

## SUMMARY

### Introduction

In coming to understand the stories of the teachers in the Knowledge-Building Communities project we encountered a multifaceted layering of contextual factors which we have addressed in the *Social Ecology of a Knowledge-Building Environment* framework. For example, the framework (Table 5), which emerged from the interviews with the teachers, illustrates how teachers experience with CSILE raised issues related to two levels of concern: (1) the micro level of the school community and the classroom, and (2) the macro level of administration and policy development. In addition, Theme Three, *The Adoption of CSILE Can Transform Social Interaction*, examined how the introduction of CSILE as an instructional tool was recognized to effect social interaction.

This report has shown that CSILE can act as a tool which embodies or articulates a social constructivist “philosophical framework” which in turn acts to “scaffold” the transformation of a teacher’s didactic instructional practices towards collaborative based intentional learning. As detailed below, this is important in terms of reforming schools, because it acts to transform the structure of classroom discourse. This change in the social relationship between teachers and students is significant because it shifts power relationships (Sarason, 1996).

Yet the teachers reported many systemic requisites to realizing a knowledge-building community supported by technologies like CSILE. When these requisites are missing, their absence is experienced as barriers. Such barriers arise from the lack of support from the realms of building level administration, educational policy and the public’s attitude towards schools. Thus the adoption of CSILE, and the social constructivist pedagogy it embraces, necessitates that we question common assumptions which characterize the structure of the present system of education and the values which undergird and enliven the roles of teachers and students and the culture of schools.

In this final section of the report we draw upon the data analysis to reintegrate and summarize our findings. In addition, the most salient findings act as a basis for recommendations regarding how schools may implement a knowledge-building community that is well-supported by technologies such as CSILE and other programs for Computer-Supported Collaborative Learning (CSCL). Although our findings emerge from specific experiences and perceptions of

the participants in our study, other educational communities considering the adoption of the knowledge-building community approach may find our study useful. It is hopeful that the thick description provided in this study will enable readers to discover a correspondence or an element of transferability between stories portrayed in this study and their own educational settings (Lincoln & Guba, 1985).

## **Altering the Culture of Schools**

### The Structure of Classroom Discourse

As noted above, Sarason (1996) believes that most attempts at reforming education are fundamentally flawed as they do not attempt to change the structure of discourse within the classroom setting. The typical discourse structure of classrooms may be portrayed as the teacher standing in the center of dialogue, such that s/he acts as a conduit for nearly all verbal exchanges. Sarason's (1996) summary of the findings on the topic of question asking in classroom discussion further illustrates his point:

1. Across the different studies the range of rate of teacher questions per half-hour is from 45-150.
2. When asked, educators as well as other groups vastly underestimate the rate of teacher questions, the estimated range being 12-20 per half hour.
3. From 67 to 95 percent of all teacher questions require "straight recall" from the students.
4. Children ask *fewer* than two questions per half hour. . . .
5. The greater the tendency for a teacher to ask straight recall questions, the fewer the questions initiated by children. . . .(Sarason, 1996; p. 105-106)

Based on findings such as these and his personal experiences working with schools, Sarason (1996) asserts that the observable criterion which signals a change in the structure of classroom discourse is "question asking in the classroom" (p. 361): who asks the questions, what are the nature of the questions, how and by whom are they answered? Sarason explains that the legions of youth who display a great deal of curiosity, questioning and creativity outside of school to understand their world, their culture and themselves in arenas that are often unsanctioned in the schools, are too often turned off by social studies, science and literature as taught in schools. Why is this so? Sarason speculates as follows:

. . . in our well-intentioned but misguided efforts to pour information into the minds of children we are rendered insensitive to what *their* interests, concerns, and questions are. . . We do not *respect* what is in their heads, i.e., they are not thinkers, they have unformed minds which it is our jobs to form. . . In *practice* we regard children as incapable of self-regulation. (Sarason, 1996, p. 363, author's italics)

Sarason's argument reflects several findings of this study regarding knowledge-building communities. First of all, we have seen how several teachers characterized their teaching practice prior to CSILE as traditional, featuring the teacher's control of classroom discourse. For instance, Jack's classroom practice was characterized by highly structured Socratic questioning. After using CSILE he had reduced the "teacher-directed" component of his practice down to 30% of his total classroom activity. Several teachers, particularly Nancy, Sue, and Charles, attested that giving students more choice, extending trust to students, and handing students more control over their own learning were key factors in transforming teacher classroom practice. Jane recognized how the secret to selecting appropriate problems for CSILE classroom investigations was to support her students' deep concern for the natural environment by allowing them to come up with their own solutions for improving it.

CSILE researchers have noted that CSILE has subtle effects on classroom discourse.

It introduces certain biases and enables certain kinds of information flow that are at least conducive to educational change. First, the physical conditions—especially the fact that not all children can be working on CSILE at the same time—militate against the traditional schoolwork model, where all the students are doing the same thing at the same time. Second, CSILE opens up a significant channel of communication in the classroom that is not mediated through the teacher. (Scardamalia, Bereiter, & Lamon, 1994, pp. 208-209).

In addition to these subtle effects, CSILE introduces what we have called a "philosophical framework" with an emphasis on collaborative learning that engages students and their teacher(s) in a shared discourse and the construction of a common knowledge base. This approach is very different from the transmission-based classroom structure. Because knowledge-building communities demand such dramatic shifts in mind-set and practices, they stand contrary to the common sense notions about schools—what has historically developed into what Tyack and Tobin (1993) call the "grammar of schools." Consequently, their implementation requires radical changes within the school culture and structure. CSCL researchers Koloder & Guzdial (1996) have recognized what they call "traditional schooling" poses a significant obstacle to the adoption of technology-supported knowledge-building communities:

. . . there are tremendous challenges in making such a conception of education work, because the educational goals themselves challenge traditional schooling (with its emphasis on worksheets, test-taking, and shallow understanding), the structures of schools (with its 50-minute periods and teachers in charge of what is learned), the expectations of students and parents (if the teacher knows, why won't she tell me? Shouldn't my kid be learning the basic facts like I did?), and the training of teachers (the notion of knowledge building does not come up in many education schools) (p. 311).

