

CSCL for Schools that Learn

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ABSTRACT

Learning communities and organizations are being recognized both as a mechanism for bringing learning about and as an explanation of what learning takes place. Systems that support learning in context and collaborative learning are increasingly being used to support performance and learning for school reform and business productivity. Similarly, many of the performance and learning outcomes that we care the most about, e.g., higher order thinking, problem solving, communication competencies, are understood as developing in the authentic activity of a community, such as a profession, a trade, or an academic discipline. Computer Supported Collaborative Learning (CSCL) is a method for bringing the power of technology to support collaborative and contextual learning. This article argues that CSCL can be a framework for school reform, not just as a method of curriculum implementation, but also as a framework for enterprise-wide, process change. The article will also illustrate how cscl-type systems can facilitate schools becoming learning organizations, not just organizations that support learning.

Keywords

Learning communities, CSCL, school reform, learning systems

INTRODUCTION

The work of Lave and Wenger (1991) provided leadership in showing how professions and disciplines have communities of practice wherein learning takes place through experience and induction takes place through apprenticeship. They argue that learning is not a type of activity, but rather is an aspect of all activity. Wertsch (1998) and others taking a socio-cultural approach have shown that the "intelligence" of actions is only meaningfully understood in the context of knowledge about the cultural tools invoked. Similarly, Donald Norman's book, *Things That Make Us Smart* (Norman, 1993), shows how technology does not simply improve the way we do things, but actually changes what we do. Multiplying with a calculator is a different mental and physical task than is multiplying with paper and pencil. These works have helped frame a view of cognition as distributed and a stance toward facilitating learning that calls for situated and social practice.

Scardamalia and Bereiter (1994) concur with the movement to view learning as a social practice, but argue that situating learning in communities of professional practice does not serve school-based learners. Scardamalia and Bereiter developed a framework of a knowledge-building community that emphasizes intentional learning of curriculum objectives as the product of the educational community of practice. Their vision for how computers could support the collaborative learning of school curriculum has provided a foundation for the development and implementation of CSCL for school reform.

Along with new curriculum models, such as situated and collaborative learning, advances in digital media and network technologies provide opportunities and expectations for school reform. To that end the U.S. Department of Education states as a primary goal that, "Digital content and networked applications will transform teaching and learning" (Office of Educational Technology, 2000). These expectations for transformation and improvement in teaching and learning are fueled by (1) dramatic increases in the levels of access to technology in our nation's schools (e.g., the percent of schools with Internet access increased from 35% in 1994 to 95% in 1999. (Williams, 2000)), and (2) the experience, common to almost all citizens, of change through information technology in so many aspects of life (business, entertainment, medicine, etc.).

Hope for improvement, however, is tempered by the recognition that even with substantial increases in access to technology the impact on public education has been limited. After a yearlong process of review and hearings, the Web-based Education Commission summarized the impact of Internet-based technology on education as: "Across America, people told us that the Internet offers one of the most promising opportunities in education ever. And yet they were troubled by their inability to harness its potential advantages" (Web-based Education Commission, 2000). Referring to an earlier wave of technology and its expectations for school reform, Larry Cuban provided a one-line synopsis: computers meet classroom; classroom wins. This epithet of computer assisted instruction indicates that even with substantial investment and great efforts at reform the role of computer assisted instruction was at best marginal and did not change the ways that teachers and students worked in classrooms. Current investments in wiring schools and bringing Internet access to teachers and students face the same challenge of actually making a difference in the ways that schools work, teachers teach, and students learn.

In *The Fifth Discipline* (Senge, 1990), one of the seminal management books of the last 75 years, Peter Senge described new ways of working and communicating that enable an organization to thrive in challenging and changing times and achieve a sustainable competitive advantage. The term "learning organization" was coined to emphasize the need for organizations to get smarter about their work by learning from experience. Just as we know that individuals get smarter (becoming better at understanding conditions, solving problems, and judging solutions) through experience, feedback and discipline (ways of thinking about their experiences and feedback), so to do organizations. Senge's book described five disciplines (ways of thinking) that facilitate organizational learning. The five disciplines are:

- Personal Mastery - personal empowerment through the identification and realization of a personal vision
- Mental Models - processes of reflection and inquiry that make tacit knowledge visible and shared.
- Shared Vision - establishing and nourishing a common purpose
- Team Learning - enabling teams to think, learn, and mobilize for change (motivated by a commitment to a shared vision)
- Systems Thinking - ways of thinking in which understanding interdependency and "change processes" lead to appropriate solutions to complex problems.

