

Reflections on WebGuide: Seven Issues for the Next Generation of Collaborative Knowledge-Building Environments

ABSTRACT

A number of software environments have been developed as media to support collaborative knowledge building, typically featuring a Web-based threaded discussion facility. We have recently developed such a system, known as WEBGUIDE. The distinctive feature of this system is support for structuring collaboration and knowledge construction with personal, group and comparison perspectives. While piloting WEBGUIDE in a middle school classroom and a graduate seminar, we encountered a variety of issues related to both software design and classroom practices. Some of these issues are common to experiences with similar systems and some have to do specifically with support for perspectives. In this paper we review seven of the major issues encountered with an eye toward suggestions for future work.

INTRODUCTION

There is a growing genre of software systems that I will refer to as *Knowledge-Building Environments* (KBEs). KBEs are intended to support collaboration processes in which, for instance, a classroom of students researches, discusses, critiques and articulates their own developing understanding of scientific phenomena. Perhaps first explicitly championed by Scardamalia and Bereiter (Scardamalia & Bereiter, 1991), KBEs have been implemented and assessed in the past

decade by research centers at the universities of Toronto, Michigan, Berkeley, Northwestern, Colorado, Vanderbilt, Georgia Tech, Stanford and Swarthmore, among others.

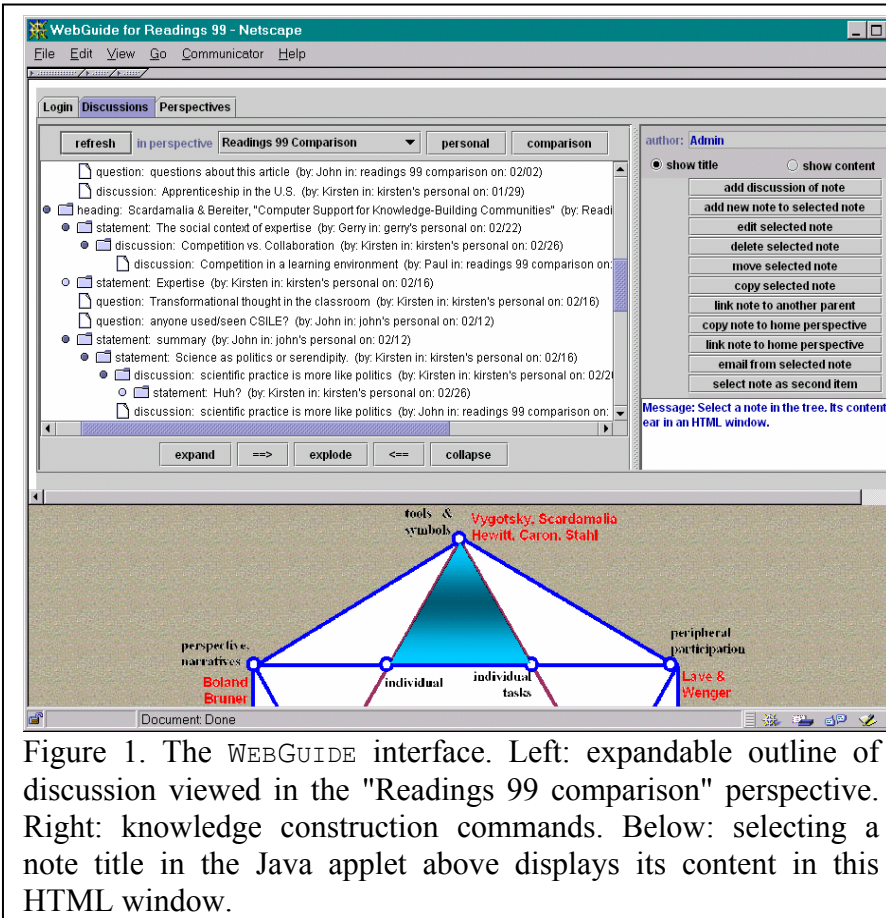
I have argued elsewhere that understanding is perspectival and that computer environments should deliver information to people based on their preferred *perspectives* on the information (Stahl, 1993; Stahl, Sumner, & Owen, 1995). In particular, collaboration consists of processes of perspective-making and perspective-taking involving personal and group perspectives (Boland & Tenkasi, 1995). To explore the representation of perspectives within KBEs, we (see acknowledgments) developed a system called WEBGUIDE. This year we piloted WEBGUIDE in a middle school environmental science classroom and in an interdisciplinary cognitive science graduate seminar. We ran into many of the same issues that have confronted other KBEs. Our perspectives-based software addresses or transforms some of the issues and raises others of its own.

