A Virtual Margin for Knowledge Work on the Web: Design, Implementation and Usability Testing

by

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Abstract

Applications like Knowledge Forum enable a group of people to work together in a collective effort to improve their ideas and develop their understanding. One of the primary features of these applications is a communication mechanism that enables the group members to discuss multiple topics via a system of publishing messages. This study considers the usability and usefulness of a virtual margin added as an interface element on the right side of Knowledge Forum windows. The virtual margin provides each group member with their own private writing space adjacent to the space containing the public notes. For the study, a group of graduate students used Knowledge Forum, with its interface modified to include the virtual margin, in a knowledge building exercise. Their interactions with the virtual margin and the comments they wrote in it are discussed. Additionally, several potential new features are described and a longer term study outlined.

Acknowledgements

We are here to help each other get through this thing, whatever it is.
— Mark Vonnegut

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1   Introduction

How do I know what I think until I see what I say?
— Edward Morgan Foster

The World Wide Web, or simply "the web," is proving the veracity of John Gage's adage that "The network is the computer." Applications that were once designed to be used "stand-alone" on each individual's computer are now commonly implemented using web technology. Whereas stand-alone applications are self-contained systems, web applications are distributed systems in which a web browser accesses a web server, which in turn accesses the application's files and data, formats them, and sends them to the web browser for interpretation and display to the application user. Rather than being dedicated to a particular application, web browsers provide an extremely flexible general purpose application environment that can be used for playing games, trading stocks, obtaining directions, searching for information, and accessing forums where people communicate via messages with each other, to name only a few types of uses.

The class of applications where people collaborate on a shared project is commonly referred to as "groupware." Web browsers' capability and their ubiquitous nature makes web technology a very attractive platform for groupware applications, particularly where communication outside the classroom is desired. Groupware applications provide central administration, many-to-many communications exchange, and support a variety of information sources and data formats at low cost. One of these groupware applications is Knowledge Forum. It has its origins in CSILE (Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989) which predates the web (Scardamalia, 2004).

1.1 What are Knowledge Building and Knowledge Forum

Knowledge Forum is specifically designed to support the pedagogy of knowledge building, as advocated by Scardamalia and Bereiter (Scardamalia, 2004). In knowledge building, the core idea is "improve-able ideas." That is, any idea can be improved, and by improving each others' ideas the group members will co-create, or build their knowledge together. Knowledge Forum has several features designed specifically to facilitate this type of knowledge development.

1.1.1 Knowledge Forum requires 'Total Publicity'

Groupware products like Knowledge Forum provide a set of forums which Knowledge Forum calls "views." In these views participants are able to publish notes (also called postings) for others to read and respond to. A posting consists of a title, which is visible in the views in which the note is published, a textual message, and possibly related files supplied by the poster. Each view has a name which describes the topic that the notes within it address. Within a view the postings are arranged in hierarchies that are intended to indicate sub-topics of discussion, commonly called threads. A thread consists of a top-level note, that begins a discussion, and potentially a series of responses called "build-ons." A build-on may in turn also have one or more responses as well. Each build-on is placed below and indented some spaces relative to the position of the note that it builds on, as shown in the following figure.
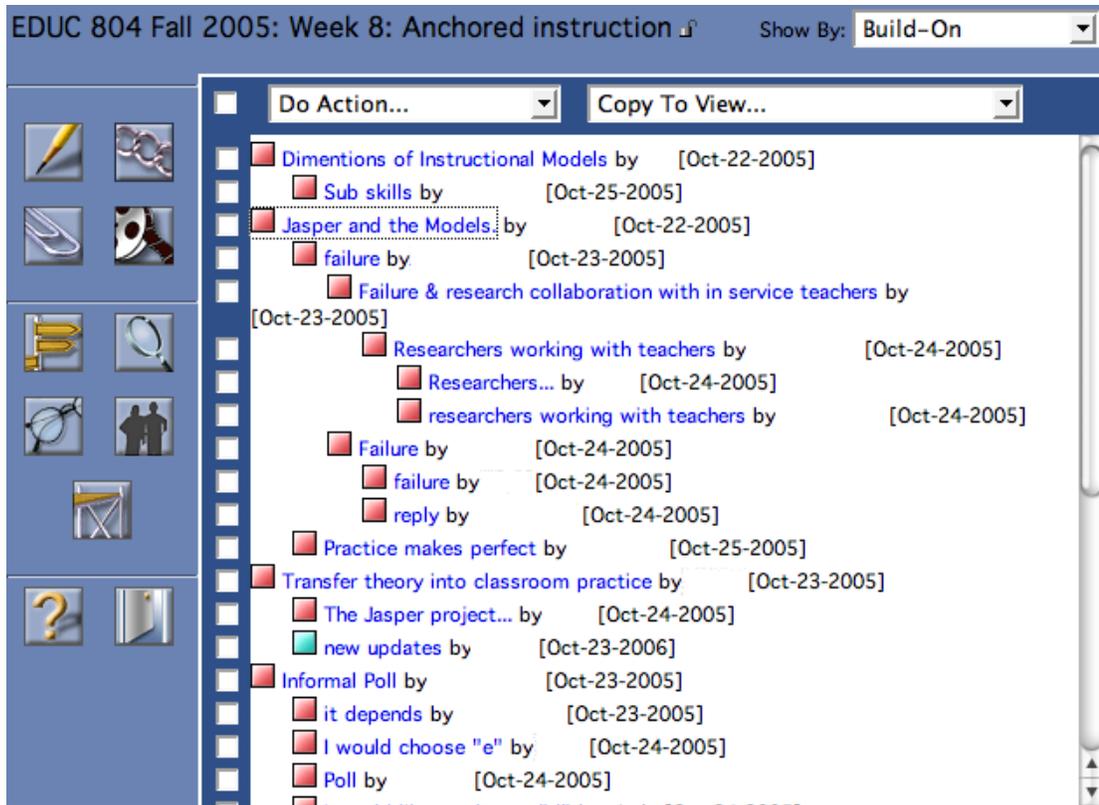
Figure 1: A Knowledge Forum view showing multiple threads.

In general any Knowledge Forum participant can read any note in any view in the database. There is, however, one exception to this rule. A view can be made private which restricts access to a specific list of participants. As is the case for the public views, anyone who can see the private view can also see the notes within it as well. There is no mechanism to make a note private to its author. Nothing saved in the Knowledge Forum environment can be kept private.

Notes are the primary way in which Knowledge Forum participants communicate with each other. There is, however, another messaging facility called annotations that participants may also use. In the author's experience, these annotations are generally used for short messages (typically a sentence or two) that don't warrant their own note. These annotations are contained within a note, and are attached to a particular location. Their presence is indicated by a little yellow icon where the annotation has been added. Clicking on the icon opens a little pop-up window which contains the text of the annotation. Just like the Knowledge Forum notes, annotations can be made by anyone and are visible to all the forum participants.

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Knowledge Forum is not unique by insisting on total publicity. It seems to be the mode in which most groupware applications work. There appears to be a lack of acknowledgement (or even a denial) on the part of groupware developers of the potential for private or personal messages to foster public contributions of high value. In the effort to enable and promote communications between people, the ability to store context specific messages for one's own private use in developing ideas has been lost.

1.2   Overview of Annotations

While the custom of writing annotations might be as old as writing itself (Jackson, 2001), the annotation facility as implemented in Knowledge Forum produces annotations that are very different from those that have been made in printed volumes for centuries. Whereas annotations historically have appeared in the margins and between the printed lines on a page, where they are always visible and can't be ignored, the text of Knowledge Forum's annotations are hidden—indicated only by a small yellow icon that signals their presence. Viewing the annotation text requires a deliberate choice on the part of the reader, who can easily choose not to make that choice. Making a new annotation is far from effortless as well. This point will be discussed in greater detail later.

Just as with paper based annotations, "[s]hared annotations associated with networked information resources allow people to communicate about what they see and read" (Roscheisen, Mogensen & Winograd 1995). But in a web forum environment this is redundant. The discussions in a Knowledge Forum view exist for the purpose of people communicating about what they see and read. That is the function of the notes. A public annotation system in addition seems to muddy the waters on the intra-group communications protocol.

There is nothing about annotations in principle that requires them to be made public. For some types of annotation, there is value just in the process of making the annotations themselves. For instance, "[a]nnotations used to be taught as part of the routine of learning. Marking, copying out, inserting glosses, selecting heads, adding bits from other books, and writing one's own observations are all traditional devices, on a rising scale of readerly(sic) activity, for remembering and

assimilating text" (Jackson, 2001). These uses of annotations are consistent with Jonassen's conception of Mindtools, as critical thinking devices that engage the mind (Jonassen, 2000). Engaging the mind is certainly valuable in knowledge building pedagogy.

There is "...another of the blessings of annotation to annotators, namely the outlet that it gives them for expressing their feelings... It is a cheap and convenient form of therapy. ... it vents feelings, demonstrates and improves self-awareness, and constitutes a permanent record of the reading experience (Jackson, 2001)." In a series of discussions where ideas are attacked and defended, it could be very useful to have a ready-to-hand outlet for thoughts and attitudes one feels like expressing, but are not appropriate for knowledge building discourse.

2   Background of Study

The palest ink is better than the best memory.
— Chinese proverb

The author attended three graduate level classes, EDUC 804, EDUC 853 and EDUC 864, in which Knowledge Forum was used for on-line discussions. For the project assignment in EDUC 853 the author designed a new knowledge building environment which extended the features of Knowledge Forum, and in addition incorporated elements of effective web design that have been learned since Knowledge Forum was written. One of the features of this new knowledge building environment as conceived was the virtual margin.

The technical feasibility of the virtual margin was demonstrated by the author in a pilot study in March 2005. The results of that study were presented at the Institute for Knowledge Innovation and Technology (IKIT) during the Summer Institute 2005 (Appendix 4). In the pilot study, two potential virtual margin interfaces were compared. The major lessons learned were that the differences between the two interfaces investigated did not affect people's usage of it, that additional functionality beyond plain text for margin notes was strongly desired, and even though the text input form element was familiar to the participants, the unfamiliar way in which it was presented required some explanation. Responses to these lessons will be addressed in the appropriate parts of the Method section.

2.1   Structure of Knowledge Forum work in EDUC 804

The purpose of EDUC 804 (Appendix 5) was to provide an introduction to the field of Education and Technology. The course consisted of a series of readings and project work in a hybrid on-line and in-class format. Each week students were

assigned a paper or an article to read. For each of these readings they were required to post a reaction of about 200 words, to a specific Knowledge Forum view created for that week's material. The students were expected to read and respond to other students' reactions in this forum. When the class met, once a week, the students would discuss the reading and their reactions in person. While knowledge building was not an explicit goal in the use of Knowledge Forum, the structure of the class discussions encouraged that outcome. One particularly important feature, from a knowledge building perspective, of Knowledge Forum is called "scaffolds" which provide sentence starters intended to prompt particular kinds of contributions. For example the "theory building" scaffold, provided to the class, has sentence starters such as "I need to understand…" and "This theory does not explain…" While use of these scaffolds was not actively encouraged, several students did choose to use them on their own initiative.

2.2   How Might Knowledge Forum Better Support Knowledge Building?

Knowledge Forum and other applications that mediate communications between people are part of a class of software known as "Social Software" (Allen, 2004). Historically, computer applications were designed for maximum computing efficiency in order to minimize the computational cost (measured in disk space and CPU cycles). Applications were designed in the expectation that people were putting information into or getting information out of the computer. That is, the dialogue was assumed to be between an expensive-to-use computer (program) and the computer user, for purposes of accessing the computer's data store. In contrast, with social software, people are not communicating with a machine. Instead they are communicating *with each other* via machines. That sounds obvious, but it has some far-reaching and not-so-obvious implications for application design.