In some ways all communities are learning communities or they would cease to exist, but high performing learning communities can be defined as enterprises that place a high value on developing the capacity to learn, see learning as the outcome of the authentic activities of that community, use the outcomes of learning as scaffolding for future activity, and enable activities as social practices (e.g., not bound by arbitrary isolation of individuals, such as individual seat work in school). These same principles that have been applied in the service of business productivity and improvement can also be applied to improving the school as a system and organization.

COMPUTER SUPPORT FOR LEARNING ORGANIZATIONS

Nearly 40 years ago Douglas Engelbart working from early experiences with communication technologies and a vision of the future with new and advancing technologies formulated a framework for "augmenting" the human intellect and improving human productivity that fits well with a model of distributed cognition and situated learning. By augmenting he meant "increasing the capability of a man to approach a complex problem situation, to gain comprehension to suit his particular needs, and to derive solutions to the problem." (Engelbart, 1962, p. 1). Considering the worker, the learner, and the work situation as an integrated whole with conditions that negate or facilitate "increasing capability." was fundamental to Engelbart's framework and links his work to distributed cognition and to Senge's model of a learning organization.

Engelbart's work was a seed for later efforts at computer-supported collaborative work (CSCW), electronic performance support systems (EPSS), and most recently a set of knowledge management systems with names, such as, ERP (enterprise resource planning), CRM (customer relationship planning) and SCM (supply chain management), etc. Von Krogh, Ichijo, and Nonaka (2000) stress that improved business practices come from implementing knowledge management systems in a "knowledge creating" company. They stress that "knowledge creation" calls for new roles and responsibilities for everyone in the organization so that innovation can be nurtured and new knowledge can be created, shared, and used for sustained advantage and productivity. The work of seeing organizations as knowledge creation enterprises takes the learning organization framework provided by Senge and maps it to the power and potential of information technology and knowledge management systems.

Similar to the substantial investment to place technology in schools and the apparent limited return on this investment, business investment in information technology experienced a "productivity paradox" from the 1960's into the 1990's. Critics claimed and had ample evidence in support of their case that huge investments in technology had not led to increased business productivity. In a comment that parallels the line from Larry Cuban about computers in schools, the Nobel Laureate Economist Robert Solow characterized the results of technology in industry: "we see productivity everywhere except in the productivity statistics." More recent analyses of productivity show that in the late 1990s technology is substantially contributing to productivity. Brynjolfsson and Hitt (1998) summarized the recent research by declaring that "computers are pulling their weight." They suggest that the question is no longer "Does technology payoff?" but rather, "How can we best use technology?" The research shows, however, that just investing in technology does not bring improved productivity. Some firms with high investments in technology have shown gains and others with equal investments have failed to show gains. A study funded by IBM (IBM Business Consulting, 2001) with collaborators from academia and business publishing associated the contributions of technology to productivity gains with a focus (1) on customers, (2) business process transformation, and (3) organizational learning.

The lessons learned about deriving productivity gains from technology investments learned in industry and summarized in the IBM report are a guide for thinking about systems design and implementation in schools. Many of the technology

implementations we see in schools today are beneficial, but substantial school improvement will not occur because of one teacher in an elementary school who uses technology, or a few projects done in the middle schools, or even an entire, but single school, in a district with advanced uses of technology. Similar to ERP (enterprise resource planning), CRM (customer relationship planning) and SCM (supply chain management) systems in business, schools need enterprise wide, networked systems that implement school processes in ways that contribute to student learning outcomes. As educators and developers our understanding and ability to develop these systems are still quite primitive, but new network-based learning systems are coming into use that offer the possibility of integrating curriculum experiences and student information systems. These new systems can help change the metaphor of the Internet from library to workspace and the metaphor of student information from report card to feedback in a systems model. We will call these integrating and process oriented systems Networked Learning Systems (NLS). An NLS is defined as a program or set of programs designed to operate over a network and support users as they undertake tasks or participate in processes related to learning. One framework for these systems for K-12 is to build out the student information system into a web-based tracking system. These systems, PowerSchool by Apple Computer is a strong example, offer great advantages for school management and administration and assist the instructional process as well as providing new linkages between parents and school teachers and administrators. Another model is to build-out the cscl-type systems that are emerging in schools to support teaching and learning so as to include information management systems that foster collaboration and new roles in the educational enterprise for all participants, students, teachers, administrators, and parents. This paper argues for using a CSCL framework that places student work as the design center of the system. Focusing on the work of teaching and learning is analogous to the focus on customers found to be associated with productivity gains in the IBM study. However, this agenda will also be advanced by building the student information-type systems so as to be web-based environments for student work, not just environments "about" student work.

