Designing for Pedagogical Effectiveness: the TextWeaver?

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Abstract

The online discussion forum is the main mode of interaction for Web-based learning. Existing online instructional management systems contain primitive discussion tools that do little to facilitate online interaction and collaborative discourse. This paper proposes the design of a new type of software – the TextWeaver? – to meet these needs. In particular, we illustrate improved design in four areas: reading and composing, message keywording and weaving, material storing and reusing, and working offline. The paper starts with an overview of existing network-based educational systems and discusses software design considerations for networked computers and related pedagogical principles. This is followed by a description of the proposed design of the TextWeaver? and a discussion of its pedagogical implications. We conclude with a discussion of evaluation strategies for the software, future directions for research, and a summary of our conclusions.

1. Introduction

Web-based learning is becoming increasingly popular. There are different pedagogical models associated with different implementations of the new systems. Several years ago there was much discussion of automated learning with the emphasis on presentation of information. Today, a consensus appears to be emerging in many institutions of higher education and among online teachers and learners in favor of encouraging and facilitating human interaction in online courses. The Western Association of Schools and Colleges (WASC) guidelines for distance education [36] and the guidelines of the new Regional Accreditation Commissions Report on best practices [21] stress the need for interactivity among faculty and students and students and students. The Institute for Higher Education Policy has published a report entitled *Quality on the Line: Benchmarks for Success in Internet-based Distance Education* [1]. In it, student-faculty and student-students interaction receives one of the highest scores for importance. The report stresses that interactivity is the *sine qua non* for quality in distance learning.

Given the intense interest today in human interaction in online education, it is time to take a critical look at the existing software in common use. Over the past several years, an increasing number of web-based instructional management systems have become available. Although many of them contain primitive discussion tools, to date there have been few software applications that are purposefully designed to promote interaction and active dialogue. This is the one area that most existing online education systems miss – and we argue that it will be the area that distinguishes the good from the mediocre.

The purpose of this paper is to propose a design for a new pedagogy driven type of software to promote interactivity and facilitate discourse. Appropriately designed software can suggest an effective way of accomplishing a goal, in this case engaged collaborative dialogue in online discussions, and simplify the technical tasks required for success. By engaged collaborative dialogue, we refer to participation in a joint conversation in a computer conferencing environment with the goal of learning a subject matter. We wish to emphasize that such discourse not only has to be a joint conversation that engages multiple participants but also that it has to engage them with the subject matter and achieve knowledge building and real penetration into the subject to be learned.

The paper starts with an overview of the existing online educational systems as they relate to software design considerations for networked computers and related pedagogical principles. This is followed by a description of the proposed design of the TextWeaver and a discussion of its pedagogical implications. We conclude with a discussion of evaluation strategies for the software, future directions for research, and a summary of our conclusions.

2. An overview of the existing network-based educational systems

In order to have a good understanding of the strengths and limitations of the existing network-based educational systems and in particular online discussion software, we need to consider the nature of networked computers and related software design and pedagogical principles.

Bruffee identifies two ways of thinking about networked computers – referentially and relationally [7]. "To refer is to transmit or convey." In this vein, we think of computers as "conduits" that convey ideas, carry information, or transfer pictures of things from one site to another. "To relate is to converse in terms of a language community's agreed-upon understanding and conventions." Bruffee asserts, "What we know is a conversational artifact" and "Learning is about change of knowledge."

However complex and interesting, the referential aspect of networked computers is instrumental; it must be subordinated to the relational aspect – "the social interaction that such software programs can be designed to induce" [7]. Unfortunately most current software designs for online education are based on referential assumptions instead of relational ones. This is reflected in the emphasis on the presentation of materials instead of the promotion of social interaction and engaged collaborative discourse.