In order "… to create an effective and acceptable collaborative workspace, we must be cognizant of the kinds of social information (actions and behaviors) and the patterns of access to this information facilitated by our design, by the media, by happenstance and by the user community" (Lee, 1999). So it is not sufficient to only concern ourselves with the individual users and their interactions with their own web

browsers (computer interface), because optimizing the efficiency of the human-machine interface is no longer a primary goal. We are instead trying to optimize the conveyance and construction of ideas between fellow participants. Therefore we need to be sensitive to the idiosyncrasies of people in relation to each other and of the effects of the tools on those relations as they are employed in that communication.

To be effective then, a Knowledge Building Environment should maximize the group effectiveness at the expense of computer and network efficiency, or even individual preferences. This is a consequence of supporting collective construction of public knowledge in preference to individual learning (Scardamalia, Bereiter & Lamon, 1994).

According to Scardamalia and Bereiter, a Knowledge Building Environment is required to have the following features (Scardamalia & Bereiter, 2003):
- enhance collaborative efforts to create and continually improve ideas,
- exploit the fullest possible potential of ideas to be improved by situating them in worlds beyond the minds of their creators and compounding their value so that collective achievements exceed individual contributions,
- provide support for
    - the formulation of knowledge problems,
    - preserving ideas and making them accessible as objects of enquiry,
    - dialogue that is democratic and favourable to idea diversity,
    - constructive criticism and analysis,
    - organizing ideas into larger wholes, and
    - dealing with recognized gaps and shortcomings of ideas

The Knowledge Forum developers attempted to provide these abilities with the Knowledge Forum environment. Participants can put their ideas together to explore and demonstrate their collective understanding to each other and external observers. However, I would argue that the support for participants to preserve their ideas is undermined by Knowledge Forum's imposition of total publicity. Further, considering that the subject matter with which the participants are working in Knowledge Forum is usually new to them, supporting their individual cognitive processes as they work with unfamiliar concepts is even more important.

Working in a Knowledge Forum environment requires participants to review multiple notes, and potentially multiple views. In an active forum, it is very difficult to keep track of who said what in which posting. The effort to do so creates additional

cognitive load on the participants, and so decreases their resources available for learning (Sweller, 1988). Knowledge Forum seems to need a mechanism to aid participant's remembering which would allow participants to focus more of their cognitive effort on the subject matter rather than the communications medium. A memory aid would enable participants to better manage their cognitive load. "As long as the load is manageable, it is not the level of load that matters, but its source. If the load is imposed by mental activities that interfere with the construction or automation of schemas, that is, ineffective or extraneous load, then it will have negative effects on learning. If the load is imposed by relevant mental activities, i.e. effective or germane load, then it will have positive effects on learning" (Paas, Renkl & Sweller, 2004).

2.2.1 Importance of Remembering

Educational Researchers in the rationalist-constructivist tradition hold that knowledge is organized and structured by the learner, but even more than that, it is also domain specific and contextualized (Anderson & Krathwohl, 2001). From a Knowledge Forum point of view, the relevant domain is the subject matter of discussion and the context is the class, or more specifically the views within Knowledge Forum itself. Within the Knowledge Forum environment students are exposed to new concepts and ideas. Part of the job of Knowledge Forum is to help the students make sense of those concepts and ideas; to build on their own understanding and assist other students in doing the same. This understanding is built up over multiple sessions in which students review each other's postings and possibly contribute additional postings.

Each time students return to a Knowledge Forum view there is a period of re-orientation as they scan the list of notes for new contributions and they try to remember the significant aspects of the postings that have already been seen. Knowledge Forum helps in this process by flagging the postings that have been read with a different icon than the postings that have not been read. Knowledge Forum preserves and updates, the record of what has been seen for each student from one session to the next. In this way Knowledge Forum aids students' remembering by reminding them of what they have already seen. "Keeping data around from prior experiences is valuable, so that old experiences can be compared to new ones and a

new generalization can be formed. We need to be reminded in order to make sense of the world around us" (Schank, 1991). Features in a knowledge building environment that aid in remembering then, directly influence the "sense-making" that students do in that environment. Because "[i]ntelligence is fundamentally a memory-based process" (Schank & Cleary, 1995), supporting people's thinking by aiding their remembering is very important.

3   Design of the Virtual Margin

A designer knows he has achieved perfection not when there is nothing left to add,
but when there is nothing left to take away.
— Antoine de Saint-Exupéry

"User-friendly" and "intuitive" are phrases often used to describe desirable computer application interfaces. These rather nebulous terms are generally ascribed to an interface when users of the interface are able to accomplish their goals without undue frustration in the process. It used to be, and too often still is, the case that applications are designed for ease of implementation; to work the way that best fits the strictures of the computer that hosts them. "It took a long time, but as computers became more powerful and we learned more about how people used them, eventually, we started catching on to the idea that, instead of designing software to work in the fashion that works best for the machine, we could design software to work in the fashion that works best for the people who use it..." (Garrett, 2003). From this it can be said that a user-friendly interface is one that "makes sense" to its users—it does what they expect it to do and it works the way they expect it to work. Ideally, the virtual margin would be easy to use and work the way the subjects expect.

3.1   Design Goals

Physical tools have an important characteristic that computer applications don't have: you can see them. That is, the tool and its interface can be seen as separate entities. A computer application has only its interface to present to its user. There is no material object a person can look at to gain clues as to the application's purpose or operation. An application interface then carries a heavy burden. It needs to convey the application's purpose and operation in a language its users understand

without the benefit of a physical presence. The study of application usability has been developed to analyze how well this is accomplished.

Usability refers to how easy or difficult an application's interface is to use. It has five qualities (Nielsen, 2003):

1. **Learnability**: How easy is it for users to accomplish basic tasks the first time they encounter the design?
2. **Efficiency**: Once users have learned the design, how quickly can they perform tasks?
3. **Memorability**: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
4. **Errors**: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
5. **Satisfaction**: How pleasant is it to use the design?

These attributes have been summed up in a quote variously attributed to either Alan Kay or Adam Bosworth which says "Easy things should be easy, hard things should be possible." Usability, as defined by the International Organization for Standardization is defined in the 9241-11 standard as: "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (International Organization for Standardization [ISO], 1998).

The purpose of any tool, whether it is a car, can opener or computer application, is to facilitate the goals of the tool's users. As much as possible the tool should "stay out of the way" while it mediates the task at hand. Phrased another way, the tool users should be looking at and thinking about what it is they are trying to accomplish; they should not be looking at or thinking about the tool being used for the job. A well designed tool directs cognitive effort through itself, not into itself. That is, the effort goes into an object (the thing on which the person is acting) via the tool. The tool then, is the vector that propagates the operator's effort to produce the result in the object desired by the tool operator. The tool operator's focus is on the goal to be accomplished, not the tool used to accomplish it. A poorly designed tool in contrast, attracts attention to itself and so necessarily away from the user's goal.

This leads to what Krug calls his first law of usability, which is "don't make me think" (Krug, 2000). Every time a person has to stop and think about what to do

next or how to get the tool to do it, causes an interruption in their train of thought which in turn causes uncertainty and hesitation. Then if an action doesn't work as expected the person can become frustrated and develop resistance to going further. As Knowledge Building (Scardamalia, 2004) requires significant cognitive effort, anything that impedes that effort should be minimized or eliminated if possible. Conversely, anything that supports or encourages the Knowledge Building effort should be promoted.

In brainstorming, the intent is to quickly share as many ideas as possible so they can prompt more ideas. The important thing is the generative flow of new ideas. Only later are the ideas filtered and classified. In contrast, the objective in Knowledge Building is to improve, or build on, ideas. The approach is more structured and deliberate, as befitting considered thought. Participants are much more aware of how their contributions advance the group's understanding, and how they are perceived by their peers.

When students read Knowledge Forum postings, ideas and impressions associated with the text occur to them. These ideas and impressions can be grouped into three broad categories: "not worth sharing", "potentially sharable, but need to think about it", and "sharable." An impulse to make a response based on a sharable or potentially sharable idea can easily be side tracked or given up for a variety of reasons and cause potentially valuable contributions to be lost. In the time it takes to compose and save a new contribution, outside influences such as friends and family members or other obligations, can interrupt or distract resulting in the posting being abandoned.

The intent of the virtual margin is to support people's thinking by aiding their remembering, so that their ideas are forgotten less often. The central question posed by this study is, in the context of knowledge building, does the virtual margin meet the ease of use goal, and is it *useful* for private annotations in a knowledge building environment?

3.2   Annotations

The writer of marginalia acts on the impulse to stop reading for long enough to record a comment. Why? Because it may be done and has

been done; it is customary. Under certain conditions (subject to change) it is socially acceptable behavior. But it is seldom *required* behaviour; not all readers write notes in their books. Those who choose to make the effort to register their responses must foresee some advantage for someone; so the question of motive resolves itself into another question, *cui bono*? For whose benefit is it done? And that in turn leads to the question of the addressee. (Jackson, 2001)

There are three potential audiences for one's annotations (Wolfe, 2002). The first is other readers of the annotated work. Historically, notes made in a document's margins were a means for scholars to share information with each other and discuss the meaning of a document's text (Wolfe, 2002). With modern print publishing, where each reader has their own "original copy", the practice of sharing commentary via a document's margins has fallen out of favour. It is much easier to share commentary through alternate means such as letters and book reviews. The second potential audience is the author of the work being annotated. This is still practised in certain well defined relationships such as a writer and editor, and student and teacher. The third audience is oneself. Document margins remain a popular location for scholars and students to preserve their nascent thoughts and ideas prompted by what they read "…as a way of remembering or remembering to remember" (Marshall C., 1997). So much so, that "…people typically read and annotate printed documents even if they are obtained from electronic sources" (Marshall & Brush, 2004).

The margins of a printed document for annotations have several advantages that alternative locations lack. The first is that the annotations are persistent. That is, whenever the author of an annotation returns to the page where an annotation was written, the annotation will still be there in the margin. The writer need not make any explicit effort to preserve it. There is no risk that the annotation could become separated from its associated document. This leads to the second benefit, which is that the location preserves context. That is, annotations in a margin retain the context which prompted them initially. This helps the author's remembering what prompted them, enabling a train of thought to be resumed. Thirdly, there is a very low barrier to usage. One need only pick up a pen or pencil and commence writing. There is no (or almost no) "getting ready" process that would distract or impede a writer's intentions from being recorded.

Conversely, modern web interfaces generally lack any kind of editable margin-like feature. Anyone wanting to preserve a thought prompted by a web forum article, for example, faces a choice. Respond immediately by making a posting to the forum (if permitted), record the thought using another application, write it down on a piece of paper, or make a mental note. The trouble with mental notes is that they are too easily forgotten: they lack persistence and tend to lose context quickly. Paper is not much better. While ink and pencil are persistent there is no good way for a piece of paper to retain the web context which prompted its use. As a result paper annotations are often misplaced or forgotten, rendering them ineffective. Using another application has the same drawbacks as paper. The only association between the content of the annotation application and the content of a web forum is within the annotator's head. So again the annotations lose their context and are forgotten. As a result the choice devolves to respond immediately or forget the idea.