A key educational implication of situated learning and the socio-cultural approach to understanding teaching and learning actions has been to set a goal of providing students with participation in the authentic work of communities of practice. Lessons learned from the research on business productivity suggests that we need to also consider the school as a community of practice for doing "school." Schooling can be improved by understanding the practices of its participants and creating environments and systems to help the school be a learning organization.

SCHOOLS AS LEARNING ORGANIZATION

In Senge's most recent book, *Schools That Learn* (Senge et al., 2001), the five disciplines are applied against the challenges and problems of schools. This approach allows educators and policy makers to see the school as a learning community, not just in the traditional framework of students learning the school curriculum, but in the sense of an organization or community that needs to get smarter about how it works, takes on challenges and mobilizes for school improvement. *Schools That Learn* references the role that technology (e.g., email or conferencing) can play in facilitating the actions of communication and sharing. However, Senge focuses upon institutional innovation, and fails to show how technology can be used to change ways of thinking and ways of working. Donald Norman's book, *Things That Make Us Smart* (Norman, 1993), shows how technology does not simply improve the way we do things, but actually changes what we do. Multiplying with a calculator is a different mental and physical task than is multiplying with paper and pencil. Having a door that is designed in a way that indicates that you should push when actually you should pull will lead to lots of less than dumb actions. This insight allows designers and developers to create systems that allow people to act as they are able and amplify, transform, and extend their work to new or additional outcomes. Efforts to build knowledge management systems so that information collected in one part of an organization can be used to make decisions in another part of the organization (over time or distance) has been a powerful tool in organizational improvement. Brown and Duguid (2000) argue that information-driven technologies lead to a tunnel vision, and that the implementation of technology needs to be grounded in the social life of the institution rather than in the information space. This argument recognizes that learning and knowledge are the result of multiple and intertwining forces of content, context, and community, and that similar to Senge, these authors see the need to harness the richness and diversity found in the community members of the organization.

USING CSCL TO SUPPORT THE SCHOOL AS A LEARNING ORGANIZATION

How can schools change the way they work and realize productivity gains of similar magnitude as those being realized by businesses? We believe that Senge's five disciplines can serve as guide for schools as they attempt to answer this question, and that recent advances in networked technologies empower schools to implement the five disciplines of learning communities in ways that have not been possible heretofore. The remainder of this article illustrates how one such system, Shadow netWorkspace™ (SNS) (Laffey, Musser, and Espinosa, 2000), supports ways of working that enact the five disciplines.

SNS is a web-based work environment designed and developed specifically to support K-12 schools. Much like a personal computer's desktop SNS provides a personal workspace for organizing, storing and accessing files and an environment for running applications. Figure 1 shows the personal desktop view of the SNS interface. The desktop has a navigation dock to

the left side, an information bar along the top of the window, and an application space that in this view shows the personal desktop of the user. The desktop provides access to data storage, groups and specialized tools. The top of the dock shows a set of locations always available to the user. The middle of the dock shows the applications that are currently active but not in the application view for easy movement between applications, such as the address book, message board and chat currently shown. The bottom of the dock shows session control options. The bar shown in the figure indicates to the user when they are running out of system resources on the server and need to close down some active applications. Other options available to the user include choosing the language (English, Spanish, Korean, etc.) of the interface or choosing the theme (screen configuration, color scheme, etc.) that would be most appropriate for the current computing environment. For example, an experienced user on a computer with a small monitor may choose to collapse the dock into a set of icons leaving more space for the application window.