To design "genuine interactive software" for educational purposes, Bruffee argues, the software designer and developers must recognize that "the educationally most important relationships are relationships among people", and not the ones between people and machines [7]. Therefore, the designers and the developers should shift the focus of their attention "from visual intensity and electronic instantaneousness to constructive interaction among users in front of the machine and those 'behind' it". Furthermore, the application should "prompt students to turn away from the machine and focus their attention instead on one another."

Brown and Harasim view the network-based educational environments as a means to support collaborative dialogues and to ensure knowledge co-construction instead of as a cognitive delivery system [6, 20].

However, researchers have pointed out that the fairly primitive discourse structures underlying most asynchronous conferencing systems limit the current state of the art of computer mediated communications [33, 34]. They propose that, "The goal of a collaborative discourse structure is to provide a template for the group discussion so that the majority of the discussion can be captured and categorized." In addition, "Such a structure would incorporate functionality to allow a group of users to thoroughly explore and analyze a problem domain by following a discourse structure they could design, maintain and evolve as the knowledge structure for that particular domain." [34]

CSILE (Computer Supported Intentional Learning Environment) is one network-based learning system that stands out in facilitating knowledge-building and collaborative discourse. The system claims as a central feature that "The flow of the information allows for progressive work on a problem, with ideas remaining active over extended peroids of time and revisited in new and unexpected contexts" [30]. To facilitate progressive building of knowledge through collaborative discourse, CSILE provides features that condense the discourse, sustain it through interruptions, and give it continuity over time [30, 31]. Some of these innovative features include automatic source referencing for preserving the centrality of the author's idea, crediting previous contributors, and providing historical accounts of knowledge building; tagging, linking, annotating, and retrieving of contributions for dealing with information overload; and specifically designed learning scaffolds such as theory-building, constructive criticism, and debate to support social and cognitive operations that further understanding. Many of these principles and features are shared with the design of TextWeaver.

However, most of the current web-based learning systems focus on the presentation of prepared materials in various formats while little attention is paid to tools that facilitate efficient and effective online discussion. Just as speech is the backbone of classroom education, and presentations supplement it, so online, writing will continue to be the backbone of the educational experience and presentations will serve as supplements, not replacements for the human interactions that are essential to learning [16]. Many researchers note that text-based communication provides a powerful means for interacting with others and with academic subject matters, for facilitating higher-order learning, and for conveying social information in knowledge communities [10, 11, 15, 18, 25]

But if discussion is still the backbone of online education, why has so little attention been paid to it until recently? This is understandable given the way in which people are being introduced to online education today through programs which emphasize presentation techniques. Trainers focus on helping teachers use these techniques and rarely emphasize the management of online discussion. When the day comes to begin the class, teachers discover that while they have beautiful presentations, they have rather primitive discussion facilities. They often don't know how to use these tools well and find online discussion very time consuming [14].

Over the past five years many Internet-based learning systems have emerged on the market. They are now

generally called instructional management system (IMS). Among these systems some of the most widely adopted are WebCT, BlackBoard, Learning Space, and intraLearn [26]. An online comparative study provides a feature comparison of some 56 IMS systems [26]. To gain market share, many of these systems keep a fast-growing feature list. While bells and whistles are sprouting like bamboo shoots in order to gain favor with the administrators who make purchasing decisions, most of these systems have paid little attention to improving text-based asynchronous discussion facilities (called "discussion forums"). Yet these are one of the most used tools if not the most used by online teachers and learners.

Although all of these systems include online forums, most are not very different from the early newsreaders built for users to browse online newsgroups. These discussion tools provide very basic functions for viewing (e.g., sorting by date or author and threaded view), composing (e.g., primitive text editing), and grouping discussion contents (i.e., categories and subcategories by topic). Some more sophisticated discussion tools such as those provided by Virtual-U offer additional options such as viewing all messages or unread-messages by date, reverse-date, author, or thread [35]. Also some of these tools allow a user to keep the list of messages in view while reading individual message(s). This enables a user to work on details (e.g., reading a message) without losing the context (e.g., list of messages). Nonetheless, reading with multiple messages displayed and composing at the same time without opening multiple browser windows is either impossible or very difficult. However, some of these discussion forums do provide ways to hyperlink messages or quotations from message(s) when composing. This feature is valuable for facilitating collaborative discourse. Unfortunately, the procedures for accomplishing such tasks are often cumbersome or non-intuitive.