Knowledge Forum uses web forums to enable participants to share ideas and collaborate with each other. However, the interface does not provide a convenient means to record spontaneous or transient thoughts for personal use. Everything a forum participant types is either shared with all the other participants or is discarded when a posting is cancelled. In the printed realm, annotations start out as private comments. They remain the annotator's secret, so to speak, until they are allowed to leave the annotators' possession. Granted, an annotator might intend from the beginning that the comments would be shared. But this is a conscious choice, barring theft or death. It's a choice that annotators in Knowledge Forum do not have. There is no simple means for a person to preserve a thought for later consideration or to save a note as a reminder. Yet, such ideas could be, or could lead to new insights. However, because they are not saved or shared they are lost to the person who had them and the knowledge building community as a whole.

Similar to the margins of a book or journal, the virtual margin is envisioned as a simple and convenient way for people to record their thoughts and impressions in a private, context-relevant location with a very low threshold to use. Just as margin notes in a book allow one to record and manipulate one's thoughts in a manner that other locations do not; the expectation is that the virtual margin could have similar affordances. In a knowledge building environment, the hope is that the addition of a virtual margin would lead to more, and potentially better, knowledge building.

3.3   Some Examples of Web Annotation Systems

Annotating web pages is not a new idea. Tim Berners-Lee, the originator of the World Wide Web, said this in his original design proposal:

One must be able to add one's own private links to and from public information. One must also be able to annotate links, as well as nodes, privately. (Berners-Lee, 1989)

"Nodes," in this context are documents such as "a small note, summary article, or comment" (Berners-Lee, 1989). Today, almost 20 years later, web browsers, as a rule, do not provide support for annotations and there are very few modern web applications that support ad hoc commentary. Even those applications that do provide some kind of an annotation interface, do so in a cumbersome fashion that impairs their utility. As Vasudeva and Palmer observed almost 10 years ago, "...there is no easy way in HTML to render annotations on the sidelines of a web page, an annotation style that is quite natural to annotators of paper books" (Vasudevan & Palmer 1999).

The annotation services that have been attempted usually share the annotations with the other group members who are collaborating on an assignment or project, because of this, the annotations become another intra-group communications medium rather than comments, or reminders, that enable people to remember something significant to them. According to Wikipedia there are over 20 different web annotation systems ("Web Annotation," 2007). Six of them are briefly reviewed in "A Survey of Web Annotation Systems" (Heck, Luebke & Obermark, 1999). Six others will be discussed here.

One of the earliest web browsers, NCSA Mosaic, had group annotations and even included audio annotations on certain types of computers (National Center for Supercomputing Applications [NCSA], 1993.1). The annotations were entered and displayed separately from the web page content and were stored on, and retrieved from, a dedicated annotation server (NCSA, 1993.2). An early investigation into annotation interfaces looked at modifying a site's content to dynamically add annotations in a browser independent way (Schickler, Mazer & Brooks, 1996). This kind of strategy provided the basis for some attempts to commercialize annotations as part of the web interface, e.g. ThirdVoice, uTOK, hypernix, and Zadu (Cadiz, Gupta

& Grudin, 2000). Each of these examples is the kind of annotation where annotators communicate with each other following the historical model. The vendors tried to use annotations to build self-supporting communities. However, all failed to find a viable market and have since disappeared. Annotations are now absent from the contemporary web interface, with the exception of a few specialized implementations that will be discussed next.

The Firefox web browser (Mozilla, 2007.1) provides a facility for 3rd party developers to write extensions (Mozilla, 2007.2) in order to provide additional features. One of these extensions, called Wikalong, provides a wiki (wiki.org, 2002) environment that enables people to associate comments with web pages. A wiki is a web site that allows its visitors to edit its web pages as well as read them, typically with no editorial review before the changes are made public ("Wiki," 2007). Comments written in the Wikalong extension are stored on the Wikalong server that makes them available to everyone who is using the Wikalong extension and viewing the web page associated with the comments. The developers characterize it as a "wiki-margin for the internet" (Cappiello, 2005). It is very much in line with the approach described by the NCSA and the previously mentioned annotation systems. All comments are public and can be edited by anyone. In addition, the annotations are hosted on a server independent of the content being annotated. This contrasts with the remaining examples where the annotations and annotated content are hosted on the same server.

Knowledge Forum has a completely different style of annotation method. In this application, annotations are created by opening a dialogue window that contains a small text input box, entering the comment and choosing the text with which to associate the annotation. Once the input box is closed, a small yellow icon is placed next to the selected text to indicate the presence of an annotation. These annotations are publicly viewable and can be seen by clicking on the yellow icon. In this way, the comments remain hidden until the reader requests to see them. This process of creating and viewing annotations is somewhat cumbersome and tends to be used for short comments that don't merit their own posting note.

Fle3 is another application intended to support knowledge building (Leinonen, Virtanen, Kakkarainen & Kligyte, 2002). In this application annotations are added by clicking on an "Add annotation" link at the bottom of an article. This presents a page where annotations can be read and new annotations can be added.

Again, annotations are hidden until specifically requested to be seen, and then they are all publicly viewable. While each annotation is associated with a particular article, they are not viewed in the context of their articles. This creates a separation between article and annotation that weakens the relationship between them.

COSE is a Virtual Learning Environment (Stiles, 2007) that took another approach to adding comments to web pages. The COSE interface has a margin in which a variety of features are located. Among them is an icon which activates the Margin Notes annotation interface. It opens a dialogue box in which the comments may be entered. Once a comment has been entered and the dialogue box closed, the icon then indicates the presence of a comment. This comment may be kept private or shared publicly (Stiles, 2003). Entering and viewing of the annotations is again a multi-step process.

Moodle "… is a software package for producing internet-based courses and web sites … designed to support a social constructionist framework of education" (Moodle, 2007). An annotation feature has recently been developed for it called Marginalia (Glass, 2007). The approach the developer has taken is along the lines of a physical margin which contains the annotations. The main content of the page is on the left side of the browser window and down the right side of the page is a grey box where the annotations are placed. An annotation is created by selecting some text and clicking the "New" button. This creates a numbered entry in the margin with a small input box into which the annotation may be typed. The annotations are publicly editable and may be hidden or visible at the viewer's option by clicking an appropriately labelled button. The grey margin is always present.

The following table summarizes the prominent interface attributes of these five annotation systems. The implementation column might require some explanation. "Browser" means that the annotation content is rendered by the browser within the browser window's display area, called the "viewport". A "browser extension" is a program downloaded separately from the browser and when installed, attaches itself to the browser in order to provide some additional functionality. In Wikalong's case, the extension adds a new viewport, called a sidebar, beside the browser viewport. It is in this sidebar that Wikalong renders its content. Plug-ins such as Java, are also separately downloaded programs that install into the browser. In contrast to extensions however, plug-ins render their content within the browser viewport as part of the page that invokes them. In summary, plug-ins and extensions

are programs that provide additional functionality separate from the browser and render their content independently from the browser.

	Implementation	Annotations Publicly Editable	Annotations Hidden by Default	Annotations Displayed Beside Content
Wikalong	browser extension	yes	no	yes
Knowledge Forum	browser	yes	yes	no
Fle3	browser	yes	yes	yes
COSE	Java plug-in	optional	yes	no
Moodle	browser	yes	no	yes

Table 1: Summary of alternative annotation implementations.

All of these annotation and commenting systems require that annotators perform several actions before they start to type their thoughts. The risk with so many steps is that each step in the process is a decision point where the potential annotator can decide not to bother. Also, by giving the person something more to think about (the mechanics of the interface in addition to their thoughts they want to preserve) the additional cognitive load can cause the transient thoughts to be forgotten, leaving the person with an input box and nothing to put in it.

In most of these systems, each comment is hidden until it is specifically requested to be seen. This feature renders the annotations ineffective for reminding. In only one case does the system support private comments, and that as an option. Generally, the annotations are intended to be viewable by other people accessing the same page. Thus the annotations become an additional communications path for the group participating in the web forum. As a result these systems only tangentially support people's remembering. In contrast, the desire for the virtual margin proposed in this study is to get as close to "no interface" as possible. By minimizing the cognitive load imposed by the interface (Drommi, Ulferts & Shoemaker, 2005), the hope is that the barrier of use will be so low that it won't be an inhibitor. Readers would be able to focus on what they want to remember – not the mechanism for doing so. The intention is for the means to be "transparent" to the annotator.

3.4   Intended Affordances

There are profound differences in the annotations people make for their own use versus annotations they make publicly (Marshall & Brush, 2004). Even private annotations that are later shared undergo significant changes prior to being made public (Marshall & Brush, 2004). This implies that an annotation system intended for private comments requires different affordances than one designed for public annotations. "...support for a smooth integration of annotating with reading - is the most difficult to interpret from a design point of view; yet, it is potentially the most important. Until we, as system designers, get this right, it is likely that people will continue to annotate paper materials, even as they read materials in a digital library" (Marshall C., 1997). In the annotation systems discussed earlier, readers who wanted to enter an annotation have to make a conscious effort to do so. They have to think about what they want to remember as well has the process for entering the information into the system. None of this is automatic. Once the information has been entered, it becomes public which inhibits the entry of impulsive, or transient thoughts. As Donald Norman points out "design should not impede action" (Norman, 2002), and yet these annotation systems seem to do exactly that. By contrast, the virtual margin requires only that the input focus be placed within the virtual margin area before the annotation can begin. It is extremely easy to place the input focus within the virtual margin because it is always visible on the right side of the browser window and its size makes it a very big target. Once something has been entered into the virtual margin, it remains private to the person who entered it. Thus there need be no apprehension about what other forum participants might think to cause censorship of the thoughts placed there. This combination of features is intended to afford the ability for the forum participants to preserve their thoughts as they occur within the context in which they occurred—just as they can with a pen in the margin of a paper journal.

3.5   Expected Usage

As with paper margins, the presence a writable area on each web page provides a 'thinking spot' where ideas can be tried out, saved for later, edited,

collected, reminders can be added, supporting evidence for an argument can be accumulated, or a posting can be started. The main intent is to facilitate people remembering things that they want to remember, for whatever reason, in the expectation these things are, or could become, useful to them in the knowledge building process. At the same time, this writable area provides the means to work with one's ideas privately, to mold them or shape them prior to sharing them with others. So in addition to remembering, the virtual margin also affords exploring one's own ideas.

Because the virtual margin interface element is so different from the rest of the way Knowledge Forum and any other annotation systems work, the expectation is that the participants will want to see for themselves that the virtual margin works as it has been described. That is, that people will put some text in, close the window and re-open it to see if what they put there is in fact preserved when the window re-opens. Once convinced that it works, the participants will proceed to read the notes in the assigned view and make comments in the notes' virtual margins as they see fit.

Naturally, people will only know how they are going to make their best contribution after they have read several notes. In the course of reading those notes, they might chose to make some comments. As we have seen in Chapter 2, annotators have many reasons for making their annotations. For the assignment in this study, the comments are expected to be related to and reference the note containing the virtual margin, perhaps as a reviewer would do. It seems likely that annotations would be used for questioning a point in a note, or framing a comment that questions the reader's understanding. The virtual margin could be used for drafting a response to a note in preparation for writing a build-on. The virtual margin seems to be an ideal place to accumulate material in support of constructing an argument. The accumulated material could lead directly to a build-on or top-level note which would satisfy the assignment to make their best contribution to the discussion.

