high discipline.

A school district can chose to change this distribution of students. They can elect to shift the "cluster" along these scales, and the others described above. When the school district elects to move the cluster, they have also committed to moving the skill sets of their teachers.

So when people talk about "training costs" being large compared with hardware costs, we suggest they think of these as redevelopment costs - which surely will be very large either as 1) personal investments by teachers and administrators in changing how they teach, or 2) budgetary expenditures on the professional redevelopment of all school staff.

Relation to Model: The shifts in learning elected by schools in the model entail extensive changes in teaching skills.

EPIE/CITS Note: A clear sign that the networking technology will not be used is if there is not a massive redeployment or redevelopment of teachers and administrators.

PART IV: Barriers to Achieving the Benefits

There are three sources of barriers:

- Perceived benefit is too low
- Derived benefit is too low
- Cost to achieve the benefit is too high

There are two major types of costs:

- Monetary, budgetary
- Personnel inertia, changeover costs

The literature raises a number of "barriers" (X) and they are discussed here, in alphabetical order (by significant keyword):

X (Lack of) Access to Technology (Cable in the Classroom (based on QED data), 1995; Newman, 1992; etc.)

What is the appropriate ratio of computers to students? Papert has been saying for years it is 1:1 yet the McKinsey study's highest cost model provides for only 1:5. As pointed out in Section III, the nation is, in fact, 1:1 in most homes of students with home computers.

Barrier Summary: As learning requires access to technologies from video teleconferencing to high-end computer simulation tools, there can never be too much technology (at least for some learning).

X (Lack of) Accounts (Honey, 1993)

Barrier Summary: Networking accounts have become less costly, but the costs will continue to be a barrier to providing enough networking accounts to carry out telecollaborative projects and other network intensive applications.

X (Problems with) Administration (Hodas, undated; many other)

The most common story is about the pioneering teacher with "arrows in his/her back" from principals and others who were "not supportive."

Indeed, in Section II, one of the dominant tips was to be sure to have the administration behind any networking plan.

Hodas (Hodas, undated, Culture) describes the most perceptive account we located on the role of administrators in accepting or "refusing" technology. This article is a chilling account of the many ways in which administrators, teachers and parents can stand in the way of adopting technology.

As the model in Parts I & II of this Section raises, adopting networking technology is fundamentally about shifting the character and kind of education a school offers. The character and kind of education a school offers is the province of the school board and the administration. Teachers often have little say in the process, except as the parents of children in the school system.

Barrier Summary: Networking is about pervasive change in schooling. If administrators do not favor a specific outcome of networking, they will (rightly) oppose the technology to preserve the educational process they favor.

X (Accessing) Administration Networks (Sun, 1995)

A major finding of the ModelNets study of schools attempting to implement networking was high resistance from MIS (Management Information Systems) to permit teacher and student access to these networks.

"While the ModelNets Infrastructure researchers found that in some cases, administrative networks could provide "positive models" for network management and development, we also found that the transition from administrative-only to a broadly used student, teacher and administrator network turned on issues of power and control with sometimes negative or at least disruptive results. MIS departments were reluctant to allow teachers and students onto sensitive or controlled networks. Teachers who had often discovered the educational uses of networks at home or in other non-managed locations were sometimes resistant to the "authority" and control on network use as imposed by district MIS staff. The result was a separation of teachers from MIS staff into two "camps." This situation, when found, was not functional in terms of growing the network and its use, expanding connectivity (i.e., creating student accounts), or even in writing systemic educational technology plans. (lines 201-234)."

Barrier Summary: In terms of the learning model, network uses that encourage exploration will clearly conflict with MIS staff's goals of maintaining tight control over records. The issue extends beyond the matter of "sufficient firewalls" (see Section II) to a cultural difference between the "two camps."