In addition to the general problems of reading and composing, we have also identified problems associated with assigning keyword(s), reuse of discussion materials and content, and working offline. Here is a description of these four types of problems with current software.

First, composing and reading at the same time is difficult. Unless one has a huge screen on which to open multiple browser windows, one sees only a single message while replying, not several related messages. It is inconvenient to capture one's thoughts in writing while reading multiple messages, so people often don't try to do so. The result is that ideas and reactions which occur to the reader when he or she is face to face with incoming messages are often lost by the time a reply is written. The small box in which one is usually expected to compose a reply offers only the most primitive word processing features. It is difficult to quote from multiple messages in replying and if there is a problem on the phone line or with the host computer, the work is lost.

Second, everyone is expected to keyword their own contributions, but authors' keywording is often unreliable and standardizing keywords in a group is difficult. This is significant since archived discussions can be a useful resource for learning if they can be easily reviewed and materials of special interest recovered. Keywords are supposed to make this possible, but rarely succeed. To be effective, the burden of assigning keywords should not be imposed on the author, but rather, it is a task for the reader who will later want to make use of them.

Third, teachers must spend a great deal of time typing in text and organizing files for teaching an online course. But they are offered little software support for reusing materials in future iterations of their courses. Support for reusing materials and discussion contents is not just a matter of efficiency. It also facilitates the continuing improvement of these materials and contents.

Fourth, almost none of the existing instructional management systems provide offline capability. This is troublesome for the composition of lengthy and complex messages since the longer one stays online, the more chance there is of a broken connection. This is a still greater problem in foreign countries with line charges by the minute and unreliable phone connections. Obstacles to working offline inhibit the globalization of online education.

To address the problems identified above, the next section proposes a new design for online discussion forums, which we call TextWeaver.

3. Description of the TextWeaver

TextWeaver is an environment for online discussion. It is designed to allow users to read, compose, organize and reuse discussion items and related files flexibly and interactively, both online and offline. The basic concepts and the design were presented at the annual meeting of the American Association of University Professors in Washington DC, June 2000 [16] as well as a few online public seminars hosted at Global Educators Network (GEN) in March and June 2000 [19]. (GEN is a web-based educator's community with participants from over 40 different countries.) These concepts and the design were well received. Many participants are looking forward to using the final product. Subsquently, some of the ideas have been prototyped or are being developed and others are in the process of being specified. Most recently we have received a three-year grant for the implementation and evalution of TextWeaver from the Fund for the Improvement of Postsecondary Education (FIPSE) of the U.S. Department of Education [17].

The design of TextWeaver has two specific goals:

First, it is to produce and disseminate a new type of discussion software offering features that make online discussion more convenient for teachers and students. Specifically, the primary aims are to make it easier to:

1. respond to multiple messages
2. quote from comments by others in reponding to them
3. review the discussion by user selected topic or keyword(s)
4. compose lengthy comments more securely
5. re-use teaching materials deposited in the forum in later repetitions of the course.

Second, it is to facilitate and encourage the use of a specific pedagogical technique called "weaving," described below. Although many teachers consider this technique uniquely effective in online discussion, it is not well supported by existing software.

The following sections describe the basic design of the TextWeaver and address the four problems identified earlier with existing designs.

3.1. Main layout

The user interface of the TextWeaver consists of three main components/panes. They are the Organizer, the Reader, and the Composer. Figure 1 shows the layout of the user interface.