4   Implementation of the Virtual Margin

If a system doesn't have to actually work it can meet any other criteria.
— Jerry Weinberg

Knowledge Forum is implemented as a web application. This means that a person uses a web browser to send requests to a Knowledge Forum server which processes the requests, generates a response as HTML and sends that to the browser which then renders, or displays, it on the screen. This is the system into which the virtual margin has to "fit." In order to add the virtual margin to the Knowledge Forum interface either the HTML that defines the interface or the browser interface itself must be modified. There are only three places where the HTML that creates the Knowledge Forum interface can be modified: in the Knowledge Forum server software that generates it, "on the wire" between the Knowledge Forum server and the web browser, or within the web browser before the HTML is rendered in the browser window. Which method is chosen depends on how a variety of constraints on the system are handled.

4.1   Constraints

In implementing any software project there are constraints that shape the resulting application. In addition to the context outlined above, the virtual margin design constraints included:

1. No modification to the Knowledge Forum server software.

   Modifying the Knowledge Forum server software to include the virtual margin as part of its responses is the obvious way to implement the virtual margin. It has the advantages of changing the interface HTML at its source, which minimizes the number of software components and provides fast

performance. On the other hand, it has a serious disadvantage in the time it would take for the researcher to understand the Knowledge Forum source code well enough to introduce the virtual margin feature without compromising the integrity of the rest of the system. In addition, the Knowledge Forum server source code is a trade secret of Learning in Motion. Through negotiation with them access to the source code might have been possible. However, such access was considered unlikely and was not pursued. Further, even if Learning in Motion permitted the researcher access to their source code, it is doubtful they would permit the publication or distribution of the researcher's changes.

2. Standard browser capabilities, protocols and features would be used.

Modifying the HTML within the web browser would require some kind of alteration to the web browser, either an extension or plug-in. Extensions and plug-ins need to be distributed and installed in order to be useful. They are also browser dependent, meaning that a different extension, or plug-in must be written for each browser. These issues create barriers to use. There are occasions where extensions and plug-ins are necessary. However, that isn't the case for the virtual margin—the virtual margin could be created without them.

By implementing the virtual margin with industry standard browser features, it will have the greatest portability and consistency of presentation. The virtual margin will automatically work in any browser that supports the industry standards with no additional effort.

3. No explicit create or save annotation interface controls or dialogue.

In keeping with the desire for a minimal interface that mimics the automatic preserving of annotations on paper, the contents of the virtual margin are automatically saved and restored for each note and view without user involvement. Saving a virtual margin's contents can be done in two ways. The first is to detect when the note or view window is closing and send the virtual margin contents to the virtual margin proxy server at that time. The second is to check for changes to the virtual margin contents at frequent intervals and send the contents to the virtual margin proxy server when a change is detected. The first method has the least impact on the browser, but there is an exposure where the virtual margin contents could be lost if the

computer lost power, or the browser or operating system crashed before the virtual margin contents cold be saved. The second method is more robust since the virtual margin contents are less likely to be lost. However, it is much more complicated since it is necessary to keep track of which changes have been sent to the virtual margin proxy server. The virtual margin proxy server must also save the changes in the right order or risk losing virtual margin updates. Implicit in the second option is additional network traffic and processing in the browser which could affect the Knowledge Forum application performance. The actual risk of a browser, operating system or power failure was considered to be remote. For these reasons, the method used to determine when to save virtual margin contents in this study is detecting window close operations.

4. Authors should only be able to view their own virtual margin notes.

    In order to restrict students to seeing only their own virtual margin notes, the margin notes must be tagged with an identifier unique to the note's author. Knowledge Forum requires its users to identify themselves with a username that is unique within a forum database. This username is sent with each request to the Knowledge Forum server after the student has logged in. This made using the Knowledge Forum usernames convenient to use for associating the virtual margin contents to the student as well.

5. Development work would be done using Free and Open Source Software (von Hippel, Hill & Lakhani, 2007).

    The proprietary nature of the Knowledge Forum server source code, e.g. difficult to obtain and licensing restrictions, makes it hard to extend or modify. Free and Open Source Source, FOSS software on the other hand is easy to alter for any purpose because the source code is readily available and the licensing terms explicitly permit alterations. FOSS also has the advantage of being free of charge. This minimizes development costs.

The consequence of constraints 1 and 2, above, is that the virtual margin is implemented as a proxy server that is placed between the web browser and the Knowledge Forum server. Each request that the browser makes, instead of being sent directly to the Knowledge Forum server, is instead sent to a virtual margin proxy server, which forwards the request to the Knowledge Forum server, receives the

response, alters it as necessary and returns it to the web browser. From the user's point of view the fact that the browser's requests are being handled by a server other than the Knowledge Forum server is hidden. The only difference is the presence of the virtual margin.

4.2   Architecture

The basic design of the system is similar to the "new annotation service architecture" used by Schickler, Mazer and Brooks in their annotation study (Schickler, Mazer & Brooks, 1996). Both systems are implemented using a proxy server that mediates the browser's interaction with the web or Knowledge Forum server. The web browser – virtual margin proxy – Knowledge Forum server dialogue looks like this:
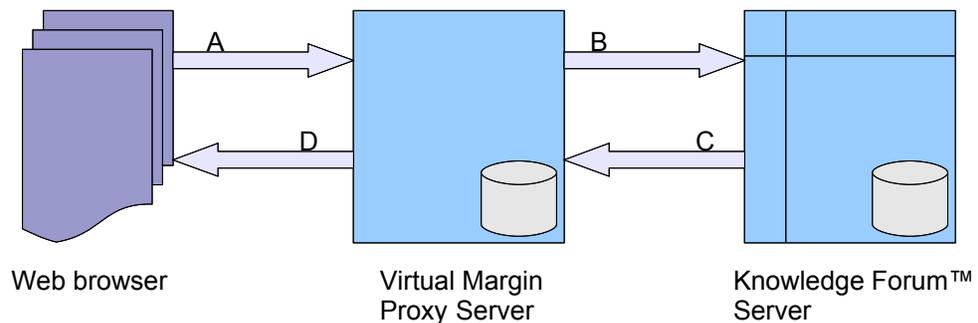
Figure 2: Web browser to Knowledge Forum server communications via the Virtual Margin Proxy.

The web browser sends requests to the virtual margin proxy server A, the proxy reformats the requests and forwards them to the Knowledge Forum server B, the Knowledge Forum server generates responses and sends them to the virtual margin proxy C, and the virtual margin proxy reformats the responses and forwards them to the web browser D. From the participant's point of view, the web browser is talking to the Knowledge Forum server.

While Schickler et al.'s annotation interface had a dialogue to create and view individual annotations and an administrative mode to manage groups and categories,

the virtual margin is a single text input area whose contents are automatically preserved and restored. This difference leads to several simplifications such as the elimination of administration, notification methods and annotation categorization features. The virtual margin proxy adds the virtual margin to a web page by modifying the HTML that describes the page. The changes required to do this are quite small and do not alter the text of the page content. There are three things that the virtual margin proxy does. The first is to add a JavaScript "OnUnload" event handler to the web page's <body> tag. The second is to add a form containing a text input area to provide the virtual margin itself. The third change is to add formatting directives to separate the main web page content from the virtual margin text area and control its presentation. These changes are explained next.

When an OnUnload event handler is attached to a web page, the web browser will call it just prior to leaving that page. That is, just before the page is unloaded in preparation for the next page to be loaded in the browser window. The OnUnload event handler added for the virtual margin captures the contents of the virtual margin input area and sends it to the virtual margin proxy server. Once the virtual margin proxy server has saved the input area contents in the MySQL database it sends an acknowledgement back to the OnUnload event handler which then exits and the browser proceeds to the next page as usual. Should an error occur in saving the virtual margin contents, the best the OnUnload event handler can do is display an error message. It is not possible for the handler to prevent the page from being unloaded.

So there are actually two types of requests that the virtual margin proxy server handles. Requests intended for the Knowledge Forum server and requests to store and retrieve virtual margin contents. The virtual margin proxy server examines each request it receives and determines whether it should handle the request, or forward the request to the Knowledge Forum server. In any case, there is only one server that the web browser talks to; the presence of another server, and the communication with it, is completely hidden.

4.3   Software Used

The virtual margin proxy server was developed using the standard LAMP (Linux, Apache, MySQL and Perl) software stack ("LAMP," 2007). In addition, the following software was also used: CGIProxy, which is a proxy service that runs as a CGI under Apache (Marshall, J., 2006); TinyMCE which is a set of JavaScript libraries that add rich text editing features to web form textareas (Moxicode, 2007); and Firefox, a standards compliant web browser (Mozilla, 2007.1).

The programming code to implement the virtual margin itself consists of:

1. CGIProxy with modifications that add the virtual margin interface element to the HTML generated by Knowledge Forum. These changes also retrieve a user's virtual margin content from the MySQL database and place it within the virtual margin so it will be present when the browser renders the HTML for the user.

2. update_margin.cgi, contains a routine that receives virtual margin updates and stores them in the MySQL database.

3. get_margin.cgi, contains a routine that receives requests for virtual margin content, retrieves it from the MySQL database and sends it back to the browser in response.

4. vmargin.js, contains a routine that sends the virtual margin updates to the update_margin.cgi routine.

5. a collection of formatting directives that control how the browser renders the virtual margin's presentation.

The first three routines were written in Perl. They run under the control of the Apache web server to create the virtual margin proxy server. vmargin.js was written in Javascript which runs within the web browser. The formatting directives were written using Cascading Style Sheets (CSS) which the web browser applies to the HTML elements as it renders the page for display.

For performance reasons, during the sessions involving the participants, the virtual margin proxy server and MySQL database ran on the same Mac OS X machine as the Knowledge Forum server.

4.4   Virtual Margin Interface

The virtual margin has been added to the right side of the usual Knowledge Forum interface. In order to do this the pop-up browser windows have been expanded horizontally to accommodate the presence of the virtual margin input area. This location was chosen to provide the maximum input area with the minimum impact on the overall application interface. The virtual margin input area is visually separate from the rest of the Knowledge Forum interface elements in the browser window. It initially appears as a blank sheet with a basic set of word processing control buttons at the bottom. The number of buttons has been deliberately limited to minimize the complexity of the virtual margin interface.