By way of caveat as much as a recommendation, therefore, we would like to state as plainly as possible that implementing a knowledge-building community approach to education can be a difficult uphill battle. At least part of the reason the project fared so well in three of the four schools in our study was because of a "bubble of support" that surrounded the initiative with the status of university and corporate involvement and the fiscal and technical assistance that came with that involvement.

#### Software as a "Philosophical Framework"

#### Scaffolds the Transformation of Instructional Practice

We have suggested that the "philosophical framework" embedded within the CSILE software scaffolded the teachers' adoption of a radically different approach to teaching practice. Let us revisit the notion of scaffolding as it is understood in constructivist learning theory and apply it to this notion of teacher professional development. Scaffolding is help in some form (e.g., from sources such as a more knowledgeable person, the learning community, a computer program, an artifact, tool, algorithm, heuristic, etc.) that supports the learner's construction of knowledge within her/his Zone of Proximal Development (ZPD). Typically the scaffolding is removed (following the logic of the building construction metaphor) as the learner is able to function autonomously at more expert levels. Then the learner's ZPD grows to permit even higher levels of knowledge-building, requiring new scaffolding to support that new learning. This implies that teachers can utilize CSILE to move towards successfully implementing an intentional learning environment. One may speculate that teachers who use CSILE to create CSCL environments will become more sophisticated with time. However, the knowledge building community itself does not necessarily require a scaffolding device in the form of a technology such as CSILE, because the required fundamental changes in instruction could possibly occur with intensive reflection on social constructivist pedagogy and collaboration as a form of instruction, with inquiry as its focus.

The spirit of the knowledge-building community is one in which practice is continually re-examined for improvement, which is precisely what Scardamalia and Bereiter (1993) envision

in their notion of school as a second-order expert sub-culture. Indeed this seems to be the case for some teachers in our study as discussed in Theme One under the subheading “Curriculum Under Constant Revision.” Recall Charles’ and Cathy’s experience when they, for a short time, left the faltering historical novel project and developed a more manageable “lesser man” CSILE knowledge base. Also, the second-order environment for teaching practice enabled by CSILE supports teachers from varying levels of experience and expertise in their attempt to build and sustain collaborative relationships. Although we did not see it happen in this project, we feel that, given time and an official forum for teacher collaboration, teachers like Cathy, who possess years of experience in collaborative-based teaching and curriculum development, could offer their expertise as a “scaffold” to support more reflective practice in their less-experienced colleagues.

In contrast to second order environments, a first order environment is characterized by fixed learning goals and routine activities. When the school policy places tight constraints on how and what teachers teach, the result is a first order environment for learning. Apple (1993) has argued against top-down school policy that removes teachers from decision making and reflective practice, claiming it amounts to the “deskilling” of teachers. He is especially concerned about the unintended side-effects educational software can have on teachers in this respect as explained in the following quote.

Reliance on prepackaged software can have a number of long-term effects. First, it can cause a decided loss of important skills and dispositions on the part of teachers. When the skills for local curriculum planning, individual evaluation, etc., are not used, they atrophy. The tendency to look outside one’s own or colleagues’ historical experience about curriculum and teaching is lessened as considerably more curriculum, and the teaching and evaluative process surrounding it, is something one purchases. (Apple, 1992, p. 49)

Although CSILE is a “prepackaged” educational software, its difference clearly is in what it brings—an empty data base with structure, prompts and search tools, but without information. Rather than the effects that Apple (1992, 1993) warns us about regarding top-down school policy, the “deskilling” of teachers and the atrophy of teacher skills, such CSCL environments can have the *opposite* effect by scaffolding significant professional development in a second-order environment through support for collaborative curriculum development among colleagues.

As we examine the reported changes in teachers’ instructional practices, their relationship to the curriculum, and their roles in the classroom culture (see Table 6), it becomes apparent that such changes had made some contribution to altering the structure of classroom discourse. This restructuring in the roles of the teachers and students gave students more opportunities to be self-

regulated learners and to take greater ownership of classroom inquiry. More than simply being a term in school reform rhetoric, the “empowerment” of students, as reported by the teachers, became realized through their learning experiences. This is especially true in the case of Jane where her students’ intense interest in environmental problems led her to realize that “they care, and they want to make a difference in their world. By letting them see how what they learn can make that difference, we increase their desire to learn.”

The transition in practices reported by the teachers is remarkable if one considers how deeply the “grammar of schools” dictates our common sense notions about what constitutes “real schools.” Yet the kind of changes which permit more student choice and self-regulation in the classroom results from changes in power relationships between the teacher and the students as well as power relationships between teachers and agencies higher up in the school hierarchy (e.g., principals, district policy) (Sarason, 1996). This specific issue will be explored later in this summary. Issues surrounding support for the knowledge-building community approach on the classroom level are examined in the following section.

#### Practical Issues Related to Support

Practical issues related to the “situationally constrained choices” (Cuban, 1986) which teachers must negotiate tend to challenge reform efforts. Some of these practical issues are structural (e.g., curriculum divided into academic subjects, the 30-student class, the 50-minute period). Other practical issues are germane to concerns arising from the individual teacher. George, for example, our most extreme “negative case” in terms of the non-adoption of CSILE, illustrates some of the support factors by revealing what happens when such factors are lacking. For example, George felt that CSILE did not support his subject, mathematics. In effect, because CSILE did not support his understanding of appropriate classroom practice, the software could not act as a scaffolding device to further his understanding of mathematics instruction in the direction of social constructivist pedagogy. George, head of the math department at Milroy after only two years of teaching experience, felt obligated to focus his concerns on meeting the state mandated Essential Elements and raising TAAS scores. The combination of lack of teaching experience, accountability concerns, and lack of specific subject-matter support in the software, may have led to his attitude that CSILE was more about “social skills” and “cooperative learning” and therefore would not address George’s pressing need of transmitting the basics to his class. In addition, the adoption process at Milroy, characterized by a of lack of technical support in the face of hardware and software glitches, prevented both George and Peggy from making more substantial progress with integrating CSILE into their instructional practice.