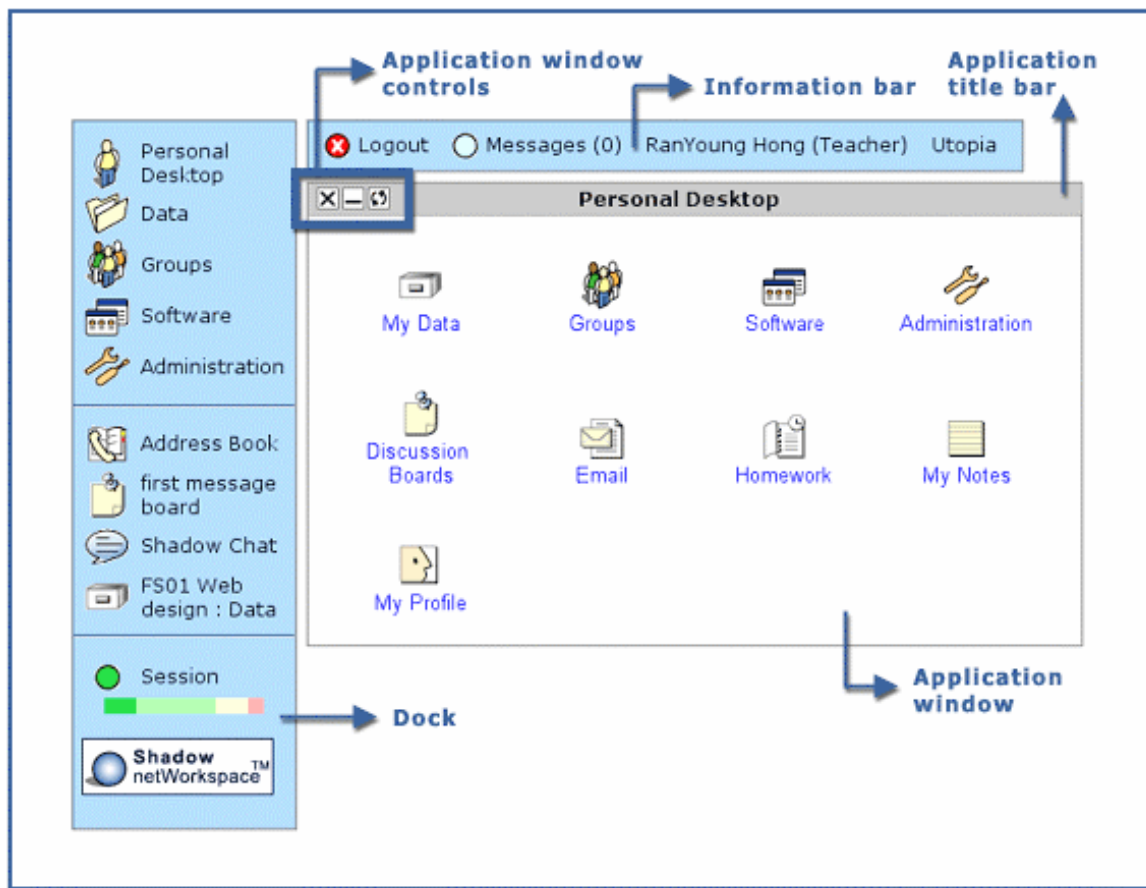


Figure 1. SNS Personal Desktop

SNS provides the ability to create groups and for each group to have a "group desktop" analogous to the personal desktop shown in figure 1 for file sharing, communication and collaboration. Because it is Web-based, teachers and students can access their workspaces from any computer that can access the World Wide Web, and partners (parents or mentors), who are unable to participate in schools because of time or distance, can participate in the internet-based workspace. SNS is freely available to all users, designed to be installed at individual school locations, and comes with an open source ([GNU Public License](#)) and Application Programming Interface (API) so others can develop applications for it and participate in enhancing and supporting it.

SNS is both an information space for organizing, storing and accessing files, and a social space in that SNS users have roles (e.g., teachers, students, parents, etc.) that structure the system interaction as well as groups for sharing, communicating and collaborating. The next sections illustrate the ways in which SNS supports activities that instantiate the five disciplines and build a learning community.

Personal Mastery.