4.4.1 Anatomy of the Virtual Margin

The following image shows the virtual margin interface element added to the Knowledge Forum 'Anchored instruction' view. Notice the participant's comments at the top of the virtual margin and the button bar containing the word processing controls at the bottom. The controls are, from left to right: bold, italic, underline, strike-through, undo, re-do, cleanup, unordered list, and ordered list.
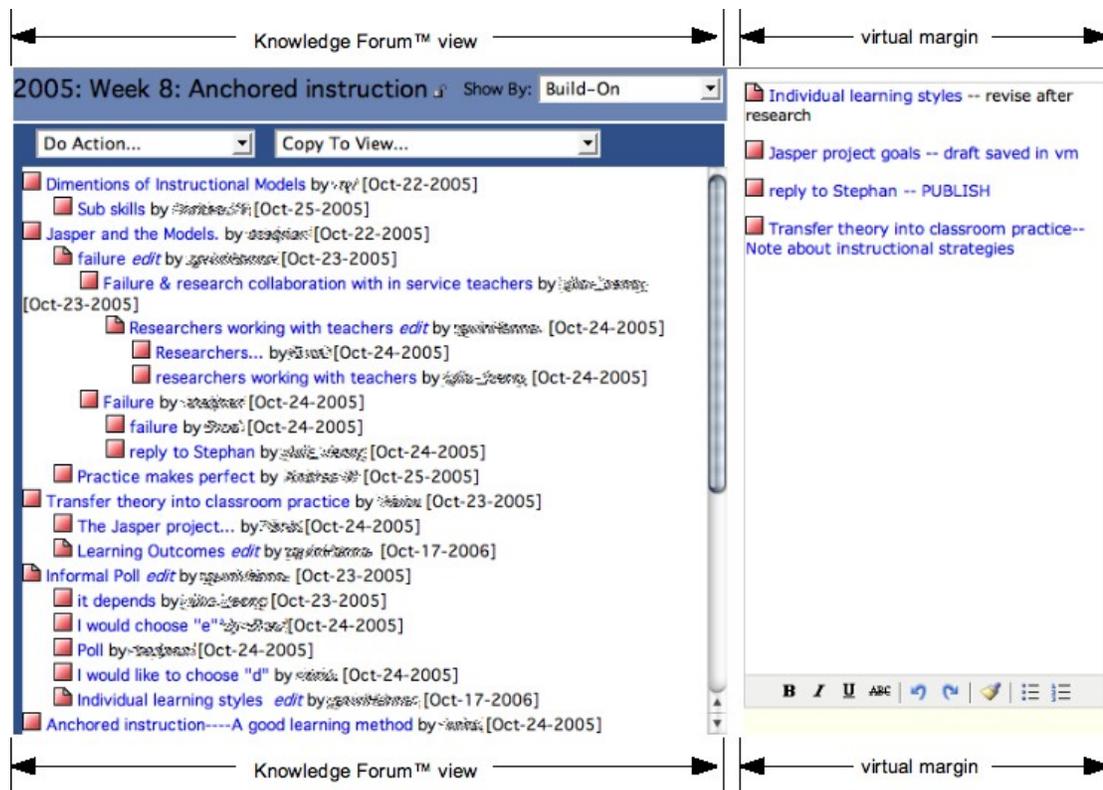
Figure 3: Knowledge Forum view with the virtual margin.

While not present in this image, if the content of the virtual margin exceeds the vertical size, a scroll bar is automatically added to the right side allowing the virtual margin to grow as tall as needed in order to accommodate the student's annotations. Lines of text will wrap automatically, however, if there is no space in a line so that the horizontal content is too wide to fit in the allotted space, a horizontal scroll bar is automatically added at the bottom, just above the button bar. Effectively, the virtual margin's size grows as necessary to accommodate whatever is placed within it.

The virtual margin is added in a similar way to a Knowledge Forum note as shown in the following image. Again, it has the participant's comments at the top, and at the bottom, the same set of word processing controls that it has in the Knowledge Forum view.
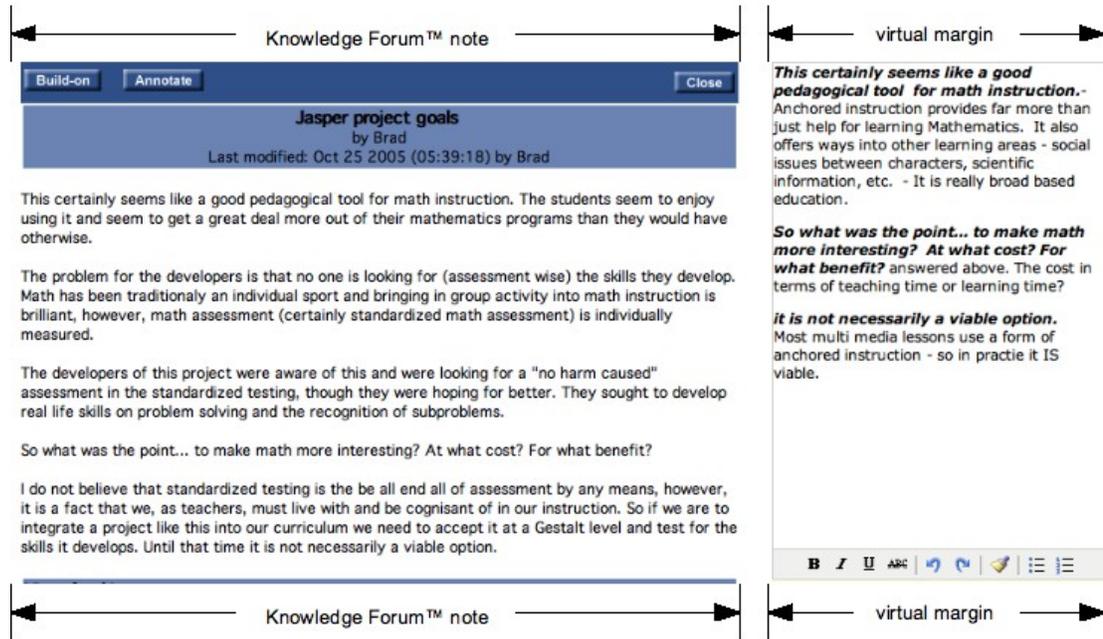
Figure 4: Knowledge Forum note with the virtual margin.

5 Method

In general terms this study of the virtual margin was very straightforward. The researcher recruited students who were already familiar with Knowledge Forum and presented them with a familiar task that provided them with opportunities, but not the requirement, to use the virtual margin. The student's interactions with the modified Knowledge Forum interface along with their usage of the virtual margin were recorded and discussed. The primary difference between the participants completing the task in the study and their prior use of Knowledge Forum was the addition of the virtual margin to the Knowledge Forum interface.

5.1 Goals of the Study

As discussed earlier, annotation features are rarely included as part of modern web application interfaces. While a variety annotation implementations have been tried, each has been cumbersome, requiring multiple steps to use, shared the annotations publicly, and in most cases hide the annotations from view until they are explicitly requested to be seen. The virtual margin, however, takes a very different approach. It requires just one step to use (a click in the margin itself) it maintains the privacy of the annotations, and it keeps the annotations in view while the content with which they are associated is in view. The expectation is that this radically different implementation will make annotating web based content so easy to do that people will use the virtual margin to record even 'transient' thoughts.

The goal of the study is to investigate some closely related attributes of the virtual margin in the context of a knowledge building exercise:

- Find out what uses people make of the virtual margin.
- Determine whether the virtual margin is a desirable feature to add.
- Determine how usable this implementation is.

The last two concerns are intimately related because if the feature isn't useful then its usability does not matter, and if it is not usable then its usefulness doesn't matter. Of course, determining whether the virtual margin is useful and usable is more a matter of degree than a matter of fact. That is, the question to be answered is, for what purposes do the participants use it, and how easily are the participants able to use it for those purposes?

5.2   Task Design

The study task was designed to replicate as closely as possible a typical Knowledge Building task that would be assigned in a course that uses Knowledge Forum. Of necessity, there were some compromises to accommodate the time pressure for data collection, and the presence of the researcher and recording equipment.

To make the task as authentic as possible, the participants were presented with their own EDUC 804 Knowledge Forum database in which they had spent a previous semester using Knowledge Forum to hold the discussions of their course readings. EDUC 804 is a hybrid model course where a new reading assignment was given most weeks and was discussed in a specified Knowledge Forum view, a separate one for each topic, prior to class. In class, the discussion was reviewed and summarized by the students. Permission has been granted by the EDUC 804 instructor to use the Knowledge Forum server and its databases to provide pre-populated, notes and views. The major differences between this environment and how the students experienced Knowledge Forum previously, is the addition of the virtual margin, the presence of the researcher and the location at which they access the discussions, e.g. The Centre for Educational Technology instead of at home.

This task is typical of what a Knowledge Forum participant is expected to do in the pursuit of "…furthering the understanding of the group" (Mackellar, F., personal communication, November 2005). From that perspective this task could be considered a Reference Task as proposed by Whittaker, Terveen and Nardi

(Whittaker, Terveen & Nardi, 2001). It is sufficiently ill-structured that participants had a range of options available to them in how to approach it, yet not so open-ended that they would spend an inordinate amount of time on it. For the purposes of this study the salient feature of the assignment is that it afforded the participants with multiple opportunities to use the virtual margin.

In order to simplify the logistics of the study for the researcher, one client computer was used by all the participants—the author's own iMac computer, a 17-inch flat panel G4. This meant that the participants would be using an unfamiliar computer with a potentially unfamiliar operating system. The expectation however, was that they would not be interacting with the operating system itself, but only the Knowledge Forum application within the Firefox web browser which would be familiar to them. Firefox might not be as familiar to people who use Windows as they likely use Internet Explorer and people who use Mac OS X most likely use Safari. Again, this was not expected to be an issue because participants would not be interacting with the browser menus or controls, just the Knowledge Forum application.

In summary, the Knowledge Building assignment, Knowledge Forum and contents of the Knowledge Forum notes and views would be familiar to the participants. Potential differences between the study sessions and when the participants were active in the Knowledge Forum database are: an unfamiliar operating system, an unfamiliar web browser, working in a lab room instead of their usual posting location, the presence of a video camera and observer, the size of the computer monitor, a screen capture utility (which affected mouse tracking) and the presence of the virtual margin interface component.

The screen capture utility recorded the entire screen ten times a second. This had the unfortunate side-effect of causing the mouse's movement to become jerky. Slow and steady movements of the mouse were fine. However, moving the mouse quickly caused the pointer to jump erratically. This was disconcerting and frustrating to the participants until they adjusted their mouse usage accordingly.

5.3   Selection of Participants

The author solicited participants from two Education and Technology graduate program cohorts who had used Knowledge Forum in their EDUC 804 course. This group of students were chosen because they were already comfortable with Knowledge Forum and the study could use the pre-populated Knowledge Forum database content with which they were already familiar. The only unfamiliar element would be the virtual margin itself.

The participant group consisted of 4 Education and Technology program graduate students from two different cohorts, neither of which is that of the author. The participants will be referred to as Andy, Bob, Carol and Doug (all pseudonyms). At the start of each of the interview sessions the participants were asked three questions: "How have you approached this kind of assignment previously?", "What tools did you use?" and "What frustrations did you experience?" The intent of these questions was to gain an understanding of how the participants experienced the Knowledge Forum interface prior to experiencing it with the virtual margin. In addition, their responses serve as a personalized summary introduction.

5.4   Selection of Knowledge Forum View

The participants were asked to complete a Knowledge Building exercise that required them to read several notes within the "Anchored instruction" view, and compose their strongest contribution to that view which could be a rise-above, build-on or new note. Anchored Instruction, as presented in the reading for this view (Cognition & Technology Group at Vanderbilt, 1992), is an instructional approach to mathematics in which students are shown a complex problem using a story in a video to "anchor" the problem. The anchor presents a life-like scenario in which students are intended to "find" the mathematical problem and then solve it. Ideally, the developers of this approach feel that students should be taught mathematical procedures in the midst of working on authentic problems. Students the masters program often find this controversial (O'Neill, K., personal communication, February 2008). Many feel that it is impractical or even unfair to give students problems for which they have not already been taught the mathematical algorithms.

This view was chosen because in both cohorts it provoked a great deal of discussion resulting in several threads, some that are shallow and some deep. Thus there is potential to pull together ideas from multiple threads, summarize a thread, or provide additional information based on the material that has been covered since the end of the course.

5.5   Data Collection

There are three sources of data for this study. The first is the pre- and post-assignment interview including the System Usability Scale, the second is the video tape of the participant made completing the assignment and the third is the screen capture recorded while the assignment was being completed.

5.5.1 Interviews

At the start of each session, the participants were asked to read and sign the consent form in Appendix 1, that outlined the purpose of the study and their role in it. Upon signing the form, the researcher proceeded with the session protocol in Appendix 2. This consisted of some initial questions and an introduction to the virtual margin. With that completed, the participant was given the task to do and allowed free-rein to use the computer. Upon completion of the task, the researcher asked several more questions, also in the Appendix 2. After the remaining questions in the session protocol had been answered, the participants were given the System Usability Scale questionnaire to answer on their own. The System Usability Scale, SUS (see Appendix 3), was developed by Digital Equipment Corporation as part of their integrated office systems usability engineering. It was designed to quickly and simply provide "a global view of subjective assessments of usability" (Brooke, 1996). The SUS provides the means to obtain a rough assessment of the virtual margin's usability with a minimum of cost in time and effort on the part of the researcher and study participants.