Both George and Peggy expressed concern that certain characteristics of their students hindered the successful adoption of CSILE. George felt that computers in the classroom were too distracting to his students, who needed to be focusing on gaining math skills, a management concern that may reflect his lack of teaching experience. Peggy expressed that her students lacked adequate keyboarding skills to use the system efficiently, a very real issue in terms of support for any computer-supported knowledge-building community.

### Knowledge-Building Communities and Support for Diverse Student Populations

Peggy commented that her lower SES students and their parents appeared “intimidated” by computer technology. We must examine Peggy’s perception in more detail to delineate common misunderstandings which may act to rationalize the current inequities in educational computing. What Peggy interpreted as “intimidation,” may simply arise from a lack of familiarity, versus a fear of technology per se or “computer phobia.”

Although computer technology is rapidly diffusing to nearly all sectors of the workplace, low SES workers are much less likely to use computers in their work, and those who do use them tend to engage in routine, non-creative tasks (U.S. Department of Education, 1994; Baran, 1995). Thus parents of Peggy’s students may have no access or very little access to the use of computers in their daily work experience. In addition, African-American and Hispanic students have much less access to computers at home for doing school work than White students (U.S. Department of Education, 1994; Martinez & Mead, 1988; Sutton, 1991). Such access may be a crucial factor in students’ ability to use computers in school, as a substantial proportion of computer-using students state that most of their learning about computers was done at home (Martinez & Mead, 1988).

Moreover, the perception exists among teachers and administrators that what constitutes appropriate uses of educational computing for “at risk” and low performing students, such as those in Chapter One programs, consists of drill and practice and tutorial programs for academic remediation (Campbell, 1984; Loop, 1986; Chan, 1989; Sutton, 1991). Given that low SES and minority students are over-represented in these categories of students, such notions of the “appropriate” uses of computers in the schools leads to tracking along the lines of SES and ethnicity in educational computing.

To counter the possible assumptions that more liberating uses of computers in education, such as computer programming, creating multimedia projects, using telecommunications to do

research and collaborate, and using CSCL to implement knowledge-building communities, may be inappropriate for “at risk” and low performing students, we would like to point out that there have been studies that counter those claims. Nearly all of the Canadian research on CSILE, for instance, was done with a highly heterogeneous student population in an inner-city elementary school in Toronto. Ann L. Brown’s (1994) Oakland project involved minority middle school classes engaging in a “communities of practice” approach that may be classified as a knowledge-building community. Though more research on the question should be conducted, it appears that the technology supported knowledge-building community is appropriate for *all* student populations. We do not deny that drill and practice and tutorial programs may benefit many students, but we do wish to stress what we see as a serious equity issue. *Equity*, which relates to the qualitative notion of fairness, needs to be distinguished from the quantitative notion of *equality*. Hence to be equitable, computer access may need to be unequal. Disadvantaged students should get their full share of the more empowering aspects of educational computing *in addition to* access to computer applications for remediation, if the school feels it is needed.

CSILE helped Doug and Jane become advocates for their students (many of whom were urban poor) in the sense that they were able to see the curriculum and purpose of education through the eyes of their students. The knowledge-building community approach scaffolded for these teachers a deeper reflection on how students were situated with respect to the knowledge they were constructing. In a study of exemplary teachers of African-American students, Ladson-Billings (1995) found that the teachers were all advocates of their students in much the same manner in which Doug and Jane were advocates of theirs. This observation suggests that CSCL environments supporting knowledge-building communities may be particularly powerful for multicultural classes where teacher reflection on the critical issues of knowledge construction and society can lead to greater teacher advocacy and academic success for their students.

### Confronting Barriers to Support

*The Contextual Factors:* Our study indicates that major factors which affect the successful adoption of a knowledge-building community arise from the social and economic context of schools. For instance, Central ISD was concerned about equity in relation to technology access and Lakeside seemed to be more concerned about the proper management of the diffusion and adoption process. Therefore decisions affecting school change need to be considered in the context of each school’s unique set of needs and concerns.

*The Lack of Fiscal and Technical Support:* The need for on site technical expertise and fiscal underwriting were factors related to support mentioned by most of our informants. Although an extensive review of this issue is beyond the scope of this report, it goes without saying that given the precarious fiscal conditions of our schools, increased financial support needs to be amplified as much as possible by committed support from both the public and private sectors. But perhaps more germane to the purposes of this report is the fact that such support issues seem to affect the perceptions of teachers, in terms of how they view the viability of reform efforts, especially in terms of their feasibility and sustainability.

## **Altering the Structure of Schools**

### Introduction

As examined in Theme Two, CSCL technologies such as CSILE, can create “power shifts” within personal, social relationships. Networked system technologies may also potentially upset the power of hierarchical-based institutional systems. The promise of connectivity to liberate and expand teachers’ roles and responsibilities beyond that of a “delivery system,” is examined in this section in light of the following: (1) how CSILE enabled changes in the social relationships within the school community and classroom, (2) teachers’ resistance to the infusion of technological innovation (Theme Four), and (3) the informants’ visions of a “new professionalism” which embraces connectivity, collaboration and collegiality as interacting features (Theme Five). The challenges to adopting and sustaining a social-constructivist based CSCL environment is also discussed.

### Characterizing the Culture of Schools

*Change and the Reallocation of Power:* As discussed earlier, Seymore Sarason’s (1996) analysis of the culture of schools portrays most efforts at reform as being flawed because they fail to address and alter the typical structure of classroom discourse. In addition, Sarason (1996) believes that most efforts at school reform do not ask fundamental questions regarding the purpose of schooling itself; nor do they address the issue of relationships of power (Sarason, 1996, p. 334). He underscores the importance of power, especially with regard to reform efforts, on several levels of relationship dyads (i.e. teacher vs. student; teachers vs. principals; superintendent vs. board members; the board vs. the political establishment including the state capital). In the following quote, Sarason (1996) underscores the importance which power wields within any reform effort.