This paper reflects on seven issues raised by our WEBGUIDE experiences. We think these issues are critical to the ability to support collaborative learning with Web-based environments. The potential for computer mediation of collaboration seems extraordinary, but our experience warns us that the practical barriers are also enormous. The following issues for KBEs like WEBGUIDE are not problems that we have solved, but rather foci for future work, in analogy with Halasz's (Halasz, 1988) issues for hypermedia.

This paper summarizes our understanding of the seven issues we identified for future work. That understanding is based on a synthesis of theory and reflection on our experiences with WEBGUIDE. For background details, see: (Stahl, 2000) which presents a theory of collaborative learning and our approaches to computer support that led to WEBGUIDE; (Stahl & Herrmann, 1999) which describes the technicalities of intertwining perspectives and negotiation to support group and individual learning and contrasts WEBGUIDE's mechanisms to related work; (Stahl, 1999) which describes the software interface, its underlying cognitive theory and its trial application in two use situations.

ISSUE 1: CONSTRUCTING PERSPECTIVES ON KNOWLEDGE FROM THREADED DISCUSSIONS

Most KBEs consist primarily of persistent discussion forums, with typed nodes and other supplementary software features and classroom practices to guide the discussion from personal opinions to collaborative knowledge. WEBGUIDE is designed to go a bit further than most KBEs in supporting both knowledge construction and collaboration with a structure of personal and group perspectives. In order to support knowledge construction, it provides functionality for each student to process the ideas in the shared discussion: selecting, editing, arranging, linking and summarizing notes freely within one's



The screenshot displays the WebGuide interface within a Netscape browser window. The main area is divided into two sections. The upper section features an expandable tree view of discussion nodes, currently viewed in the "Readings 99 Comparison" perspective. The nodes include questions, discussions, and statements, each with a timestamp and author information. The lower section shows a diagram with five nodes: "tools & symbols" (top), "perspective narratives" (left), "individual" (bottom center), "individual tasks" (right), and "peripheral participation" (far right). These nodes are interconnected by lines, forming a network. A message at the bottom of the diagram area reads: "Message: Select a note in the tree. Its content appears in an HTML window."

Figure 1. The WEBGUIDE interface. Left: expandable outline of discussion viewed in the "Readings 99 comparison" perspective. Right: knowledge construction commands. Below: selecting a note title in the Java applet above displays its content in this HTML window.

own perspective without affecting the views in other people's perspectives (see the knowledge construction commands in Figure 1).

Constructing knowledge involves tasks that are difficult for people to do individually, let alone collaboratively. Providing virtual workspaces for people to formulate their own perspectives and to view each other's ideas may simplify and clarify this process. WEBGUIDE also provides group perspectives in which a team or the class as a whole can agree on expressions of negotiated knowledge. This is designed to structure and model the collaborative process, seen as an interplay among individuals and groups. In this way, WEBGUIDE is intended to support collaboration.

The ability of students and groups to select subsets of the shared repository of discussion notes and to arrange them at will also addresses the problem of growth of the repository contents, which can otherwise lead to information over-load and chaos. Our theory of group memory evolution identifies phases of seeding (e.g., the teacher starts a project off with some ideas or background information), growth (the discussion takes place) and reseeded (somehow the repository must be weeded and reorganized) (Fischer *et al.*, 1993). In WEBGUIDE, the reseeded process can take place continuously, simultaneously with the growth process. Individuals or groups can be responsible for organizing their own perspectives on knowledge.

ISSUE 2: DISTINGUISHING LEARNING TASKS

In iterating the design of WEBGUIDE it has become increasingly clear that there are significant differences between knowledge building and simple discussion. Students more readily engage in discussion, responding spontaneously to existing notes without taking time to appropriate the ideas in new syntheses. True construction of knowledge involves distinct tasks – including brainstorming, articulating, reacting, organizing, analyzing and generalizing. Rather than trying to support all of these within a threaded discussion format, it may be more effective to provide specific components, such as an editing window to set down tentative ideas, a discussion area to respond fluently to a flow of interchanged ideas and a separate facility for making sense more reflectively of selected notes. (Buckingham Shum & Hammond, 1994) These different tasks require distinct skills, states of mind and supports.