The Organizer is the place where conferences are organized and their related keywords, files, and materials are indexed and displayed. The layout of the Organizer is based on a tab structure. Each tab represents a distinct functional module centered on one main task. The main functions are the Keyword module with which the user can annotate the text with keyword(s) while he or she is reading or composing messages, and the FileCabinet module where the user can save and store course related materials, messages, or private notes as files. The keywords or the saved files are organized hierarchically according to conversation topics or courses/conferences. The user can easily switch between tabs while working within the Organizer.

One purpose of using a tab-based structure is to make possible the addition of further functionalities while preserving the basic look and feel of the software. Additional tabs in the Organizer pane can give access to other functions, for example, a readily visible list of abbreviations to be used in real-time chat sessions or asynchronous discussions, and a clipboard storage area to display and allow access to recently copied and cut text.

The purpose of the Reader is to provide the user with multiple ways to sort and view the messages of a conference. The Reader pane consists of two sections: message header and message body. The upper part shows the list of message headers and the lower part shows the message contents. These headers can be sorted by date, reverse-date, author, keyword, and topic. Users can also specify the Reader to display a set of messages under a date range (e.g., last week or last day), an author, keyword, or topic. This allows a user to separate the contents of interest at a particular time from other material, so as to better focus on the currently relevant work context. The lower part of the reading pane displays the content of a single message or a group of messages according to the selected view mode chosen by the user. The user has the option of closing one of these parts of the reading pane in order to enlarge the other.

The user writes replies, new messages, or private notes in the Composer pane. The Composer resembles a standard word processing tool such as WordPad with the usual editing and formatting features. The user can queue messages in an outbox when offline and send messages when online from the Composer. In other words, writing in a discussion forum should be a lot more like using a good e-mail client such as Eudora where one has special facilities for quoting and commenting. The difference is the necessity of handling responses to multiple messages simultaneously.

Each pane can be minimized, maximized, sized, positioned, or closed individually based on the user's present need for screen space and focus of the activity. TextWeaver provides a variety of functions via menu bar and keyboard shortcuts, and a text-sensitive menu via right mouse clicks.

We will now offer a detailed description of how TextWeaver addresses our design goals in the following four areas:

1. Reading and composing;
2. Keywording and weaving;
3. Material storing and reusing;
4. Working offline.

At the end of this section we will describe a typical scenario of how to work within the TextWeaver.

3.2. Reading and composing

In order to make notes conveniently, reply to messages, or compose new messages while reading, users should be able to work with both the Reader and the Composer at the same time. The TextWeaver therefore allows a user to interact with the Reader and the Organizer while working in the Composer. In TextWeaver, instead of replying to only one message at a time, participants can reply conveniently to multiple messages. Users can look back and forth at posted messages or other materials on which they want to comment as they write. They can select passages from the reading window and drag and drop them into the composing window. This makes it easy to comment on quotations from the messages to which they are responding. The quotations from previous messages will

be automatically hyperlinked to their original contexts, which enables readers to go back to the original messages to which the reply is addressed.

possible to the marks and comments readers are accustomed to writing in the margins of books as they read.