Any nontrivial attempt to change a feature of the school culture immediately brings to the fore the power basis of relationships . . . The problem of change is the problem of power, and the problem of power is how to wield it in ways that allow others to identify with, to gain a sense of ownership of, the process and goals of change (pg. 335).

This process of change within educational settings, he adds, cannot be “engineered” but rather is characterized as a slow *process* that requires much patience and time.

*A Culture of Individuals*: In addition, Sarason’s (1996) understanding of the culture of schools characterizes their structure as creating for teachers a “culture of individuals” versus that of a group (p. 367). Also, Andy Hargreaves (1995), who has done extensive work on problems related to educational reform, has found that before action towards reform efforts take place, certain relationships amongst teachers and other members of the school and extended community need to change. Like Sarason (1996), Hargreaves (1995) found that the culture of schools, in terms of teacher’s relationships, may be characterized as “cultures of individualism” where teachers are isolated and collaboration is minimal to nonexistent. He also found them to be characterized as “balkanized cultures” of “self-contained subgroups” such as subject departments (p. 17). Hargreaves explains how these two characteristics effectively disempower teachers.

Both individualization and balkanization fragment professional relationships, making it hard for teachers to build on one another’s expertise. They also stifle the moral support necessary for risk-taking and experimentation (p. 17).

Both Sarason (1996) and Hargreaves (1995) acknowledge how the cultures of schools (or any other institution) are situated by structural factors. Hargreaves (1995) explains how school cultures are “grounded in structures of time and space. These structures shape relationships” (p. 18). For example, teacher isolation is accommodated by the physical structure of “egg crate” classrooms. In terms of the structure of time, the typical day of a teacher allocates very little formal time for collaborative planning and discussion amongst colleagues. These structural factors, which affect the practice of teachers, in turn affect the lived experiences of students.

Sarason (1996) states that in addition to changing the dialogue structure of classroom communication, efforts at reform will fail if they also do not acknowledge a second criteria: “*Teachers cannot create and sustain contexts for productive learning unless those conditions exists for them*” (author’s italics p. 367). Decades of experience with working in schools has led him to the realization that “there were absolutely no forums, no traditions that brought teachers together on a scheduled basis seriously,” a factor which not only adds to their sense of isolation,

but sustains a “culture of *individuals*, not a *group* concerned with pedagogical theory, research, and practice. Each was concerned with himself or herself, not with the profession’s status, controversies, or pressures for change” (author’s italics, p. 367). This is a serious structural factor which disempowers teachers and which top-down technology infusion approaches to inculcating change can easily exploit.

#### How CSCL May Support Changes in the Structure of a School Community

*Creating Structures for Teachers’ Collaborative Efforts* : CSILE is unique as an instructional technology as it can act to alter the structure of classroom discourse. In addition, through the demands of collaborative curricular and general decision-making efforts, CSILE emphasizes teachers as a *group* versus individuals. Teachers working in a CSCL environment are invited to work more closely in the spirit of collegiality and shared professional interests. Yet, the teachers explained that working within a collaborative setting is not a panacea. As detailed in Theme Two, there were problems related to shifts in power, which seem to occur when new technologies are introduced into social settings (Kipnis, 1990). Cathy’s story (see “Cathy’s Search for Collegiality and Collaboration,” Theme Two) illustrates how attempts at collaboration, even in a project designed to support it, can face serious challenges. The pitfall is that change efforts requiring or utilizing collaboration may face challenges which seem to override the benefits of collaboration. As a result, teachers could retreat to their familiar, but nevertheless, isolated positions.

In collaborative based instructional environments interpersonal struggles are naturally common. Therefore teachers need to anticipate this, and be given the opportunity to develop skills in negotiation and team building. In addition, the bonds of collegiality within a CSCL environment may need to be strengthened by a forum which addresses issues related to technology adoption and policy. This forum would provide a space for honest and open discussion amongst teachers (and administrators), as they learn to value their individual differences as well as their shared goals. How this may be accomplished is discussed later in this section of the summary.

*Creating Structures for Students’ Collaborative Efforts*: The experiences of the informants illustrated how the application of social constructivist pedagogy, through the use of CSILE, may emerge as a “mixed blessing” with both painful challenges as well as positive changes. Theme Two detailed how the introduction of the computers and CSILE software created a new forum through which they could share ideas, and build a sense of a community of

practice. And although teachers reported that some children found it difficult to adjust to the collaborative process or working with computers in the manner demanded by CSILE, there were many positive changes observed by the teachers. For example, they cited positive changes in the structure of classroom social interaction as well as reports of increased motivation and deeper, more critical thinking, especially regarding greater appreciation for differences in viewpoints and other's opinions (see Theme Two).

*Connectivity and the Enhancement of Teachers' Professionalism:* For many of the teachers, working with CSILE expanded their vistas in terms of their professional landscape, where perceptions of their professional identity were related to embracing electronic networked technologies, including CSILE. This envisioning of a "new professionalism" revealed the importance of connectivity as a means for enabling collaborative projects and to make available the delivery of a vast amounts of information to teachers and their students. To some extent the vision which the informants struggled to create tacitly acknowledged the potential for networked technologies to undo existing hierarchical structures and teachers' isolation, both of which characterize the existing educational system. Networked technologies such as CSILE may act to facilitate shifts in social relationships not only on the level of classroom discourse but potentially on the macro level of school structure. For example, a communications infrastructure may alleviate constrictions and certain structural elements related to time and space. Computer mediated communication via telecommunication networking systems enables aspatial and asynchronous communication; thus extending teachers' professional and curriculum development efforts outside of their classroom and school into the wider "virtual educational community." Yet, like all idealizations, such visions need to be approached cautiously, as discussed in the next section.