X Change is a Process, Not an Event (Weir, 1992)

(see next entry)

X Change Takes Time (Solomon, 1995)

"Participants agreed that change takes time, and those promoting change must be patient and persistent. Technology can facilitate this change, possibly accelerate it, and to some degree can promote common standards and equity. Change will reflect the character, diversity, and creative effort of local communities. (lines 107-114)"

Barrier Summary: Time for change is a barrier; yet true change does take time — just as it takes years to raise a child, it also takes time for significant changes in schooling to occur (we note Means' observations that changes can take three to five years, p. 76)

X (Problems) Coping with Hardware and Software Change (Means, 1995)

"'We have continually upgraded the machinery and software since we began. We've been through three or four versions of MacPaint and now use Canvas as a drawing program; three or four versions of MacWrite and AppleLink.... Just as soon as you think you've got a handle on something, it disappears or version 4 comes out.' - Elementary school teacher (p. 84)"

Barrier Summary: While Bikson (1987, 1994) emphasizes that "resistance to technology" is often overemphasized when users see clear benefits in its use, nonetheless, software and hardware "improvements" to some are barriers to others. (And it is not easy to "stand still." If one doesn't upgrade say, a wordprocessing program, an imported image from another program may not print correctly. The same is true of the Internet, where features in HTML 2 and 3 are inaccessible to users capable of only HTML 1. See, for example, the discussion regarding Imperial software in Section II.)

X (Lack of) Funding (Cable in the Classroom (based on QED data), 1995; etc.)

"Survey reveals higher than expected use of technology in the classroom -- also reveals other barriers, beyond funding."

Barrier Summary: The McKinsey study puts the peak average cost of networking classrooms (5 students per computer) at about 4% of the annual school budget. Yet the average spending on the most used teaching resource, the textbook, is less than 1% of annual expenditures. While some may interpret the McKinsey study to demonstrate the "smallness" of the expenditure, the costs are more than four times higher than for traditional teaching tools.

Further, the hidden costs of teacher/administrator redevelopment are probably much larger than any study projects. While we can expect more teachers graduating from schools of education to have skill sets more in line with changing expectations, the major impact of these changes will require redevelopment of the existing teacher base.

X (Problems) Getting Connected to a Resource (Teles, 1991)

Five years ago it required very high Internet proficiency to obtain anything of value from the Internet. Teles' experience, around 1990, reflects those realities.

Today, Internet tools have become easier to use, but to many teachers they still represent a challenging technology to operate.

Barrier Summary: It is said that to make technology "fool proof" you are inviting "fools" to use it. In Section II we describe the use of presentation machines and exploration machines. The use of either of these tools will continue to require skill and will, therefore, stand as a barrier to its use.

X Inadequate Electrical Power (GAO, 1995)

The GAO study finds it will cost $112 billion to fix or rebuild the Nation's schools.

Barrier Summary: In many schools the problem of wiring a network is dwarfed by the need to get electrical power to operate hubs and computers in the classrooms.

X Inequity (Newman, 1992; Komoski & Priest, 1995, Virtual Ghetto)

"Cut off from potentially life-changing information, learning and earning, these potential sharers and producers of wealth are being isolated in a virtual ghetto. The cost of escaping this ghetto is the cost of the technology and training needed to learn how to share in, and contribute to the growth of an information-based economy. (line 24)"

Barrier Summary: As extensively discussed in Section III, the costs of technology can be afforded by the affluent, and many families and schools will be deprived of access to important learning tools

✗ (Lack of) Integration of Computer Mediated Communication with the Curriculum (Teles, 1991)

The gulf between exploratory or peer-to-peer resource uses of the Internet (such as computer mediated communications) looks like a barrier when the activity is not viewed as a part of the curriculum.

✗ (Lack of) Knowledge About Various Services (Cable in the Classroom (based on QED data), 1995)

"Lack of knowledge about the service, lack of training and workshops, lack of time to learn how to use, lack of access to equipment, and lack of phone, cable and data lines in the classroom were barriers to usage of online services and Internet for approximately 80% of teachers, and media coordinators, compared to 50% to 60% for Cable in the Classroom (p. 9)"

The Services include computers, Cable in the Classroom, Channel One, the Internet, and Online Services.

✎ Cable in the Classroom programming included in-school television programming such as by PBS, The Discovery Channel, and CNN. Forty percent of the country's teachers and media coordinators used PBS programming during the last school year, 34% used The Discovery Channel programs, and 28% used CNN. Cable in the Classroom is the cable television industry's 5320 million public service initiative to enrich education. It serves over 70,000 schools (approximately 70% of all public and private schools K-12) reaching 80% of all U.S. students with commercial-free, educational programming (p. ii)

Barrier Summary: Lack of information on network-based services are a barrier to their use.