5.5.2 Video Tape

During each session the participants were video taped as they completed the Knowledge Forum assignment. The camera was placed next to the computer's screen and aimed at the face of the participant seated in front of the screen. The purpose of video taping the participants was to have an accurate record of what they said and to capture their facial expressions as they performed their assignment. From these recordings a transcript of each session was created.

5.5.3 Screen Capture

While each participant was working on their Knowledge Forum assignment, a screen capture utility program was running that recorded the contents of the screen ten times a second. These screen images were combined into movies that reproduced each of the participant's actions as they completed their Knowledge Forum assignment. By recording both the participants and their on screen interactions as they completed their assignment, complete history of their activities as they performed the assignment was obtained.

5.6   Interpretation of Data

The narratives in the "How the Participants Completed the Assignment" part of the Results section were constructed by first compiling a composite transcript of each interview session from the audio/video, screen capture and server logs. These transcripts provided a detailed description of each person's actions and the events of their session. From this the virtual margin uses and note contributions were isolated, and then the events and behaviours around them were noted to create usage summaries. These summaries provided the basis of the researcher's narrative for each person. Of the 25 virtual margin comments that were made by the participants, 20 were included in the narrative discussions. Of the five that were omitted, two were by Bob, two were by Carol and one was by Doug. They were omitted because they were very similar to other ones already included in the summaries.

The "Participant's Perspectives on Their Virtual Margin Usage" narratives were constructed by summarizing the subject's responses in their post knowledge

building task interviews. The open ended interview questions provided the subjects with the opportunity to reflect on, and explain in their own words how the virtual margin affected their approach to the knowledge building assignment.

In this way there are two perspectives on each subjects' interactions with the virtual margin for each session. First the researcher's and then that of the subject.

5.7 Limitations of the Study

A short term study such as this necessarily creates an artificial environment for the subjects. The camera pointed at them and the researcher beside them are constant reminders to the participants that they are being watched. Furthermore they are working in an unfamiliar location using unfamiliar equipment and they know that unlike in a real class, their posting contribution will not be seen by the rest of their cohort. As a result, the context in which the subjects were working was artificial in obvious ways. However, the actual task set before them, to make their best contribution to a Knowledge Forum view, was a familiar authentic task. The Knowledge Forum view they were given to work with was familiar and authentic–it was the result of their own cohort's previous work. In essence what the participants were asked to do in this study, was something they had already done as part of their EDUC 804 coursework. The participants, their task, and the data they were supplied with were authentic.

To the degree the participants were influenced in their virtual margin comments or posting contributions by being part of the study, it is most likely that these effects are due to the presence of the observer and the instrumentation. E.g. the screen capture utility, rather than the artificiality of the task they were given. Because of this, one might expect some amount of self-censorship in the virtual margin comments given that they were not private, but visible to the researcher. However, given the pointed nature of some of the comments and the variety of uses to which the virtual margin was put, it is difficult to argue that the participants were inhibited by the researcher's presence.

The lack of a real audience (meaning the other members of their cohort) for their postings might have had some influence on the subject's posting behaviour. This is hard to quantify because it could equally well be argued that the lack of a real

audience freed them to post more boldly than they otherwise would have. Just as they could put whatever they wanted into their virtual margin, they could also put whatever they wanted into their postings.

Finally, given the short duration of this study, little can be said about the long term potential and implications of supporting peoples' thinking by aiding their remembering via the virtual margin. How people would use an accumulation of virtual margin comments over the duration of a semester, or longer time frame, is primarily conjecture at this point.

6   Usability Testing: Data Collection and Analysis

Learning is not a spectator sport—it is an active, not a passive, enterprise. Accordingly, a learning environment must invite, even demand, the active engagement of the student.
— D. Blocher

Even in the short time the subjects used Knowledge Forum with the virtual margin, several interesting behaviours were noted that suggest the virtual margin has greater utility and application than simply serving as a memory aid. To put this another way, having a contextualized memory aid as an integral part of the Knowledge Forum application yields interesting ways of interacting with notes and views that aren't possible without the virtual margin, or even in the analog paper and pen environment on which the virtual margin is modelled.

The study took a two pronged approach to investigate the two questions: is the virtual margin useful for knowledge building, and, is the implementation useable? The task given to the participants was designed to provide them with opportunities, but not the requirement, to use the virtual margin. The following sections describe many of the uses made of the virtual margin and some of the implications for knowledge building. To investigate the usability of the virtual margin after the participants finished their task they were asked to complete the System Usability Scale. This scale provides a rough indication of how easy the virtual margin is to use.

6.1   Introducing the Study Participants

The next four sections provide a brief introduction to each of the study participants, their backgrounds and typical approaches to working on knowledge building tasks similar to the one assigned in this study.

6.1.1 Andy

The first participant in the study was Andy. He has been using computers for over 35 years. In that time he has used over ten different computer operating systems and so has experienced a wide variety of computer interfaces. Andy typically approached the weekly posting assignment in EDUC 804 by reviewing the notes others had already made. Normally he had the assigned reading for the week at hand for reference. He generally used Microsoft Word or Notepad to draft his notes prior to posting them. One of the most important features of Microsoft Word to him is the automatic spell checking. Word and Notepad were also useful for accumulating notes while researching papers as references. Another tool that he made use of in composing his postings was a dictionary for looking up unfamiliar terms. His primary frustration with the Knowledge Forum interface was that he didn't know the interface very well. He just used the features he needed to make the required postings.

6.1.2 Bob

Bob, the second participant in the study, had been using computers for over 20 years and is familiar with two operating systems. Bob also used Microsoft Word to compose his Knowledge Forum postings and then used cut and paste to transfer his completed notes from the Word document window to the note editor in Knowledge Forum. Bob's frustrations with the Knowledge Forum interface have to do with the pop-up windows. He does not like pop-ups because he "loses his place in the stack." He mentioned that he would also like Knowledge Forum to be able to save a draft posting without publishing it.

6.1.3 Carol

Carol was the sole female in the study. She has been using computers for over 15 years and is familiar with just one operating system (Windows?). She sometimes drafted her postings in Microsoft Word because it is a very familiar interface to her and so she is quite comfortable using it. She made use of cut and paste to construct her postings as well. Her frustrations with Knowledge Forum relate to its complexity and the number of features that she didn't use. When she first started using

Knowledge Forum, in the fall of 2005, she was confused about the nature of Knowledge Forum "views" and had trouble figuring out how to make a posting.

6.1.4 Doug

Doug has been using computers for over 20 years. He is familiar with 3 different operating systems. His approach to composing his postings is a bit different from those of the proceeding three participants. He would print off a collection of other people's postings and scribble notes to himself in the margins looking for anything new or something that hadn't been said before. After making notes on paper he would push them aside because they would get in the way while he was writing on the computer. Searching through them was too tedious and difficult. The main frustration Doug experienced with Knowledge Forum was not technical in nature, but social. He characterized it as "build-on envy" which resulted from a lack of responses to his own postings. He attributes part of the reason for this to his work schedule, which put him out of sync with the other members of his cohort.

6.2   Common Characteristics

The participants in this study share several common characteristics. Perhaps not surprisingly, as befitting students in the Education and Technology Graduate program, they are highly experienced computer users. The median years of experience was 20, with a minimum usage of 15 years. This implies that they have been exposed to a wide variety of application interfaces and can be expected to have developed a high comfort level with the applications they use the most often, such as Microsoft Word. Microsoft Word has certain features e.g. bold, italic, underline, spell check, formatting and draft document persistence, that the participants found lacking in Knowledge Forum's interface. The virtual margin intentionally incorporates several of these features so that the participants features that they have come to expect to have while working with text.

6.3   How the Participants Completed the Assignment

The following sections describe how each of the participants completed the task of making their best contribution to the "Anchored instruction" view in Knowledge Forum.

To give a sense of how they used the virtual margin, most of their virtual margin notes are included in the discussion. For simplicity, consistency and clarity, the virtual margin comments and the note next which they were made are presented in a columnar format. This allows the note and virtual margin content to appear together, similar to the way the participants saw them, but without the Knowledge Forum interface elements around them. A few of the longer notes have been truncated for space reasons. None of the virtual margin comments have been truncated, all of them are presented in their entirety. To preserve the "flavour" of the comments and the authenticity of their presentation, all spelling and punctuation are presented exactly as they were written. Where bold and italics were used, they are reproduced here as well. The only changes were to various person and usernames. These have been anonymized. For the virtual margin comments made in the Anchored instruction view, screen captures of the view window are used. This greatly simplified their formatting at the expense of omitting some note titles at the bottom of the view.

6.3.1 Andy

Andy's initial reaction upon hearing the assignment: "To create your best contribution to the 'Anchored instruction' view" was to say "I wouldn't be able to do my best because I can't, I won't have time to read everything." Even so, he "just picked one at random" and started reading. Andy read and closed several notes in rapid succession. He observed, "As you can see from this, most of my postings for this particular topic were first offs so they weren't in respect to anyone in particular." He went on to say "Not having the document in front of me I would not, I wouldn't feel particularly happy about saying too much about it, 'cause I can't remember the document." So it appears that with the absence of the Anchored Instruction paper, the study environment placed him in an uncomfortable situation. He felt forced to respond to his fellow students' contributions rather than the assigned paper.

Andy did find a posting where he said, "Ok, I do have a reaction to this. And on that basis I could easily put a note in here." At this point he started typing in the virtual margin. He copied some text from the note and pasted it into the virtual margin. Seeing the result, he realized that he wanted "to do something with that to make that different. I want to see what *my* comments are as opposed to the one I captured. An extra colour would help there." What he decided to do was use bold face for the text copied from the note to distinguish it from his own text. When he was done, he said, "I've just written a comment, so I'm happy there. I'm going to close the page. I'm not prepared to put it in [publish it] at the moment." The result is shown in the following figure:

Jasper project goals	virtual margin
This certainly seems like a good pedagogical tool for math instruction. The students seem to enjoy using it and seem to get a great deal more out of their mathematics programs than they would have otherwise. The problem for the developers is that no one is looking for (assessment wise) the skills they develop. Math has been traditionaly an individual sport and bringing in group activity into math instruction is brilliant, however, math assessment (certainly standardized math assessment) is individually measured. The developers of this project were aware of this and were looking for a "no harm caused" assessment in the standardized testing, though they were hoping for better. They sought to develop real life skills on problem solving and the recognition of subproblems. So what was the point... to make math more interesting? At what cost? For what benefit? I do not believe that standardized testing is the be all end all of assessment by any means, however, it is a fact that we, as teachers, must live with and be cognisant of in our instruction. So if we are to integrate a project like this into our curriculum we need to accept it at a Gestalt level and test for the skills it develops. Until that time it is not necessarily a viable option.	***This certainly seems like a good pedagogical tool for math instruction.*** - Anchored instruction provides far more than just help for learning Mathematics. It also offers ways into other learning areas - social issues between characters, scientific information, etc. - It is really broad based education. ***So what was the point... to make math more interesting? At what cost? For what benefit?*** answered above. The cost in terms of teaching time or learning time? ***it is not necessarily a viable option.*** Most multi media lessons use a form of anchored instruction - so in practie it IS viable.