The Organization of Schools and Networked Technologies:  
Two Possible Outcomes

Donald Morrison and Bruce Goldberg (1996) have been involved in projects dedicated to idea that new electronic technologies can "transform the life of schools" (p. 125) for the better. They recognize that networked technology as an infrastructure has the power to "dramatically rearrange the way schools are organized internally" as well as how they communicate with other social institutions because "networks can open schools up to the outside world, flatten hierarchical relationships, distribute responsibilities for teaching and learning and for managing educational resources" (p. 127). However, they also acknowledge that these same technologies can have an opposite effect, creating an environment characterized by "greater central controls,

narrowing the scope of teaching and learning, and concentrating management and resources among a small number of designated experts” (p. 127). They describe how a school or district’s use of wide or local area networked systems may be characterized by an open and wide range of communication efforts with other organizations and individuals. Such communication efforts are generally tolerant of diversity and feature collaboration. In contrast, a more restricted organizational use of networked systems would be characterized by restricted access by teachers and students through central controls and limited integration of telecommunications within curriculum and instruction.

These two scenarios are further challenged by the fact that schools are faced with several paradoxes today (Hargreaves, 1995). For example, in order to meet society’s and business’ perceived needs (i.e., students capable of accepting cultural diversity and active engagement in critical thinking), schools respond by embracing interdisciplinary curriculum and elements of multiculturalism. Yet such efforts are unsettled by an “obsession with national strength and identity [which] is spawning standardized tests, international comparisons and even school-by-school competition based on traditional performance evaluation” (Hargreaves, 1995, p. 2). In contrast to an interdisciplinary curriculum, such demands require restricted definitions of intelligence, narrow curriculum and various forms of tracking and sorting of students. The reader may recall that many informants expressed concern about the incongruency between the CSILE project and the reality of demands made by state mandated standardized testing and curriculum standards. As it is, Morrison and Goldberg (1996) explain that policy makers and administrators who perceive that schools are in dire straights because they are “highly decentralized and give teachers too much autonomy” will tend to use networked system technology to strengthen accountability systems where instructional delivery and assessment are tightly aligned. This scenario may simply further strengthen some of the most restrictive aspects of the existing educational system.

*How Schools Typically Make Decisions About the Diffusion and Adoption of Technological Innovations:* Although it is too early to assess which scenario will become dominant within schools, Morrison and Goldberg (1996) sense that schools will use networked systems in a hybrid fashion, utilizing qualities from both scenarios. Yet at the present time it does not seem that an active, open questioning or reflective approach characterizes the diffusion process of technological innovation. In the absence of inquiry and serious reflection, the appropriation of networked systems to support the existing system may become the default approach to adoption taken by many schools. In reference to reform programs in general, Sarason (1996) reports that there is “little or no thinking through, *in the planning process*, the extent, sources, and strength of

predictable resistance” (p. 338, author’s italics). This means that typical adoption models do not fully address the range of social elements which impact reform efforts.

In his review of the current campaign to restructure education via electronic technologies, Kerr (1996) states that technology as an end in itself has “guided the infusion of electronic technologies into schools” and consequently the uses of what technology is “good for” is “often either ignored or postponed until their consideration has become a moot point.” He perceives this approach as “being fundamentally flawed, and we ignore these concerns at our peril,” for such an approach “will ultimately lead to impoverished schools (in the moral not the financial sense)” (p. 4).

Educational psychologist, Frank Smith (1995) believes that our understanding of how to apply electronic technologies to educational settings is delimited by the fact that we view the role of the teacher as a “delivery system.” That we also understand the function of schools as institutions in terms of delivery systems serves not only to configure curriculum and instruction around standards and accountability, but such an approach also reinforces a limited and debilitating understanding of teachers’ roles (Reid, 1992).

Networked technologies clearly have the potential to be a catalyst to “break the mold” of traditional school structure and its characteristic instructional practices. Conversely, these same technologies could be applied to entrench the “grammar” of the existing system. The negotiation of these two extreme scenarios may very well characterize the nature of current technology adoption efforts within many schools today as they develop their rationales for investing so much money and effort into building network infrastructures. The salient question becomes whether this deliberation will take place with the school as an institution or as a community.

#### Technology Adoption and the Role of Teachers’ Resistance

Some informants explained that several barriers exist which may thwart the adoption of electronic technologies like CSILE, such as lack of fiscal and technical support. Yet teachers also pointed to other challenging elements related to the culture of schools and social values, including the perceptions teachers hold about technology. However, the construction of teachers’ “resistance” to technological innovations, as explained in Theme Four, is complex, and related to historical, structural and ideological elements.

The contextual nature of adoption was found to be related not only to teachers’ personal concerns or “computer phobia,” but also to: (1) practical matters (i.e., incongruency between a

teacher's pedagogy and that which is embedded in the design of certain instructional technologies), (2) historical contexts (the practice of top-down infusion programs of change through technology), (3) philosophical, as exemplified by Cathy's questioning the wisdom in making the acquisition of technology as an end in itself, and (4) structural, where teachers are forced to negotiate adoption of a technological innovation with factors arising from the system of education over which they have no control. Yet it is important to point out that, in the case of Cathy, despite her questioning stance or resistance to the manner in which the technology was being infused into her district, she readily embraced CSILE and was an avid user of telecommunications and collaborative learning in her instructional practices.

However, the contextual factors which affect the process of adoption are rarely addressed; the notion of computer phobia as a "personal defect" predominates in the discourse related to technology diffusion in education. Even so, Cathy is not alone in her questioning stance. There are many educational researchers who question the current approaches to rapid infusion of electronic technologies into schools (i.e., Bowers, 1988; Smith, 1996; Goodman, 1995; Streible, 1991, and others). Yet the pejorative labeling of teachers who resist as being "laggards" or "computer phobic" may effectively silence the voices of concern and opposition, marginalize any challenges and in the end, quell any opportunity at authentic deliberation. Educational researcher, William Reid (1979) questions the ethics of practices, whether based on official procedure or tacit assumptions, which discount and disempower the alternative and critical perceptions of teachers.