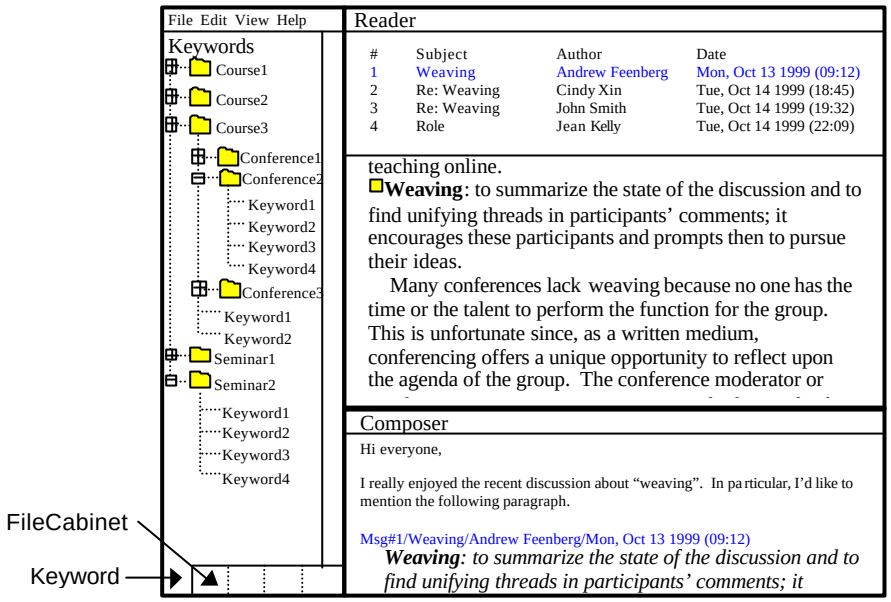

Figure 1: The user interface of TextWeaver™

3.3. Keywording and weaving

Keywords are essential for reviewing items in a discussion forum. Turoff notes that effective discussion structure should allow individuals to classify their contributions into meaningful categories that structure their relevance and significance according to the nature of the topic, the objective of the discussion, and the characteristics of the group [32]. This notion supports the technique we illustrate here, called "active reading." In active reading, keywording is not the responsibility of the author of the text but of the reader. The reader can keyword the text for his or her own future review much more effectively than the authors.

An initial list of keywords can be supplied by the teacher and supplemented by the student. The keyword list is displayed in the Organizer pane. With the Organizer, Reader, and Composer panes visible at the same time, the user can work interactively with all three modules concurrently. The user keywords a selected passage of text in the Reader or Composer by assigning a keyword or multiple keywords to it from the menu or by dragging and dropping keywords onto it. To show that the text has been marked, a yellow "post-it" note pops up behind the selected word. The user can open the note to view the keyword it contains, and add comments on the keyworded text. As they read, users mark what interests them, for example, exciting ideas or material relevant to an assignment. The goal is to make keywording as similar as

This technique is used to create hypertext stacks of related materials. When the time comes to review materials that have been keyworded in this way, the user double clicks on a keyword to start a review session. The review works its way back through the conference to show all passages marked by the chosen keyword, starting with the most recent. More complicated or less used operations, such as searching based on keyword(s), printing keyworded passages, saving them as a file, reviewing them in different orders can be made available from the menu.

Reviewing hyperlinked materials organized by keywords is particularly useful for composing what we call "weaving" comments.

In face-to-face settings, the fast pace of discussion and problems of time sharing constitute major obstacles to mutual understanding. We cherish those rare individuals who can sum up the discussion periodically, recalling what has been said and pointing out the similarities and differences between the various ideas that have been brought up. Such interventions put participants in touch with each others' ideas, recognize their contributions, and shape a consensus [12, 13].

This summarizing activity, called "weaving" in online discussion forums, is considerably easier on the Internet where the record of the discussion is available for retrieval and study. The keywording features described above are intended to facilitate the composition of weaving comments. Weaving can help the teacher address

the difficulty with which students focus and interact, while also introducing sophisticated concepts and methods in the course of commenting on students' own contributions. Weaving comments can summarize the state of the discussion, compare and contrast the various ideas expressed over a definite time period, and launch the discussion into a new phase on the basis of what has been achieved. Weaving comments are among the best techniques available online for enhancing dialogue among students, building the understanding of a discussion topic, and advancing the agenda of the course. Students can be assigned to write weaving comments, an excellent challenge to their ability to engage with the ideas of others. This is a valuable way to fulfill the dialogic potential of online education.

Another pedagogically interesting use for the keyword function resembles the way in which CSILE designs learning scaffolds to support and facilitate knowledge building processes. In this case, teachers give students a set of predefined tags or headers. These tags or headers can be used to guide a specific learning activity such as a debate or problem solving session. The tags and headers can be organized in the same way one organizes keywords. The use of these tags and headers can help students to focus their thinking, lead to more critical and creative discourse, and better awareness of their fellow students' state of mind, all functions of more effective communication. Teachers can also use them as a means to assess students' progress in learning and understanding.