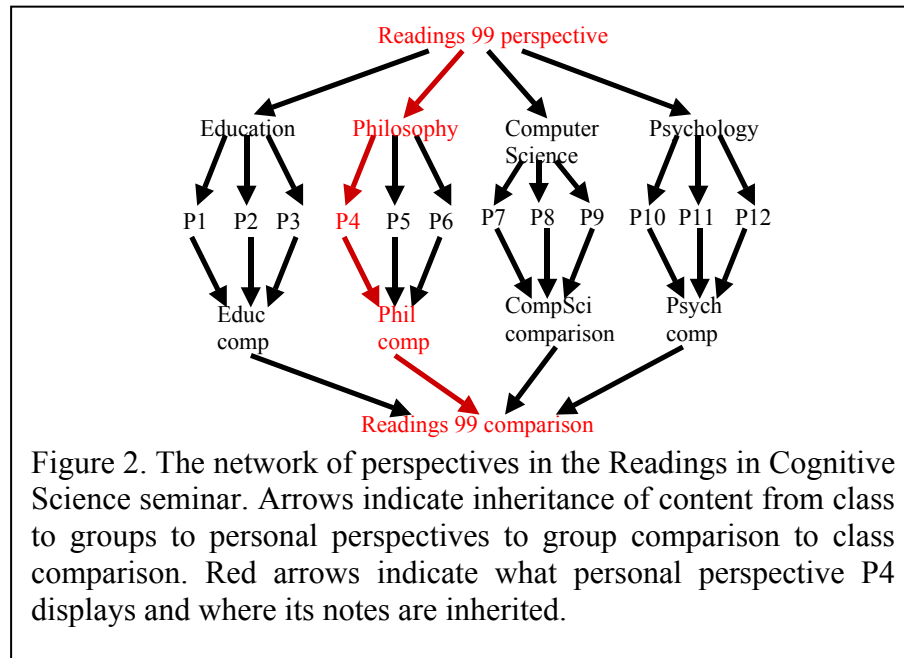


Figure 2. The network of perspectives in the Readings in Cognitive Science seminar. Arrows indicate inheritance of content from class to groups to personal perspectives to group comparison to class comparison. Red arrows indicate what personal perspective P4 displays and where its notes are inherited.

Collaboration can facilitate knowledge building by bringing many minds (and perspectives) to the job and by practicing social processes that will later become internalized skills (Vygotsky, 1930/1978). But collaborative learning also introduces complexity. We should not expect novices in thinking, writing and researching (e.g., middle school students) to do what most experts cannot do – like write a truly collaborative paper – on their own without significant scaffolding. It will be important to develop new forms of functionality, structure and computer support to enable collaborative knowledge construction – and then to differentiate and integrate these various supports within KBEs.

ISSUE 3: REPRESENTING COLLABORATIVE PERSPECTIVES

In our classroom experiences, WEBGUIDE provided three kinds of perspectives or views on the shared network of notes: group, personal and comparison perspectives (see Figure 2). The *group* perspectives were seeded by the teacher to suggest topics of research and discussion. All participants had their own *personal* perspectives, where they could create, modify, link and organize whatever notes they wanted to.

Personal perspectives included or inherited all information that was in their group perspectives. The *comparison* perspectives included all information from a set of personal perspectives, so they could be browsed to see notes by everyone in the group. The goal of the class was to share ideas (perspective-taking) in the comparison perspectives, synthesize them (perspective-making) in personal perspectives and then agree to promote some of them (collaborate) to the group perspectives. Thus, the network of perspectives represents and supports the dynamics between individuals and groups that defines collaboration.

The fact that an individual note may have different edited versions and different linking structures in different perspectives, that notes may have multiple parents within the discussion threads, that new perspectives can be added dynamically and may inherit from multiple other perspectives sets WEBGUIDE apart from simple threaded discussion media. It also makes the computations for displaying notes extremely complex. This is a task that definitely requires computers. Although the software now hides much of the complexity, it is not yet at the point where people can operate smoothly without confusion.

One problem is that people using WEBGUIDE do not have a clear mental model of relationships of perspectives to each other. The current WEBGUIDE interface of the perspective structure (see Figure 3) is inadequate. The expandable outline hierarchy, which is useful in other ways, cannot accurately represent the convergent structure of multiple inheritance (compare Figure 2). The comparison perspectives are listed multiple times, under each perspective that they aggregate. A graphical representation is needed to show the structure of perspectives and also that of multiply-linked notes. Similarly, a graphical interface might be useful for manipulating and organizing notes within a perspective as well.