#### Sustaining a Knowledge-Building Community Through a Collaborative Decision Making Approach to Adoption

This study has shown that the introduction of CSCL environments like CSILE has the potential to alter both the structure of classroom discourse and the school community. Yet the opportunity to capitalize on the benefits of connectivity may not be fully realized if their adoption only serves to support elements of the existing system and the traditional organization of schools, which reflect first order environments and therefore further the "deskilling" of teachers. Therefore, the process of adoption itself needs to be seriously addressed, especially in terms of the role of teachers and the underlying pedagogical assumptions of the technology.

We have discovered that teachers' resistance to technological innovations may be discounted and/or misunderstood. Historically, teachers have been excluded from the decision-making processes within schools, especially in the case of top-down reform campaigns based on technology infusion. Also, the current structure of schools creates for teachers a "culture of

individualism.” However a formal approach to school decision-making based on teacher collaboration would challenge and potentially reverse the tradition of teacher isolation.

Although there are several models which guide the organizational changes of schools, many have been adopted from the field of business administration and therefore do not address the importance of building community specifically within school settings. In addition, there are several reform frameworks germane to education that address specific educational goals and student needs (e.g., Ted Sizer, James Comer and Henry Levin). However, the approach to curriculum adoption developed by Joseph J. Schwab is unique in that it addresses the decision-making process itself. Schwab’s approach characterizes the adoption process as collaborative decision making and emphasizes the central role of the teacher. His approach is examined more closely in the following section.

*The Commonplaces of Schools and the Adoption of Technology:* Schwab’s deliberative approach to decision-making outlined in his four papers on “the practical,” offers a community effort of deliberation shared by students, parents, the school principal, community members, social scientists and professional academics and especially teachers. In fact, the role of the teacher is central to the decision making process. Noting that “teachers practice an art,” Schwab (1993) believes that the process of active involvement in deliberative decision-making “constitutes the only language in which knowledge adequate to an art can arise” (p. 245).

Reid (1979), who has written extensively on Schwab’s work, explains that by focusing on the role of the teacher, Schwab is underscoring the moral reality of teachers and curriculum development and how teachers’ practices are the manifestation of the public interest. Because teachers are typically not considered capable of making rational decisions (or that their tacit and practical knowledge, which may exist in the form of resistance, is devalued), they are not invited into decision-making processes. When teachers are denied this role they regard themselves as mere technicians. Reid (1979) describes how situating the teacher as such raises moral and ethical issues:

More serious, however, for anyone concerned about curriculum and education, are the moral and ethical consequences of the denial of possibilities for choice, and the subscription to models of the school that legitimate the use of coercive or persuasive powers to induce teachers to accept and implement grand designs that are foisted on them from outside (p. 333).

Unlike typical models of diffusion and adoption created from business and industry's guiding principles and goals, Schwab's model pertains to the specific needs and goals of educators and schools. His framework encompasses all of the "commonplaces" of education: students, teachers, subject matter and social-cultural milieu. His approach would therefore address the contextuality of technology adoption, including the influence of political concerns. The framework, however, is designed so that each of these commonplaces bears equal weight. Each commonplace is examined in its full range of complexity, as the framework utilizes an "eclectic" approach to deliberation of concerns and issues, inviting a variety of contending perspectives, viewpoints and theories. Thus, the concerns of those who question or resist the infusion of electronic technologies into schools would be given a safe forum for discussion.

Schwab's framework applied to technology adoption would characterize it as an ongoing process. Technology adoption and its integration into curriculum would be seen as a trial and error process of discovery characterized by flexibility and open-endedness (versus blame and "failure"). In effect, Schwab's approach could act to "scaffold" a "convivial" (Illich, 1973) approach to the realization of CSCL environments. A "convivial" approach fully recognizes both the benefits and limitations of a technological application/innovation. This balanced (and less naive) understanding about a particular technology becomes anchored through the process of deliberation and discussion. The resultant guidelines and stated values become integrated into adopted policies which guide the instructional aims and applications for an educational technology. In effect, the outcome is a reflective model of technology adoption and diffusion. This reflective aspect is imperative as our technologies become more powerful and complex.

In the context of this study, the application of Schwab's approach to technology adoption would provide an open, deliberative forum in which George's concern about CSILE's "fit" with mathematics, and Cathy's struggle to maintain trust and collegiality amongst her colleagues, could be shared and discussed. (Indeed in the case of Cathy, her isolation could perhaps have been prevented). Collaborative decision-making could help to assuage the power shifts and divisive attitudes which arise from the condition of change. Teachers could debate issues related to equity versus equality in terms of serving the needs of various student populations and the appropriate application of technology to meet those needs. Collaborative decision making would accommodate a discussion on the incongruity between standardized test based assessment and the goals of social constructivist pedagogy. In effect, utilizing Schwab's approach as a framework for collaborative decision-making acts as a form of scaffolding in the social/cultural sphere, as well as the pedagogical, which provides support and structure to collaborative efforts. Because the forum is based on discussion where all perspectives on the commonplaces are given

voice, teachers' roles may be fully realized as they engage in reflective practice, an opportunity to act as a group, and fully embrace their professional responsibilities in terms of pedagogical theory, research and practice. Such changes and empowerment in teachers' roles would help to enliven and empower the learning experience of students as well as the culture of schools, and possibly lead to greater fundamental changes in the structure of schools.

## RECOMMENDATIONS

The five themes which emerged from the data analysis indicate how a CSILE based CSCL environment can scaffold the transformation of teachers' instructional practices and ultimately change the structure of classroom discourse. It was also discovered that the introduction of CSILE caused "power shifts" and transformed social interaction within the school community as well as in the classroom. These shifts in social interactions are dependent upon support from the realm of policy (fiscal, leadership and teacher development) as well as the school community. We also found that the technology of CSILE as a "philosophical framework" not only aided teachers in transforming their instructional practice but also influenced a re-envisioning of their professional roles; especially when they considered the general "inevitability" of the diffusion of networked telecommunications systems into education. This is very powerful.