Community members must have a personal identity that both empowers them to achieve to a high level of personal satisfaction and represent themselves in the community in a way that is coherent with their own self image. For example, programmers in the open source community are empowered with tools (licenses, source code, web-based information and sharing) and invest their time and resources to create interesting and powerful programs. These programmers want to share

their work freely with others who could benefit or learn from it. If the programs were made available anonymously there would be far less drive to mastery, creation and sharing. SNS provides each member of the community with an identity and an extensive section for presenting a profile. SNS also provides substantial customizability for the desktop and organization of files. Users in all roles can create groups, invite members to participate, invoke chat or other communication tools, and share their work in multiple ways. The name "netWorkspace" signifies that core to the design of SNS is a work environment, a place to accomplish a variety of types of work, and one which is resourced, connected and customizable. The workspace facilitates students having a personally meaningful identity in school that is associated with their accomplishments, so that they will see themselves as a part of the school community.

Mental Models.

Mental models are guides to behavior. Much like the set of expectations we have for going to a restaurant causes us to take a seat, order food, and pay for it before leaving. Our expectations and models for how the world works and how we will work within it guide our actions and the sense we make of the actions of others. Senge argues that we need to have a clear understanding (or visible representation) of our mental models as well as the mental models of those with whom we work. Reflecting on our own models is how we will change them or adjust them to best fit the situation. Inquiring into the models of others is how we come to understand their actions as goals and intentions, not simply behaviors. Central to the processes of reflection and inquiry are ways of making these assumptions visible, so that they can be examined and communicated. A way of thinking about this idea that especially fits schools is to think of making learning visible. Making learning visible challenges the learner to represent what they know and enables the teacher or learning partner to not only see an answer but to see the underpinnings and mechanisms that generate that answer. Much like asking a student in mathematics to show their work of calculating an answer we want students to show their work in all forms of learning.

SNS supports making learning visible by: (1) providing online tools for creating multimedia content, providing a special viewer application for examining media, and facilitating the sharing of most document types, (2) allowing users to organize and store documents so that iterative steps toward a final production can be maintained and shared, and (3) supporting multiple reviewer types (including teachers, other students, parents, mentors from in and outside of the local community) so that the teacher does not have to be the only source of review and feedback. One of the key barriers to examining mental models or making learning visible is the lack of time and the pressure to cover subject matter. Since the student's workspace is available wherever they have an Internet computer or appliance, teachers can create teaching materials for asynchronous teaching and learning. It may be unreasonable to expect many teachers to create many materials, but teachers and other members of the extended school community could collaborate to develop instructional materials and have a common and easily accessible platform for implementation.

Shared Vision.

The articulation and sharing of mental models provide individuals with the opportunity to discover other individuals with similar mental models and personal visions. This discovery can lead to the aggregation of individuals into groups and the identification and shaping of a shared vision. This shared vision serves to motivate individuals and foster commitment to learning and action (Team Learning). Key to building a shared vision is participation and inclusion of all the stakeholders in the learning community. By providing a social context for participation (members have roles with appropriate rights and authority), easily available grouping techniques, and an easy to use interface, SNS supports the participation of all appropriate members and facilitates their interaction and sharing.

Team Learning.

How can members of a community interact and mobilize to achieve common goals so that the collective effort is greater than what could be accomplished by isolated individuals? SNS makes it easy for schools to setup classes with teachers, but also allows any member to create workgroups or review groups. Each type of group provides different rights and privileges for the members of the group. For example, in a class group students cannot throw a document created by the teacher into the trash, whereas in workgroups all members have equal rights and responsibilities regarding the managing and editing of files. Workgroups can be setup for the purpose of a group of students working on a team project, teachers collaborating on curriculum development, or students forming a chess club. Review groups allow an individual to organize a set of work for review by others. Review groups could be setup for the purpose of an electronic portfolio, a science fair exhibit, or having a teacher, student, guidance counselor, truant officer, and parent collaboratively review a student's work over time. To date, SNS provides the three group types described above, but other group types could be developed based upon new definitions of roles and rights.

Being in a group of a certain type provides affordances and constraints for what the member can do, and what can be done with documents. Within a group, members can invoke discussion boards or chat sessions whenever appropriate. The user experience is that of easy and flexible group formation, various communication tools, and file sharing and security. Just as the name "netWorkspace" communicates an environment for personal mastery, it represents customizable work

environments for teams and groups. The groups and types of groups in a learning community can change as the need for new types of social interaction emerge over time.