ISSUE 4: CONVERGING IDEAS

In reviews of KBE experience, Hewitt (Hewitt, Scardamalia, & Webb, 1998) and dePaula (dePaula, 1998) identify divergence of ideas to be a common problem. They argue that the tree structure imposed by standard threaded discussion support is inadequate for collaboration. The idea of a threaded discussion is that one contribution or note leads to another. The result is that discussions proceed along ever diverging

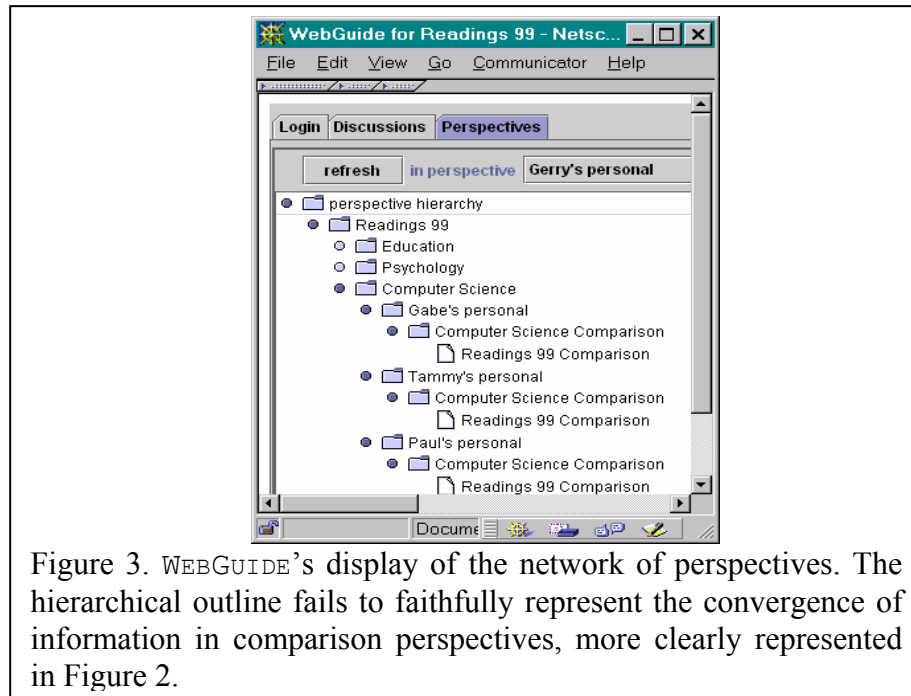


Figure 3. WEBGUIDE's display of the network of perspectives. The hierarchical outline fails to faithfully represent the convergence of information in comparison perspectives, more clearly represented in Figure 2.

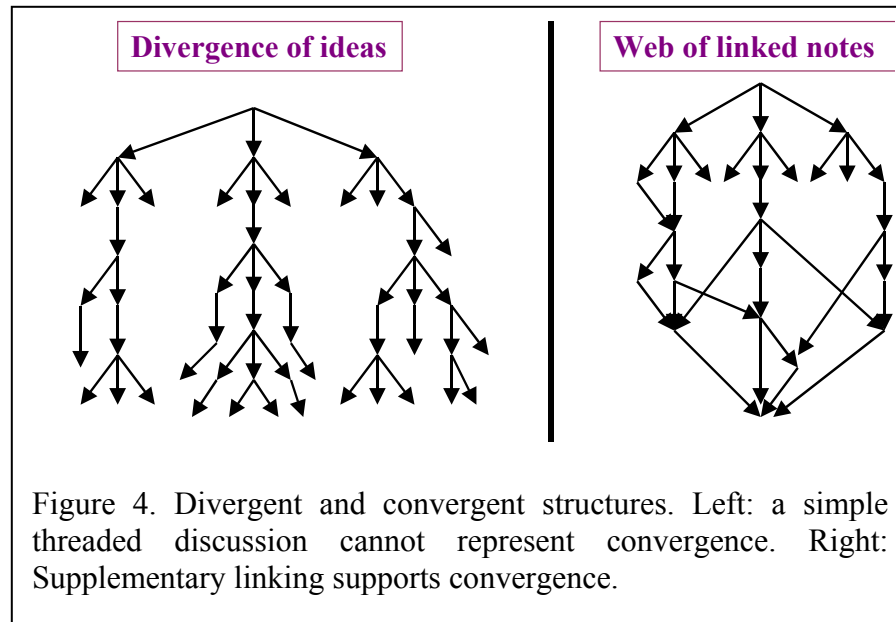
lines as they branch out, and there is no systematic way to promote convergence (see Figure 4). It seems clear, however, that collaboration requires both divergence (e.g., during brainstorming) and convergence (e.g., during negotiation, synthesis, summary and consensus).