The interaction of the three major components (school community, the technology and the realm of policy) underscore the breadth of contextuality and complexity which characterize the conceptualization and realization of a CSCL knowledge-building community. The networked systems scenarios outlined by Morrison and Goldberg (1996) indicate that *our values and normative understandings about schools* tacitly, if not overtly, guide the application of a technology. Thus support, in its many forms, acts as a framework for adoption. *This factor becomes especially important if the technological innovation, as with networked systems technologies, possesses the power to alter our relationship to time and space and ultimately change social interactions (i.e., discourse structure and "power shifts")*. It may be that the traditional models of diffusion, and the assumptions which guide them, need to be abandoned or augmented by an approach which questions a dominant cultural bias, which is to approach technology as a solution to social problems uncritically (Segal, 1996) and apolitically (Winner, 1980).

Based on the findings presented in the data analysis and the summary sections of this paper, we make the following recommendations:

- Technology adoption aimed at creating a CSCL environment guided by social constructivist pedagogy needs a structure which *invites* the concerns of those typically excluded from participation in traditional, top-down models of infusion. We strongly recommend that educators review the work of educational researchers who have developed models of *community-based approaches to reform* which support collaborative decision making. No matter what approach to decision making a school employs, *a deliberative approach is central* to the success of collaborative efforts, as it gives equal weight to the commonplaces of schools and invites a wide range of perspectives, includ-

ing those which counter the status quo. Although Schwab's approach, for example, focuses specifically on curriculum development it could also be applied as a framework to the practice of technology adoption on the level of school communities, as well as diffusion, which includes the realm of policy (building level and state administration, and to some extent, federal influences).

- Commitments from the micro (School Community) and macro (Policy) levels are required to support the necessary changes to make CSCL knowledge-building communities a sustainable reality. Such changes may include alterations in school culture by means of shifts in power structures including the discourse structure of the classroom, the professional responsibilities of teachers, and the general hierarchical power structure of schools.
- Changes in the discourse structure of the classroom requires teachers to become actively engaged in students' lives. In order to support teachers' efforts to become effective and compassionate advocates of students from diverse populations, the training of teachers in methods germane to CSCL knowledge-building communities also needs to address multiculturalism.
- Teachers must have time for reflective practices, especially as they adopt roles as curriculum developers and engage in an iterative process of curriculum and instructional development. Teacher collegiality and collaboration amongst teachers must be encouraged and supported in a climate of professional status and respect.
- Schools must be transformed into second-order environments where the level of professional expertise is continually rising. Steps in the process may include a "master teacher" program where teachers more experienced in CSCL and knowledge-building communities mentor less experienced teachers.
- School communities and districts must nurture and formalize committed long-term relationships with businesses and universities where teachers are recognized as full partners in active research leading to innovative practice.
- Universities supporting real school change must establish closer, long-term relationships with the schools that endure beyond the scope of short-term funded projects. Additionally school/university relationships must expand beyond research projects in colleges of education. All college departments offer rich pools of subject domain expertise in their professors, graduate students, and undergraduates. These resources must be accessible to K-12 students and teachers using a knowledge-building approach to classroom practice.

- Educators involved in the adoption of educational computing technologies need to be more mindful of the underlying assumptions which relegate certain student populations to only a few specific instructional technologies (i.e., low SES or “at risk” students’ needs best served by drill and practice instructional software). These underlying assumptions may in effect serve to create inequities regarding student access to more empowering tools of educational computing (i.e., CSCL, telecommunications, multimedia).
- Both teachers and administrators must be aware that prepackaged technologies can have unintended side effects, specifically the “deskilling” and the disempowerment of teachers.
- CSCL approaches to education implies new skills for practicing teachers and administrators that in the past have not been a part of the typical training programs. Colleges of education and teacher education programs should reexamine their programs in light of these new skills. For example, experience in team building and negotiation become necessary and fundamental skills to engage successfully in CSCL knowledge-building communities.
- Given that innovations such as CSCL face significant challenges in overcoming the common sense notions of schooling, a key element in effective support is the need to educate not just the immediate school community (administrators, teachers, parents, and students), but the community-at-large, about the pedagogy, educational philosophy, and educational research behind the knowledge-building community approach and the technology that supports it. The public already expects to see computers in the schools, but this expectation must be cultivated toward greater understanding and awareness of the collaborative and knowledge-building applications of not only computers, but network system technologies.



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## APPENDIX I

### TCET Interview Format

**How did you become involved in the TCET project?** (• selection process)

- involved earlier in MacCSILE pilot
- introduced to CSILE by TCET project
- other/explain
- selected by-
- prior technology knowledge/experience base
- understanding of reason for being selected
- other/contributing qualifications

**Characterize your teaching experience and practice prior to CSILE involvement.**

- prior teaching
- subjects/ages
- classroom teaching style
- core curriculum decisions driven by
- core instruction & range of instructional practices

**To what extent ? How?**

**In what ways had you previously incorporated into your professional activities?**

- no computer use
- for teaching/admin/word processing only
- variety of productivity tools for teacher &/or students?
- sequential, tutorial into & practice of some skills

**Openended TCET Question:**

What did you do in your teaching practices during the spring 1993 semester. Explain

**After-effects Question/post TCET project:**

School year Sept93-June94: teaching assignment\_\_\_\_\_

In what ways did your teaching practices

- differ from
  - improve upon what you or others had done in the TCET project
  - embody or reflect
- (or original CSILE work)

Are there **any changes in your teaching practices which you would link to the experiences** you or others had or witnessed as part of the TCET project.

What do you understand or experience to be

**your school's and your district's technology posture/policy:**

- resources (in place and/or budgeted)
- assistance (in place and/or budgeted)
- level of cooperation / collaboration / encouragement / support regarding technology

Please comment on **the support and reactions** among colleagues / parents / or administrators

Against the range of your experience and insiders' knowledge, what would you identify as **the main ingredients and core factors** necessary to make technology-supported classrooms a reality?