✗ (Presence of) Latent Values (Burron, 1995)

"By resolving the value-laden philosophical differences among school personnel, parents, and the general public, we can all approach reform in the cool light of reason. (p. 92)"

"I see four community values that have become bones of contention:

- safe passage (e.g. not having a student's values ridiculed)
- opt-in (e.g. agreement about objectionable materials)
- parents' rights (e.g. banning showing of tape on breast self-examination)
- child-centered curriculums
    - individuals will eventually gravitate toward self-fulfillment, and so will focus on aspects of the curriculum they value, and forget things they don't
    - society is strengthened most by the diverse contributions of people whose gifts are most fully defined (p. 93)"

The issues raised here further illuminate aspects of the model introduced in Parts I & II of this Section. This article was written by the Director of the National Center for Community Consensus on Education, and clearly demonstrates a keen appreciation for underlying issues.

Barrier Summary: There are strong, often unspoken values that control the freedom schools have to move about in the "model space" we describe above. Without the flexibility to move within the space, there is doubt that networking technology will succeed except as teacher presentation tools described in Section II.

X (Networking Technology Leads to) Marginal Impact to Schooling (Newman, 1992)

"A serious development effort will be needed to fill the technological gap. More importantly, a research and demonstration effort will be needed to articulate an alternative model. Few school systems are likely to take advantage of their installed local infrastructure for instruction or staff development unless there is a compelling pedagogical rationale. (p. 7)"

Barrier Summary: Networks that are installed outside of the framework of how schooling really occurs are likely to go unused.

X (Problem of) Mismatch between School Values and Technology (Hodas, undated, Culture)

"Yet despite the tenor of the current hand-wringing our schools are not 'failing.' On the contrary, they are doing exactly the job they were set up and refined to do. It is the world around them that has changed, and this mismatch between school and society is so blatant, so pervasive, its consequences for the nation so malignant and ineluctable, that a trans-ideological consensus has congealed around it: something must be done. (lines 32-38)"

Barrier Summary: Without redevelopment of both teachers, administrators, and schools, the system's intertia will prevail.

X (Problem that there is) No One Blueprint (Gargano, 1994)

As discussed in Section II, each school district's networking needs are unique — defined by its individual culture, staff resources, and existing technologies.

Barrier Summary: The uniqueness of each school district requires that each district develop and design their own technology plan. While there are guidelines discussed throughout this study that can be drawn from, there is no one, economical design that can be adopted by each school.

X **Not** a Problem with Relevance to the Curriculum or Teacher Motivation (Cable in the Classroom, 1995)

"Only some 40% felt that lack of relevance to the curriculum and lack of motivation on teachers' part were barriers to greater usage of Cable in the Classroom [and other technologies such as Online Services and the Internet]. (p. 9)"

This statement must be taken within the context of the Cable in the Classroom/NEA/QED study. These two barriers were relatively less important than issues such as funding, knowledge, training, time, and equipment access which ranged from 60-85% of teachers reporting them as barriers.

Barrier Summary: Teachers and Media Coordinators see "Relevance to Curriculum" and "Teacher Motivation" as significant but as less of a barrier than other barriers.

X (Problem that) Online Databases Carry Higher Costs Outside the School (Teles, 1991)

Various vendors of online database services provide significant discounts to schools.

Barrier Summary: When students graduate, they find that database resources often cost more than they can afford, negating the benefits of learning to use them.

X (Problem with) Parents' Displeasure over Student Cognitive and Affective Changes (Hodas, undated, Culture; Kozma, 1995)

"What is perhaps less clear is public acceptance of this approach to learning and of a system of assessing students in the context of authentic group projects. As Cohen (8) points out, the majority of the public

adheres to a very conventional model of education as knowledge transmission and assessment as performance on standardized multiple-choice tests. (Kozma, p. 34)"

"If students, parents, and teachers are all pleased with the cognitive and affective changes induced locally by working with these types of tools (and it is by no means certain that they will be), it may become difficult to sustain the older, more repressive features of school organization of which centrally-administered and imposed technology is but one example. (Hodas, lines 855-859)"

Hodas's paper *Technology Refusal and the Organizational Culture of Schools* is frank to the point of being brutal about the many ways cultural values can place a halt to the educational use of technology. If Lewis Perlman's *School's Out* represents one extreme along the expression of the viability of schools, Hodas's paper represents the other extreme, indicating that schools are well entrenched and likely to remain that way. Both writers draw from the same realization of cultural rigidity and arrive at different conclusions about where schools will come out. [Author Note: this morning (1/24/95) the City of Hartford announced they were abandoning their attempts to privatize the public schools.]