The review panel, as an example, illustrates how the feature set of SNS can be used to support the type of process transformation that can be valuable to schools and has been associated with productivity gains in the IBM study. Feedback and evaluation of student work is one of the most important processes of schooling. Typically feedback is only provided by the primary teacher and only on the current work effort. Portfolios are recognized as mechanisms that allow students to aggregate work into meaningful chunks and provide for more extensive review. In practice, however, portfolios have many problems. Physical portfolios are cumbersome and it is difficult to manage the review process for more than a very small number of students. Electronic portfolios usually call for technical skills on the part of the producer or reviewer that often yield weak approximations of the goal of appropriate and extensive feedback to important work by the student. The Review Panel Group of SNS facilitates both the work of the portfolio producer and reviewer. An example desktop for a review panel group is shown in Figure 2. In this case the group is being used by the member, Jim Laffey, for a review called "Interface Design Review." The desktop provides a file storage space called Portfolio. In this space the owner can place any documents (including word processing, spreadsheets, graphics, or video) that are to be reviewed. The owner can arrange these documents in folders, and thus has a great deal of presentation flexibility. The owner can provide instructions for reviewers, as well as an introduction to him or herself and to the work to be reviewed. Communication tools such as discussion boards or the ability to leave notes are available. The owner can use the Member Editor tool to invite reviewers to the portfolio. If the reviewer is a member of the SNS community, the Review Panel will show up in that members Groups. If the reviewer is not a member of the SNS community, for example a college admissions officer, then the invitation process creates an email or letter to be sent to the non-member reviewer with a specialized password that will admit the reviewer to this panel but not to other areas of the SNS community. For students using SNS to carry out their regular school work the creation of a portfolio is an easy process of copying files from their personal workspace or other group space to their new portfolio space. Reviewers have easy access to the files and communication tools for collaborating with other reviewers or interacting with the student. If specialized scoring or grading is required new applications could be developed and added to the desktop. This review panel example illustrates how the key steps and transactions of an important process of schooling can be facilitated in a networked learning system.