3.4. Material storing and reusing

The Organizer gives access to virtual files in which to store and organize texts for later re-use. We call this the FileCabinet. The FileCabinet can save and store course related materials, conference messages, and notes written from the Composer. Stored materials can be organized under different folders based on course, conference, file type, etc.

The user can cut and paste or drag and drop items – whole comments or passages – from the reading and the composition windows into the FileCabinet. There the items can be labeled to make it easy to find them later. For example, the teacher might decide to use the same topic raisers in the next semester's repeat of the course. Each week they are sent not only to the conference but also dropped into the FileCabinet under "Topics" and labeled as Week 1, Week 2, Week 3, etc. When the course is offered again, the teacher can drag and drop them to the composition window and send them back to the forum.

This points to one of the unexploited advantages of online education: at least some of what the teacher says can be re-used. In contrast, classroom lectures require the teachers' presence and they take the same amount of time no matter how often they are repeated. But online teachers can save time through re-use. The frequent complaints about the time demands of online discussion could be addressed at least in part in this way.

3.5. Working offline

Many developing countries have expensive Internet services, poor telephone connections or unreliable electrical supplies [3, 9]. In Europe and Japan, line charges for local calls make it expensive to use the Internet. If we want online education to prosper worldwide, it is essential to address these problems. The TextWeaver is designed for teachers and students to work both online and offline. When online, the TextWeaver will synchronize with the central server either automatically downloading all unread messages and new course materials or downloading a subset according to specific instructions given by the user. The user can choose to stay and work online or go offline after the synchronization. Whether online or offline, the working environment will have the same look and feel. With the offline function, users can continue working for many hours on all needed course/conference materials without worrying about expensive telephone charges. They can resume their work from wherever they were interrupted by a power or telephone line outage.

3.6. A usage scenario

Here we describe a typical scenario of how to work within the TextWeaver. For example, a user – let's call her Julia – prepares to download the new messages in her online course. She sees from a status report on waiting messages that there are quite few of them. As she has plenty of time today, Julia sets the Reader to download and display all new messages chronologically and she then reads them one by one in the scrollable reading window.

Since Julia has a dial-up connection and expects a phone call, she signs off and works offline.

As she reads she finds quite a few interesting ideas and comments. Some of these ideas and comments are related to messages from previous days, which she has already categorized under various keywords. She tags these related messages under those existing keywords by dropping the relevant keywords on significant passages. There are also new ideas in some of the messages. These are assigned new keywords which she adds to the keyword list in the Organizer pane. Julia decides to reply to some of these new ideas right away in two different messages. As she reads, she drags and drops a few passages into a composing window and writes some sketchy notes to herself. She then opens up a second composing window, drags and drops some other passages there, and writes some more notes. Julia continues with

these activities until she finishes reading all the new messages.

Julia now wishes to concentrate on writing her replies. She reviews the quotations and her own brief comments. There are a few things she finds unclear and she decides to go back to the original messages and check her understanding of the text. She does this by clicking on the hyperlinked quotations and this takes her back to the original context of the comments she has quoted.

As she reviews the messages, she discovers that there is an emerging theme in the discussion which brings together many of the ideas expressed over the last week. To make the linkage among different participants' ideas, she opens up more messages/comments under several related keywords. Julia can now review both old and new messages, scrolling them back and forth in the reading pane as needed. Julia decides to close one of her two composing windows and instead of responding to the new messages in separate replies, writes a weaving comment in the other composing window exploring the common theme she has identified in the previous week's discussions. Before she sends her responses, she considers whether what she has just written could possibly be useful in a different occasion or context. She knows she will have to write a paper later in the semester. Perhaps her weaving comment is the core of that paper. She decides to save it as an individual file in the FileCabinet under the name "Paper topic." To do this, she clicks on the FileCabinet tab of the organizer, bringing up the list of files and folders. She adds her new file under the folder for her course and drags and drops the reply from the composition window to it. Julia then queues her replies to her outbox and posts them to the forum when she next goes online. This whole process took slightly over an hour, but participation in the conference is half her grade. It was worth the time and effort.