Barrier Summary: There are schools, today, drawing up thousands of technology plans, but it is not clear if these plans reflect the underlying "biases" in the school's culture.

X (Problems with) Principals (Peha, 1995)

"Probably the most disturbing problem came out in direct interviews with teachers who were not part of the Pittsburgh project. Not only are rewards for innovative teachers often small, but some principals and teachers actually discourage resourceful teachers from disruption of the status quo. The reasons for such opposition may include two fears: that benefits will be small and not worth the effort, and that benefits will be great, so other teachers will be expected to keep up. (p.22)"

Barrier Summary: School principals, and other administrators, must "buy-in" to changes or pioneering teachers will be undermined and left unsupported.

X (Lack of) Quality Time (Solomon, 1995)

Participants agreed that technology offers opportunities for new learning experiences at the K-12 level for both teachers and students. A critical component of technology use is professional development and ongoing support; it's as important as the hardware, software, and curriculum. Finding **quality time** may be the biggest issue in training teachers to use the equipment and professional development for integrating technology into classroom activities. (lines 128-132)" [emphasis added]

Barrier Summary: Insufficient time.

X (Lack of) Role of Technology (OTA's Report: *Teachers and Technology: Making the Connection*, in O'Neil, 1995)

"A third explanation for the somewhat disappointing status of technology use is an overall lack of vision and clarity of goals in the school. Technologies are changing rapidly, and so are the ways schools are expected to use them. Schools were first urged to teach students computer programming, for example; a few years later, they were prodded to focus on applications such as word processing and spreadsheets. Add in the fact that 'getting the technology' sometimes overshadows the question of how teachers want to change their instruction, and what role technology can play in assisting that, 'It is a small wonder that teachers have become confused, and administrators frustrated, with many educators unclear where they should be heading in technology use,' OTA says. (p. 12)'

Barrier Summary: From the model discussed in Parts I & II of this Section, this perspective is not only not surprising, but epitomizes the frustration felt when technology is put before setting clear educational goals that include the use of technology.

X (Technology Causing) Teacher and Technology Embarrassment (Hodas, undated, Culture)

"Much of the question of teacher self-definition revolves around the anxiety generated by their unfamiliarity and incompetence with the new machines. The fear of being embarrassed is a major de-motivating factor in the acquisition of the skills required to use computer technology in the classroom (Honey & Moeller, 1990; Kerr, 1991; Sheingold & Hadley, 1990). (lines 552-556)"

Barrier Summary: In many cases student proficiency with technology exceeds the teacher; in traditional roles this is a source of embarrassment.

X (Lack of) Telephone Lines (Honey, 1993)

Until recently, the only means a teacher had to connect a classroom machine to an outside network resource was the telephone. More recently, those schools that elect school-wide network connectivity can achieve a connection to outside resources more cost-effectively than using the telephone.

Yet, with the newer telephone network systems by Homework Hotline, Parlant, and others, the telephone has taken on a difference importance. It is an important means for a teacher to maintain contact with:

- Other teachers
- Administration
- Parents (and students)

Barrier Summary: Schools that do not install telephones prevent network-data uses in schools where there are no school-wide local area networks(LANs). Also, schools that do not install telephones inhibit the growth of voice-mail based systems which have been found to be extremely effective in improving teacher-parent relationships and in coordinating activities within the school.

X (Lack of) Time (Cable in the Classroom, 1995; O'Neil, 1995, Teles, 1991, National Commission, 1995)

Barrier Summary: In Section II a guideline was to "provide sufficient time," but as many point out, there is not sufficient time for teachers to carry on five classes a day **and** learn/develop a networked-based curriculum.

X (Problem with) Top Down Integration (Means, 1995)

"When teachers are not involved in selecting technology and do not see the connection between its capabilities and what they are trying to accomplish, the technology is likely to be either ignored or used in ineffectual ways. (p. 114)"

Barrier Summary: Bottom up integration is ineffective when administration is not supportive, yet top down integration is ineffective when teachers are not involved in selecting technology. This strongly suggests that Technology Plans will only be successful when there is a continual dialogue between teachers, administrators, and designers.

X (Lack of) Workshops and/or Training (Cable in the Classroom, 1995; O'Neil, 1995, Pitfalls; Kozma, 1995)

Barrier Summary: Lack of time, constrained budgets, and lack of clear educational goals using technology leave too little effort in teacher professional redevelopment.