WEBGUIDE addresses this structural problem at three levels:

The note linking mechanism in WEBGUIDE allows notes to be *linked* to multiple parents (Figure 4), so that they can act to bring together and summarize otherwise divergent ideas.

Similarly, the graph of perspectives (Figure 2) allows for *multiple inheritance*, so that comparison perspectives aggregate or converge the contents of multiple perspectives.

By introducing carefully conceived *headings* high in the perspective inheritance network, a teacher can define topics that will be inherited in all other perspectives, encouraging related ideas to be arranged together.



ISSUE 5: NEGOTIATING AGREEMENT

However, it is not enough that convergence is technically possible or that a teacher desires it. Students need opportunities and supports to bring ideas together and to agree on whose ideas will be accepted as group positions. *WEBGUIDE* was originally designed to include a negotiation component to complement the perspectives mechanism. The idea is that individuals propose notes from their personal perspectives to be voted on. When enough votes are entered for a given proposal, that proposal is promoted to the group perspective. Communication on proposals proceeds asynchronously and is subject to threads of discussion.

A promoted note represents knowledge accepted by the group. As such, it is automatically inherited into the personal perspectives of all group members, where they incorporate it into their own knowledge organization. In this way, collaborative knowledge exceeds what any one member had expressed and it is always subject to interpretation by individuals. As in unsupported collaboration, individuals build upon knowledge they inherit from their social context, and the relation of their understanding to the group interpretation is always tenuous.

In our classroom trials, negotiation had to proceed face-to-face or not at all. Clearly, the addition of software support for negotiation is a priority. The hard part is to make it an enjoyable social experience and a flexible, consensual process rather than a burden that discourages usage.

ISSUE 6: ENCOURAGING SYSTEM USE

The clearest failure of KBEs is that people avoid using them. There are many explanations for this. *Media competition* poses a barrier to acceptance of new communication software. People are naturally hesitant to adopt yet another communication technology. They must calculate how much a burden the new medium will impose in terms of learning how to use it, acquiring the equipment, checking regularly for incoming messages and letting people know that they are communicating through it. Clearly, a *critical mass* of adoption by one's communication partners is necessary as well.

In a classroom context, some of these problems are minimized. Still, communication with classmates is much easier face-to-face than typing everything (knowing it may influence grading). Perhaps the integration of new capabilities and uses of KBEs can increase their practical value and spur increased usage, as long as confusions and conflicts are not introduced. For instance, providing facilities for people to maintain lists of annotated Web bookmarks, things-to-do, favorite references, upcoming deadlines, etc. within their personal perspectives might not only give them familiarity with using the system, but would also spur adoption. Gradually, they could start to construct their own knowledge in the KBE: personal diary, research notebook, inspirations for papers, theory insights. Then, the step to computer-mediated collaborative knowledge building would follow more naturally.

ISSUE 7: SCAFFOLDING LEARNING PRACTICES

We have argued based on previous experience that the crucial aspect of supporting collaborative learning has to do with structuring social practices (Koschmann, Ostwald, & Stahl, 1998). *Practice* is the set of generally tacit procedures that are culturally adopted by a community. In introducing WEBGUIDE into its two user communities, we tried

unsuccessfully to establish certain usage practices, both by instruction and by enforcement in the software (see Figure 5). In the middle school classroom it proved too confusing to allow students to work in every perspective, so the interface was changed to limit navigation to the student's personal perspective and their group and class comparison perspectives. This still left the problem that they preferred to work in the comparison perspectives where they could easily engage in threaded discussion.