- What are **the potential barriers** and what would be the ways to address these barriers?

What are the most important **elements of classroom practices emerging** from projects such as this one, which have the greatest potential (even without technology support) to significantly improve education?

How would you characterize the equilibrium between

- a climate and vigorous support for change VS the maintenance of the status quo
- teacher risk-taking VS caution/withdrawing support for change/challenging the process
- the understanding and encouragement for non test-related learning outcomes VS minimal performance on state proficiency tests

## APPENDIX II

### Emergent Codes from the Interview Analysis

Code Name	Code	Description
Classroom Management	ClsMgmt	student reactions/responses to CSILE environment
Subject Matter	Subj	
Notion of Experimentation	Exper	
Technology as Permission	TchPerm	teachers express how the technology allowed them to take a risk, giving them license to experiment and the freedom to fail without censure
Teacher as Observer	TeaObsv	teacher as observer/reflective practice/judgement
Technology as Powerful Tool	TchPowr	Technology enables things not possible or practical without it
Teacher Background	TeaBkgd	past teaching styles, experiences, years of experience, what grade level, preservice experience
Teacher's Competence Using Tech	TeaComp	Teacher's competence and/or confidence in using technology, factor in using CSILE or other tech in classroom
Parent support	Parents	Parents reactions, support, participation in the classroom, school
District Policies on Tech/Ed	District	School District policies toward technology and education
Admin support	Admin	School administrators support, lack of support, indifference, reactions, policies
Collegial reactions/support	Colleg	Fellow teacher reactions, support for CSILE teacher, collegial interaction in general
School Culture	SchCult	Aspects of the school culture as a whole, at the level of local school, district, state, or nation
Curriculum & Instructional Practice	C&IPrac	Teacher's curriculum and instructional practice in general terms (specific instructional practices mentioned below)
Traditional Classroom Practice	TradCls	Direct Teaching, lecture, teacher as sage/authority, worksheets, etc.
Textbooks	Text	Past, present, future role of textbooks in the classroom -- How technology, teaching practices affect the role of traditional text?
Cooperative/Collaborative Learning	CoLrn	Cooperative or Collaborative teaching techniques (may double-code with Project-based teaching )
Student-directed learning	StuDir	Student-directed learning, esp. when contrasted to direct teaching, how much it occurs, effect of tech. upon (may double-code w/ Project-based teaching)

## Schools as Knowledge-Building Communities

Code Name	Code	Description
Usage of CSILE	UseCSILE	How CSILE was used to create a knowledge building community. Specific approaches, struggles, successes, disagreements consensus-building
Use of Other Technologies	OthrTech	Non-CSILE technology gets used/integrated into teaching practice: Telecom, CLARIS, multimedia, etc.
Technology as Curriculum	Tch=Cur	Technology itself needs to be or is becoming part of the curriculum
Student Outcomes	StuOut	Improvement/change in student learning/attitudes attributed to CSILE or technology use
Assessment Issues	Assess	Assessment issues and effects on teaching/learning Change in assessment practice driven by CSILE, Technology, or emerging classroom practice
CSILE's Effect on Teaching Practice	EffCSILE	How CSILE and the TCET project have changed the teacher's practice
Sharing of Scarce Technological Resources	SSTR	How technology as a scarce resource gets used How technology resources are or are not shared (Labs vs. classroom computers, etc)
Technology Support Issues	TechSup	Presence/lack of technology support before, during, after TCET Effect on teaching practice, technology use (including teacher technology training, hardware maintenance, trouble-shooting)
Funding and Equipment Availability	FundEqui	Funds and equipment availability—lack of as barriers or existence as enablers for change
Equity Issues	Equity	Equity issues: equal access to technology and education for all students and adults
Requirements for Change	ChngReq	Aspects of education policy necessary for implementing change. Barriers to change
Access to Technology	Access	Availability of technology—ease or difficulty of using technology
Cultural Currency	CulCur	Teacher's perceptions about how children understand technology with specific reference to how children of different SES interact with it, e.g., how computers inspire some low SES students to higher achievement, technology as a motivator, how some low SES students are intimidated by computers or public education in general
Diffusion/adoption of Technology (Resistance)	Resist	Teacher's perceptions about the diffusion and adoption of technology in general, how the diffusion is "inevitable" and the problematic of adopting to change ("resistance").
Classroom Social Interaction	Social	How technology alters classroom social interaction. How technology alters teacher's social interaction, how it changes the role of both teacher and student.
Technology's Role in Implementing Change	TechRole	Teacher's vision of technology's role of advancing changes in classroom and in education in general, whether technology is required for such changes.

## APPENDIX III

### Authors' Biographies

**Mark Christal, M.Ed.**, is a doctoral candidate in the Instructional Technology program of the Curriculum & Instruction department at the University of Texas at Austin. He has a B.A. in psychology and Texas teacher certification in secondary mathematics and physical science. Prior to entering graduate school, he taught high school mathematics. Since 1993, Mr. Christal has been a research assistant for several education projects involving computer-supported collaborative learning, telecommunications and multimedia. Other interests include teachers as change agents for school change and educational technology for implementing a locally responsive curriculum.

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**Adrienne Kennedy Puthoff, M.A.**, is a doctoral student in Curriculum and Instruction at The University of Texas at Austin. She came to her doctoral studies with a background in classroom teaching, teacher education, collaborative learning, multi-age and interdisciplinary curriculum, and inquiry models of computer applications to education. She was an instructor for the University of California at Santa Cruz and guest lecturer/workshop director at Utah State University, Logan, Utah. Adrienne served as an educational consultant for SRI International, Menlo Park, CA., in early research in computer applications for inquiry-based learning. During her doctoral work, Adrienne has served as a project designer, a research assistant and a project evaluator for various state and federally funded research projects in schools. Other interests include teacher culture and teacher renewal, parent/school collaboration, school restructuring and community building.

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