Figure 5: Andy's virtual margin comments in 'Jasper project goals.'

It was at this point that Andy wanted to verify for himself that what he wrote would come back when he re-opened the note. So, after the window had disappeared he clicked on the 'Jasper project goals' link again, and the note window opened with the virtual margin containing his comments in place. Reassured that his comments would be preserved he moved on to read some more notes.

Next Andy decided to make some virtual margin comments in response to the note titled "Jasper assessments." Again he copied the text he wanted to annotate into the virtual margin, and used the bold face font to clearly separate it from his own words. The result is in the next figure:

Jasper assessments	*virtual margin*
As I said in a previous post, I really liked Jasper. I still believe that the traditional way teachers have delivered the curriculum (i.e. direct instruction) is far better than allowing students to flounder on their own... I particularly connected with the Model 1: Basics first, Immediate feedback, Direct Instruction... (now how did you know I'd say that?) The Jasper adventures seem terrific for reinforcing those basic lessons, providing a rationale for learning the concepts, demonstrating that math IS useful in the real world, providing for visual learners, improving overall attitude about math. Having the experience working through a real-world-type problem gives students a reference point for solving similar word based problems. Sure, Anchored instruction has its faults... it can't instruct the curriculum on its own, it's more for supplementing existing teaching; the adventures are extremely time intensive; it's hard to assess the effectiveness of Jasper... but if it gets kids interested in math that would otherwise be burning their books in frustration? Yee haw!	***the adventures are extremely time intensive*** Certainly time is required for students to both get involved with the story and be part of the resolution of the problem. Brad mentioned "making Math more interesting" and 'd have to agree that the drama portrayed absorbs the children to such an extent that they want to help out - they don't want the class to end!

Figure 6: Andy's virtual margin comments in the 'Jasper assessments' posting.

At this point Andy was ready to make his posting to the view. To do that he wanted to contribute a paragraph from his virtual margin comments in "Jasper project goals" as well as the paragraph from the virtual margin in "Jasper assessments." So he wanted some mechanism that would take his virtual margin comments and publish them as a note in the view. I explained to him that the notes in the view are the public space, while the virtual margin is a private space. So there's no way to directly or automatically move content from one to the other. It must be an explicit action by the participant. With that understanding, Andy selected his virtual margin comments from the 'Jasper assessments' note and proceeded to create a build-on to the 'agreement on time usage' note. When he pasted the virtual margin contents into the input box for the new note, the text that had been bold faced, became regular text again. All the text looked the same. This was very disappointing to him. I guided him through process of using the "advanced note" option in Knowledge Forum to recreate the bold-faced text where he wanted it. The following figure shows the result:

agreement on time usage
the adventures are extremely time intensive (from previous posting) Certainly time is required for students to both get involved with the story and be part of the resolution of the problem. Brad mentioned "making Math more interesting" and 'd have to agree that the drama portrayed absorbs the children to such an extent that they want to help out - they don't want the class to end!

Figure 7: Andy's posting: a build-on to 'Jasper assessments'.

Prior to "closing and contributing" this note, Andy had indicated that he wanted to place two paragraphs in it, one from each of his virtual margin comments. However, after going through the process of copying and pasting the comment from one virtual margin, and recovering the formatting he wanted, he did not pursue obtaining the paragraph from the earlier virtual margin comment. It's not clear why he did not. He might simply have forgotten, or decided it wasn't worth the bother, or something else. What seems clear is that the interface made it more work than he expected, or desired, to move his formatted words from the virtual margin into a similarly formatted published note.

6.3.2 Bob

Bob started his session by clicking on the link for the 'Researchers working with teachers' note, which is one of his own. While viewing that note, he repeatedly used the mouse to move the scroll bar up and down. The effect of this was to cause the note contents and Knowledge Forum interface elements to scroll in the usual fashion. However, the virtual margin did not move. Scrolling the window did not cause all of the contents of the window to move. This was probably surprising to him because this is not the usual behaviour.

Bob's note had a build-on called "Researchers…" so at the bottom of the note was a link to it, which Bob clicked. This resulted in another note window opening, with that note's content and another virtual margin. This time Bob clicked three times in the virtual margin, closed the note window without typing anything, and closed the "Researchers working with teachers" note window as well. Presumably, this behaviour was just Bob experimenting to see how the virtual margin would react.

Next he opened the "failure" note, another one of his postings and proceeded to start typing in the virtual margin. The results are in the following figure:

failure	virtual margin
Good points George, Do you think that Jasper represents the opposite view of Schank? I got the impression that Jasper places value on BOTH failure and success. CTGV found that the structured problem solving model, which "focuses on the need to help students minimize errors and feelings of confusion" (pg. 74) does not promote generative learning. Jasper does work best when failed expectations do occur. [rest of posting deleted]	Failure-based success - A concept that is rather harsh to most people. Have had difficulty explaining this concept to others. Opposition to this concept comes from those who feel success follows small successes. People from this camp seek not to dwell on or even acknowledge failure.

Figure 8: Bob's virtual margin comments in the 'failure' posting.

Bob's elaboration, in the virtual margin, on his own note raises a new issue that hadn't been considered in the design of the virtual margin. That is, what if Bob decided he wanted to edit his posting? Currently, that would open a new edit window without a virtual margin in it. It seems the right thing to do would be for the new edit window to have a virtual margin with the note's virtual margin comments. However, given the way Knowledge Forum works, there would then be two windows open for the same note, with the same virtual margin contents. A problem arises if in addition to changing his note, Bob were to also edit the virtual margin contents in one, or both of the windows. Only the virtual margin contents in the last window he closed would be preserved. This isn't necessarily what he would expect, or desire. It will take some further investigation to determine how best to handle this situation.

Next, Bob opened his "Informal Poll" note, and wrote a build-on, "Individual learning styles." After clicking the "Close and Contribute" button, Knowledge Forum presented the new note complete with virtual margin. Immediately, Bob started typing in that virtual margin. The result showing his new note with virtual margin comments are in the following figure:

Individual learning styles	virtual margin
Failure = learning? Is this something that you think differs between individuals. Are there those who thrive after failure and others who aren't able to overcome the disappointment?	Look at learning styles -- review the different types (bodily kinesthetic, visual, etc...)

Figure 9: Bob's first posting along with its virtual margin comments.

This behaviour was surprising because, while the virtual margin enables private commentary on any note at any time, my expectation as designer was that the virtual margin would be used primarily for making comments or remembering things about *other* people's notes. Here, though, Bob is not making comments on one of his *old* notes, but on a note that he just made—one that he *just finished typing*. Yet, he still felt that it warranted additional comments to himself.

It really seems that there are two notes here. One is the Knowledge Forum posting that is visible to all the forum participants. The second is the combination of the posting and virtual margin comments that Bob sees. In other words, Bob has a different view of this new note than the other participants do. Of course this is the case with any posting for which a participant has made private comments in their virtual margin. What is different in this case, is that Bob constructed this posting this way right from the beginning. Whether he had this in mind before he clicked on the "Build-on" button, or the "Close and Contribute" button or it occurred to him once he was presented with the posted note, it's impossible to say. The result is that the virtual margin makes it possible not just to annotate notes, which was the original intention, but also to construct multi-part notes.

With this technique one could publish a part of a note and in the virtual margin provide an outline, or other hints, to the intended development of the note. In subsequent sessions the note could be developed further and the virtual margin comments updated as a scaffolding in support of the note writing. In this way, one does not have to publish fully fleshed out notes, but could instead publish a posting in sections while maintaining a train of thought and supporting information in the virtual margin until it is read to be revealed. The alternative, as discussed earlier is to wait until the entire note is complete or abandon the idea.

The next note in which Bob wrote virtual margin notes is "Jasper project goals." This is presented for comparison with Andy's virtual margin comments in the same note. The two sets of virtual margin comments are both questioning, but they are questioning different things. Bob is concerned with assessment, while Andy was concerned with the relevance to math instruction. In any case, they both took the time to wrestle with the posting and preserve their thoughts in the virtual margin. This introduces the possibility that either, or both of them, could return to this posting and make some further contribution to the discussion.

Jasper project goals	*virtual margin*
This certainly seems like a good pedagogical tool for math instruction. The students seem to enjoy using it and seem to get a great deal more out of their mathematics programs than they would have otherwise. The problem for the developers is that no one is looking for (assessment wise) the skills they develop. Math has been traditionaly an individual sport and bringing in group activity into math instruction is brilliant, however, math assessment (certainly standardized math assessment) is individually measured. [rest of posting deleted]	How is this measureable? Could Pre and post tests be conducted with loosely structured problems? This would give an indication of improvement to problem solving ability.

Figure 10: Bob's virtual margin comments in the 'Jasper project goals' posting.

The next note and virtual margin comments are interesting because they show the desire to place comments in a specific location relative to the note text. However, as the note content scrolls with the window control and the virtual margin does not, this positioning is illusory. The note and Bob's virtual margin comments are in the next figure:

Jasper assessments	*virtual margin*
As I said in a previous post, I really liked Jasper. I still believe that the traditional way teachers have delivered the curriculum (i.e. direct instruction) is far better than allowing students to flounder on their own... I particularly connected with the Model 1: Basics first, Immediate feedback, Direct Instruction... (now how did you know I'd say that?) The Jasper adventures seem terrific for reinforcing those basic lessons, providing a rationale for learning the concepts, demonstrating that math IS useful in the real world, providing for visual learners, improving overall attitude about math. Having the experience working through a real-world-type problem gives students a reference point for solving similar word based problems. Sure, Anchored instruction has its faults... it can't instruct the curriculum on its own, it's more for supplementing existing teaching; the adventures are extremely time intensive; it's hard to assess the effectiveness of Jasper... but if it gets kids interested in math that would otherwise be burning their books in frustration? Yee haw!	Existing teaching most likely already contains similar teaching techniques. Most teachers use a variety of "techniques". If this weren't the case, there would be a lot of burned books.

Figure 11: Bob's virtual margin comments in the 'Jasper assessments' posting.

As discussed earlier, the positional relationship is problematical due to the way the text can reflow when the browser window is resized, the participant changes the font preference or scrolls the window. The way Bob achieved this positioning is by repeatedly pressing the enter key until the input cursor was positioned at the line he wanted.

The next two figures show two notes and Bob's virtual margin comments, because they were important to Bob. These virtual margin comments are referred to in another virtual margin's comments. This was something that was unexpected. My expectation, as the designer of the virtual margin, was that virtual margin notes would refer to the note in which they were made, and perhaps to external information sources. Though thought had been given to the idea that a participant might want to draw from the content of multiple virtual margins in order to write a new posting, I had not explicitly considered the possibility of a comment in one virtual margin referencing a comment in another virtual margin. There is, however, no reason why it shouldn't be done, and it clearly has the potential for linking one's thoughts together which could lead to a new insight or new posting contribution.

reply	virtual margin
No, I don't think Jasper is based on success or failure. I think it's based more on the notion of the benefits of collaborative learning. I think we're all getting off topic with this discussion on failure. I don't think that this is part of the big idea of Jasper.	Big idea is experiential learning? Experience here includes success and failure, but of course, this is not all that forms our experiences.

Figure 12: Bob's virtual margin comments in the 'reply' posting.

Transfer theory into classroom practice	virtual margin
A topic was just discussed at the Education with/out Barriers Conference about the gap between theories and classroom practices. We realized when the practicing goes to teacher individuals who try to realize/transfer values of "pictured apples" to "real apples", things could be off the way because: 1.Teachers may have their own understandings and instructional techniques for teaching. 2.Not all theories could fit classroom, some are applied to collaboration only. 3.The same theory may not be applied to all situations. [rest of posting deleted]	No teacher uses one basic model of instruction. Add to post?