For the graduate seminar, the interface was configured to let students navigate to any perspective but to limit what they could do in most perspectives. Most knowledge construction operations were allowed only in one's personal perspective and new options were added to permit copying or linking notes back to one's personal perspective from the other perspectives. This made discussing someone else's note awkward, so simple discussion notes were later allowed everywhere. But then one could not edit even typos that one made in fluent discussion. There seemed to be no satisfactory solution to these detail

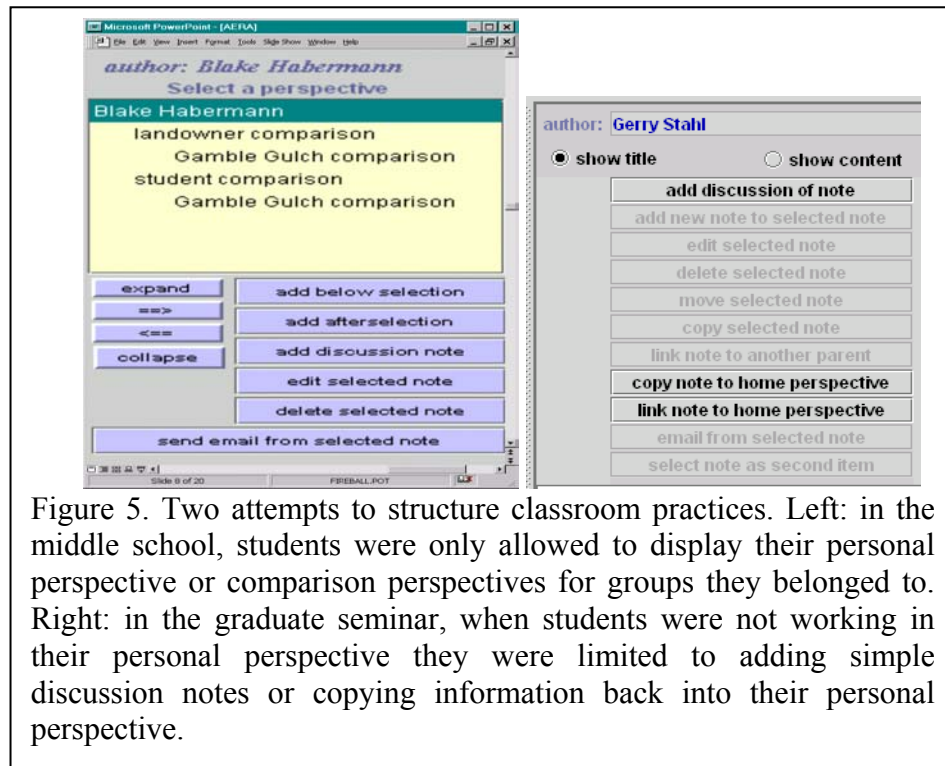


Figure 5. Two attempts to structure classroom practices. Left: in the middle school, students were only allowed to display their personal perspective or comparison perspectives for groups they belonged to. Right: in the graduate seminar, when students were not working in their personal perspective they were limited to adding simple discussion notes or copying information back into their personal perspective.

design decisions short of rethinking the larger issues raised in this paper. The problem of designing classroom practices and matching them with software supports will be with us for the long haul.

Powerful KBEs are not just a fulcrum for leveraging practices that are more student-centered; ideally, they facilitate new classes of practices that would not be feasible without such computer support. Nevertheless, such technologies can also be adapted to reinforce traditional teacher-centered approaches. As Scardamalia & Bereiter (Scardamalia & Bereiter, 1996) say, "Nobody wants to use technology to recreate education as it is, yet there is not much to distinguish what goes on in most computer-supported classrooms versus traditional classrooms" (p. 249). How can the use of KBEs be structured to provide students with a visionary model of collaborative learning? Such a model could prefigure a networked globe where individual competition is replaced by collaborative cognition, social division of manual and mental labor is superseded by equal intellectual access and private ownership of socially created ideas succumbs to unfettered sharing.

CONCLUSION

It has become a cliché that computer mediation has the potential to revolutionize communication just like the printing press did long ago. But the real lesson in this analogy is that widespread literacy involved slow changes in skills and practices to take advantage of the technological affordances. Culture and technology co-evolved dramatically; the transition from orality to literacy involved a radical change in how the world thinks and works (Ong, 1998). Although social as well as technical changes can be propagated much faster now, it is still necessary to gradually evolve suitable mixes of practices and systems to support the move from predominantly individual, paper-based construction of knowledge to a new level of collaborative, Web-based cognition. This will involve the refinement of software support systems that are sophisticated, specialized and flexible, yet capable of becoming transparent in skilled practice. The design of such software will involve extended research into issues such as those raised in this paper.