4. Pedagogical implications

Many of the features described above are for convenience and efficiency. However, the most important feature, keywording, is far more than a matter of convenience and reflects pedagogical needs identified by many students and practitioners in the field. Like classroom discussions, online discussions can be used to communicate an educational agenda. Teachers can provoke and guide discussion by offering conceptual bridges between students' ideas and between them and the concepts and methods of an academic field or a community of inquiry. This is a form of collaborative learning better suited to the online environment than "lecturing" – that is, writing long documents for students to read online or presenting canned materials, techniques which rely on the referential aspects of networked computers. Collaborative learning of this sort is rooted in the notion that knowledge is socially constructed through negotiation among members of a community of knowledgeable peers, negotiation at the boundaries among knowledge communities, and negotiation at the boundaries between knowledge communities and outsiders who want join them [7].

Unfortunately, it is not easy to manage online discussion. Some teachers adopt a passive role, only responding to questions about course procedure. Although restful for the teacher, it is a peculiar idea of pedagogy that would have the teacher abstain from substantive interventions that introduce students to the concepts and culture of the field. In the absence of strong leadership from the teacher, discussion often fails to get going in many online classes [2, 4, 16, 24]. When discussion does engage the students, without leadership they sometimes have difficulty staying on subject, understanding and responding to each others' comments, and feeling a sense of recognition and accomplishment. Research studies on how best to lead successful online discussions have identified helpful techniques [2, 4, 24]. The TextWeaver is designed to facilitate one of the most important and certainly the most difficult of these techniques, the writing of "weaving" comments.

One would think that given its widely recognized pedagogical importance weaving would be well supported by online educational software, but in fact this is not the case. The weaver faces a mass of documents sent by many different authors in which are embedded many remarks worthy of comment, but there is no easy way to see them all online while composing or to get them all into a writing pad to prepare a synthesis and reply. Currently, weaving comments are most often prepared by marking up printouts, a laborious procedure, but necessary in the absence of any easy way of working with the archive online. An interface which favored weaving would encourage dialogic interaction in educational conferencing.

The keywording feature of the TextWeaver accomplishes this goal with a seamless merging of hypertext and online discussion. The TextWeaver facilitates access to the conferencing archive, a currently very much underused feature. Once access is made easier, users will be encouraged to study the archive and to use it for various purposes, including the construction of weaving comments that enhance interaction and the exchange and convergence of ideas.

5. Evaluation method

The TextWeaver software will be built as an open source product under the recently received grant from the U.S. Department of Education. Once built, it will be distributed and evaluated. The evaluation will investigate the three dimensions of acceptance: use, subject

satisfaction, and benefits. These dimensions were determined by early evaluation work on computer-mediated communication [22, 23]. The evaluation of the use of the software examines its effectiveness and efficiency in performing its intended tasks. Subject satisfaction concerns the extent to which the users are satisfied with the software and with their educational experience in using it. These two sets of evaluations contribute to the usability study of the software. Benefit evaluation examines the pedagogical effects of the software on teaching and learning. One of our central research questions concerns whether and to what extent the use of the TextWeaver promotes online interactivity and engaged collaborative discourse.

Rafaeli and Sudweeks argue that "Interactivity is a theoretical construct that grapples with the origins of captivation, fascination, and allure that can be inherent in computer-mediated groups" [29]. They claim that interactivity plays a role in making a network community attractive and in generating its growth patterns.