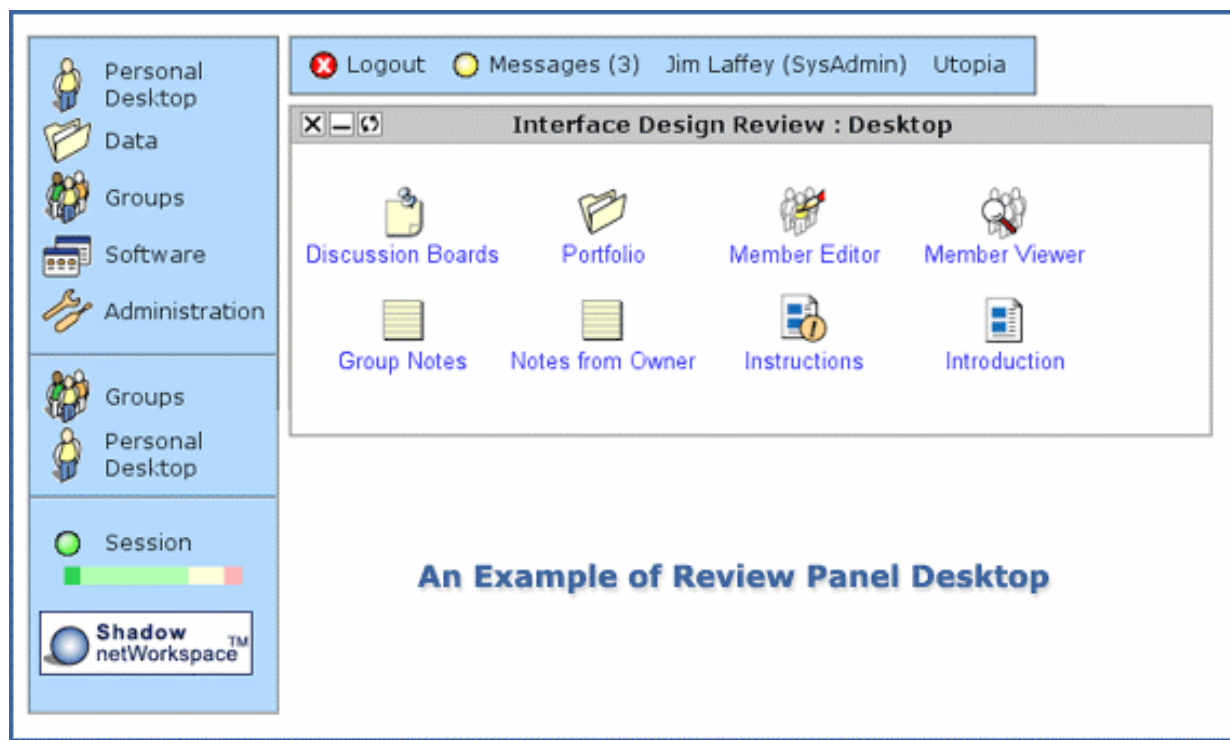


Figure 2. Desktop of Review Panel Group

Systems Thinking.

Senge calls systems thinking the fifth discipline of learning organizations, and entitled his seminal book, *The Fifth Discipline*, to highlight how important systems thinking is to bringing the benefits of the other disciplines to bear on knowledge creation and learning. While there is much to be understood about systems thinking, the practice of systems thinking starts with a simple concept called "feedback." Feedback provides the information needed to recognize causality,

to see patterns, and to understand the interrelationship of phenomena. If NLS become places where much of the important work of schools is done or represented, then representations of this work can be viewed, reviewed, and monitored for patterns and relationships. While it is certainly possible to build NLS that represent unimportant or non-critical aspects of the work of schools, and build elaborate systems models that will lead to no substantial improvement in schools; the hard and creative work of systems thinking is drilling down to the essentials and core focus of the enterprise. The report from IBM suggests that information systems in business must be clearly tied to the effect of work on customers, and it is likely that in schools NLS must focus on students and student work. Neither SNS nor any other NLS that we have examined claims much progress in providing the core feedback needed for school improvement. One of the goals of NLS developers who have created open source licenses for their work is to build communities of users so that the shared experience of the school communities can provide feedback to the NLS development, which in turn can lead to systems that improve over time and experience.

SUMMARY

Networked Learning Systems hold great potential and promise for school improvement. The rapid deployment of technology into schools and the relentless advancement of technology for digital representation and network services for information and work, call for "ways of thinking" that will turn schools into learning organizations in the fullest sense of the term. Although substantial investments and deployment efforts are being made in schools, the scope of this work is miniscule when compared to the experience and lessons learned over the past 40 years of bringing information technology to bear on business productivity. Lessons from this work may not be directly translatable into school practices, but they point us towards a focus on student work, enterprise wide systems, and mapping technology use to process improvement in the organization. Further the work undertaken in the business community focuses our attention on turning schools into learning organizations that not only work to support student learning, but also work to improve their ways of working. NLS can be a substantial contributor to helping schools become learning organizations.

Systems like Shadow netWorkspace are early and somewhat primitive instances of the environments we envision for schools as learning organizations. These systems must advance through evolutionary and learning processes of their own. Schools must adopt NLS and begin the process of fundamental change to management, organizational structures and human resource allocation that these systems will enable. NLS as a vision in schools has been impeded by limitations in access to technology (not every child and/or parent has a computer and computers are not in all the places we want them to be) and limitations in bandwidth (some things just are not worth doing over a 28.8 modem connection). However, we are already seeing instances of schools where every child has a laptop and it is not hard to imagine a future where in many schools every child has some form of PDA. Similarly, wireless connections and Internet2 connections into schools foreshadow ubiquitous high bandwidth. Our implementations of NLS and our ways of thinking about schools need to advance, so that as ubiquitous access becomes a reality, we will have schools that can learn to bring these new network services to bear on improved teaching and learning.

The foundational work of scholars such as Scardamalia and Bereiter for using computers to support collaborative learning can be a basis for enterprise wide systems that focus on the total process of teaching and learning. If we do not find creative ways to make the work of student learning the design center for knowledge management systems, we will end up with knowledge management systems for schools that fail to represent the real work of schools, and we will have failed to learn from the lessons of the "productivity paradox" in business.

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