ACKNOWLEDGMENTS

The WEBGUIDE research has been a collaboration of the author with Rogerio dePaula and other L³D members, Ted Habermann and his group at NOAA, Dan Kowal and his middle school students, the participants in the WEBGUIDE seminar, Thomas Herrmann and his students at Dortmund, and the researchers in the ICS “Articulate Learners” project. The work reported here was supported in part by grants from NSF IRI-9711951, the McDonnell Foundation and NSF EAR-9870934.

REFERENCES

- Boland, R. J., & Tenkasi, R. V. (1995). Perspective making and perspective taking in communities of knowing. *Organization Science*, 6(4), 350-372.
- Buckingham Shum, S., & Hammond, N. (1994). Argumentation-based design rationale: What use at what cost? *International Journal of Human-Computer Studies*, 40(4), 603-652.
- dePaula, R. (1998). *Computer support for collaborative learning: Understanding practices and technology adoption*. Unpublished Masters Thesis, Telecommunications Department, University of Colorado, Boulder, CO.
- Fischer, G., Nakakoji, K., Ostwald, J., Stahl, G., & Sumner, T. (1993). *Embedding computer-based critics in the contexts of design*. Paper presented at the Conference on Human Factors in Computing Systems (INTERCHI '93), Amsterdam, Holland. Retrieved from <http://www.cis.drexel.edu/faculty/gerry/publications/conferences/1990-1997/chi93/CHI93.html>.
- Halasz, F. G. (1988). Reflections on notecards: Seven issues for the next generation of hypermedia systems. *Communications of the ACM*, 31(7), 836-852.
- Hewitt, J., Scardamalia, M., & Webb, J. (1998). *Situative design issues for interactive learning environments*, from http://csile.oise.on.ca/abstracts/situ_design

Koschmann, T., Ostwald, J., & Stahl, G. (1998). *Shouldn't we really be studying practice? [panel position paper]*. Paper presented at the International Conference on the Learning Sciences (ICLS '98), Atlanta, GA. Retrieved from [http://www.cis.drexel.edu/faculty/gerry/publications/conferences/1998/icls98/ICLS Workshop.html](http://www.cis.drexel.edu/faculty/gerry/publications/conferences/1998/icls98/ICLS%20Workshop.html).

Ong, W. (1998). *Orality and literacy: The technologizing of the world*. New York, NY: Routledge.

Scardamalia, M., & Bereiter, C. (1991). Higher levels of agency in knowledge building: A challenge for the design of new knowledge media. *Journal of the Learning Sciences*, 1, 37-68.

Scardamalia, M., & Bereiter, C. (1996). Computer support for knowledge-building communities. In T. Koschmann (Ed.), *CSCLE: Theory and practice of an emerging paradigm* (pp. 249-268). Hillsdale, NJ: Lawrence Erlbaum Associates.

Stahl, G. (1993). *Supporting situated interpretation*. Paper presented at the Annual Meeting of the Cognitive Science Society (CogSci '93), Boulder, CO. Retrieved from <http://www.cis.drexel.edu/faculty/gerry/publications/conferences/1990-1997/cogsci93/CogSci.html>.

Stahl, G., Sumner, T., & Owen, R. (1995). Share globally, adapt locally: Software to create and distribute student-centered curriculum. *Computers and Education. Special Issue on Education and the Internet*, 24(3), 237-246. Retrieved from <http://www.cis.drexel.edu/faculty/gerry/publications/journals/c&e/>.

Stahl, G. (1999). *WebGuide: Guiding collaborative learning on the web with perspectives*. Paper presented at the Annual Conference of the American Educational Research Association (AERA '99), Montreal, Canada. Retrieved from <http://www.cis.drexel.edu/faculty/gerry/publications/conferences/1999/era99/>.

Stahl, G., & Herrmann, T. (1999). *Intertwining perspectives and negotiation*. Paper presented at the International Conference on Supporting Group Work (Group '99), Phoenix, AZ. Retrieved from <http://www.cis.drexel.edu/faculty/gerry/publications/conferences/1999/group99/group99.pdf>.

Stahl, G. (2000). Collaborative information environments to support knowledge construction by communities. *AI & Society*, 14, 1-27. Retrieved from <http://www.cis.drexel.edu/faculty/gerry/publications/journals/ai&society/>.

Vygotsky, L. (1930/1978). *Mind in society*. Cambridge, MA: Harvard University Press.