To measure interactivity, researchers apply the autoassociative neural network (ANN) to explore threads and the types of messages that typically initiate or contribute longer lasting threads [5]. ANNs are special kinds of neural networks employed to simulate and explore associative processes. They can be trained by large data set (e.g., thousands of newsgroup messages) to create typical messages under different scenarios. In particular researchers have defined the following measures of the nature of threads:

1. *reference-depth:* how many references were found in a sequence before this message.
2. *reference-width:* how many references were found, which referred to this message.
3. *reference-height:* how many references were found in a sequence after this message.

Based on these measures, a message may be considered "good" if it is referenced by at least one other message, or "bad" if it is not referenced at all. To examine the interactive patterns of messages, earlier work by J. A. Levin, H. Kim, and M. M. Riel called *intermessage reference analysis*, not only counts the number of references to a message, i.e. *reference-width*, but also the number of references made by the message to previous messages [27]. Both quantities are important measures of the quality of weaving comments. Good weaving comments should draw as many participants' contributions together as possible, establish common ground, and identify discrepancies and differences. Furthermore, good weaving comments should function as a jumping off board and initiate the next round of discussion. In this context, we hypothesize that TextWeaver promotes the composing of quality weaving messages.

Moore defines three types of interaction with regard to learning: interaction between the learner and subject matter, interaction between the learner and the expert/teacher, and interaction between learner and learner [28]. Later researchers argue that there are essentially two types of interaction – a learner's individual interaction with content and a learner's interaction with others about the content [4]. We hypothesize that TextWeaver is suited to promoting engaged collaborative discourse through both types of interaction. Some questions to be asked in this context are whose messages are referenced, who references whom, what are the levels of engaged collaborative discourse, and how it progresses from one level to the next.

The evaluation of the TextWeaver's impact on interactivity and engaged collaborative discourse will be conducted through several cycles of implementation to compare classes using conventional discussion forums and those that use the TextWeaver. Because the adoption of new technologies often fails to achieve implementers' expected goals in the first round of implementation due to the overhead of learning and adaptation of the software, it is important to test the effects through several cycles of implementation [8].

We propose the following hypotheses which we will be testing in the course of the evaluation:

Hypothesis 1: The learning outcomes of a class using TextWeaver will be significantly better that those using conventional online discussion forums.

Hypothesis 2: The outcomes of the later offerings (e.g., third or fourth attempt) of a class using TextWeaver will be significantly better than those for the early offerings (e.g., first or second attempts).

The basic evaluation techniques include online transcript analysis, computer-generated usage data analysis, questionnaires, and interview data analysis. Rich information about the teaching/learning process and outcomes is deposited in the online transcripts. Analysis of this data will give us valuable insights into individuals' intellectual progress and group interaction. Computer generated usage data record individuals'interaction with the software: how frequently, how long and in what sequence they interact with the system. This provides us the data source to study online and offline behavior. Knowledge learned from the study will help us to understand learning/teaching needs and styles and improve the design the system. Questionnaires and interviews are integral parts of our evaluation. Demographic data will give us the basis for studying individual differences. Specific questions concerning the three dimensions of acceptance will also be posed. Interviews with individual teachers and students will give us in-depth knowledge of their attitudes, feelings, and experiences. Data collected from different sources using

different techniques will give us the basis for triangulating and validating our results.

6. Conclusion

Software is not just a tool. It also shapes behavior. It is true that one doesn't have to do what the software makes convenient, but most people do follow the lead of their software. If the software makes it easy to write weaving comments and to re-use text, these activities are likely to occur far more often. If there are no facilities for weaving or re-using text, then it is much less likely to happen. Thus we can use software to quickly guide teachers toward an appropriate online pedagogy. Programs such as Blackboard and Web CT have already done that as far as presentation and contextualization are concerned. The software helps teachers see right away that they have to offer a syllabus and useful documents on line and it gives them a good way to do that. Now we need to do the same for the discussion forum. We must provide teachers with software that guides them toward an effective online pedagogy.

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