Figure 13: Bob's virtual margin comments in the 'Transfer theory into classroom practice' posting.

Bob, like the other participants, was asked to make his best contribution to the 'Anchored instruction' view. The expectation was that this would result in a single posting, either a build-on or a top-level note. However, Bob contributed a total of three postings. In addition to the one shown earlier, he wrote two more. For completeness, these are shown in the following two figures:

Learning Outcomes
I think it's important to note that learning outcomes are essential to understanding the usefulness of a learning opportunity like Jasper. If the learning outcome is to master an algorithm, then Jasper is not useful. If the learning outcome is the employment of effective problem solving strategies, then I feel it would likely achieve that outcome.

Figure 14: Bob's second posting: a build-on to 'Transfer theory into classroom practice.'

Usability/Feasibility
Conner, this is something that I've also noted. Practicality, usability and efficacy are often difficult for researchers to examine. Classrooms are messy places -- it's so difficult to know if a study will apply to other classrooms and to other learners. The huge variety of learning styles make it difficult to evaluate effects. What works for one student might not work for another. Action research is a possible solution. That's what teachers do independent of research and theory.

Figure 15: Bob's third posting: a build-on to 'Consider the support for the technology.'

Bob's last virtual margin comments were made in the Anchored instruction view, as shown in the following figure:
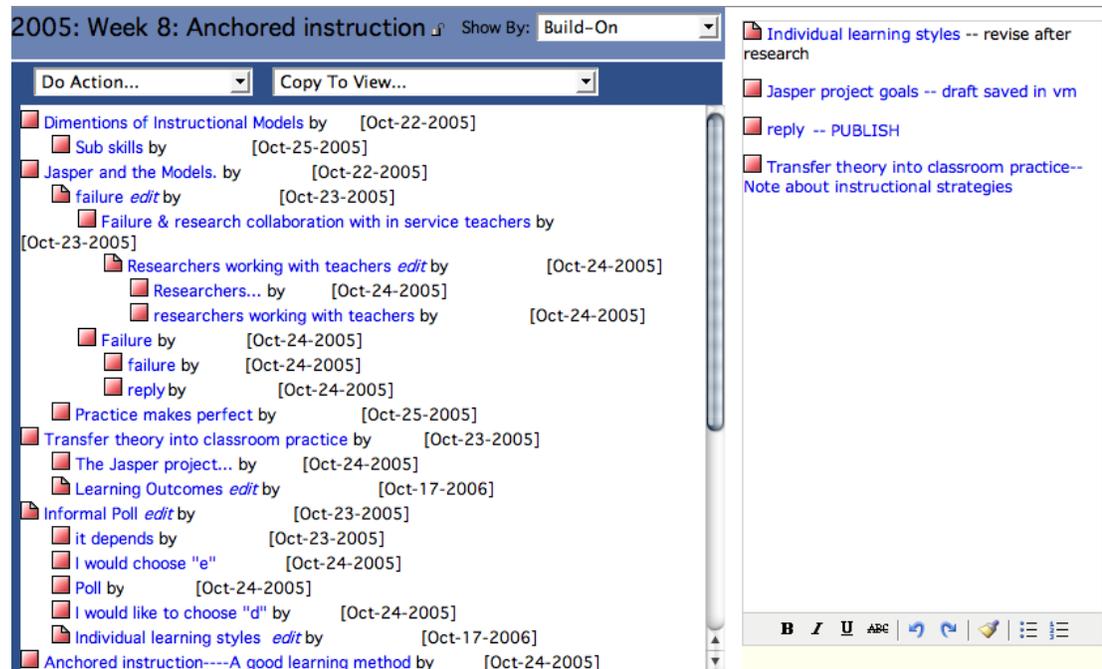
Figure 16: Bob's virtual margin comments in the 'Anchored instruction' view.

These comments were made by clicking on the note links in the view and dragging and dropping them into the virtual margin. After each link was placed in the margin, Bob added additional descriptive text next to it. This was quite surprising because, in effect, he was making reminders for himself of 'things to do' with his earlier virtual margin notes. Particularly interesting is the 'Individual learning styles' posting, which is a build-on to the top-level note 'Informal Poll.' With the usual Knowledge Forum interface, the 'Individual learning styles' note would be where Bob stopped writing. However, the virtual margin has enabled Bob to write two additional

layers of commentary, the virtual margin comments in the note itself and the virtual margin comments that reference them at the view level. It was this kind of purposeful aid in remembering that the virtual margin was designed for, so it is gratifying to see it used in this way.

6.3.3 Carol

Carol began her session by dragging the scrollbar for the "Anchored instruction" view window down a couple of lines and then down to the bottom of the window. From there, she dragged the scrollbar bar back to the top of the window. During this time, the virtual margin did not move. Once the view was back at the top of the window, she clicked on the link for her "Transfer theory into classroom practice" note. When the note window appeared, again, she dragged the scrollbar to the bottom of the window and back to the top. It seems that the reason for the repeated scrolling of the note windows is to realize and accept that the virtual margin does not move. A page element that does not move is unusual, so her behaviour is not surprising for someone who has never seen it before.

After the note was positioned back at the top, she clicked in the virtual margin and typed the virtual margin comments which are shown in the following figure:

Transfer theory into classroom practice	*virtual margin*
A topic was just discussed at the Education with/out Barriers Conference about the gap between theories and classroom practices. We realized when the practicing goes to teacher individuals who try to realize/transfer values of "pictured apples" to "real apples", things could be off the way because: 1.Teachers may have their own understandings and instructional techniques for teaching. 2.Not all theories could fit classroom, some are applied to collaboration only. 3.The same theory may not be applied to all situations. [rest of posting deleted]	some questions were asked...any comments are welcomed!

Figure 17: Carol's virtual margin comments in 'Transfer theory into classroom practice.'

After closing the note window she asked "So how many more minutes?" To which I responded, "You made your contribution? You read a few postings and ..." At this point Carol replied "Yeah, I just did. Added a new comments based on my previous one and I'm thinking what can I see generally based on the whole topic." It seemed to register with her that more than a brief comment in the virtual margin was expected. She took a half-minute, or so, to read some more note titles in the view and said, "Kevin could make something here as an instructor to summarize..." Hearing this, I interrupted, saying "That is your personal area. Only you see what you put in there." After some further explanation, Carol resumed reading more notes and then made a comment in the "Dimentions(sic) of Instructional Models" as shown in the following figure:

Dimentions of Instructional Models	*virtual margin*
"Different instructional materials afford different kinds of learning activities." It is pretty reasonable even though it is not absolutely suitable for ever situation. Based on the concept of affordances, there are three dimensions of instructional models. For the first dimension, I agree with following points. [rest of posting deleted]	I'd like to discuss with you about your questions...

Figure 18: Carol's virtual margin comments in 'Dimentions of Instructional Models.'

In three other notes, Carol made one sentence virtual margin comments as well. One of the design goals of the virtual margin was to provide a means to capture transient thoughts with the same ease as a pen and physical margin. It appears from the virtual margin comments that Carol has made that transient thoughts are what she has chosen to record. The following figure shows the last virtual margin comment Carol made in a Knowledge Forum note.

Practice makes perfect	_virtual margin_
I really liked the idea of anchored instruction.... having a complex problem and seeing how children work together and individually to solve various aspects seems like an excellent way to reinforce the basics and provides a "reason" for learning these skills. How many Jasper problems are there, that students can continue to practice and implement these strategies... practice makes perfect?	can they transfer?

Figure 19: Carol's virtual margin comments in the 'Practice makes perfect' posting.

For her contribution to the 'Anchored instruction' view, Carol made a build-on entitled 'new updates' to her 'Transfer theory into classroom practice' posting. This is the posting in which she made her first virtual margin comment. The unusual thing about her build-on, is that it was empty—the place where the text body of the note should be is blank. It's not clear whether this is what she intended to do, or if the posting of the empty build-on was a mistake and she didn't know how to fix it.

After making her build-on, Carol added some comments in the virtual margin of the 'Anchored instruction' view which are shown in the following figure:
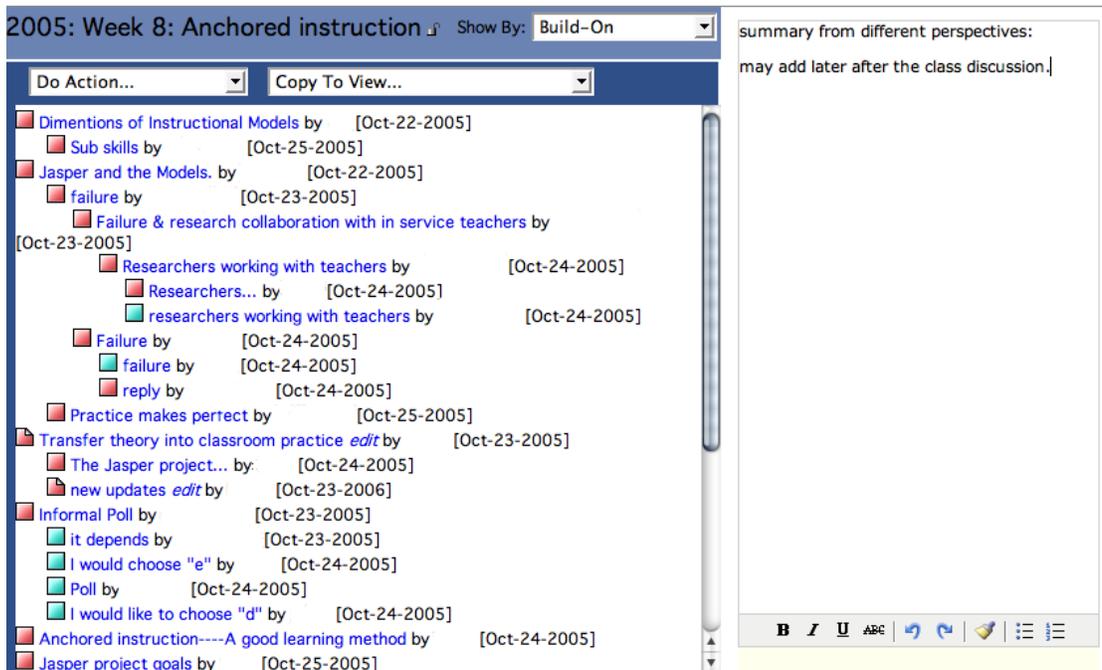
Figure 20: Carol's virtual margin comments in the 'Achored instruction' view.

Notice Carol's build-on, "new updates," to her previous posting "Transfer theory into classroom practice." Carol's comment looks like a reminder to herself to put a summary of the class discussion in the virtual margin for the view. That is a potentially very interesting idea. One could put a summary of the class discussion in the virtual margin and incorporate pointers to relevant notes to support the summary. This is a novel use of the virtual margin that had not been anticipated.

6.3.4 Doug

Doug did not test the automatic save feature of the virtual margin. Instead he started his session by making a very short comment in the virtual margin for the first note he read, as shown in the following figure.

the teachable moment and unraveling	virtual margin
How would students learn the computation skills they would need to solve the problem? The authors are critical of the 'basics first' model. The ideal model (#3) is that they learn these things on an 'as needed' basis. So the kids are merrily working on their problem and the teachable moment has come, but is the teacher available at that moment? Maybe not. A possible solution to the problem is to include links to lessons about the needed math skills, but I wonder how deep the students' understanding of these skills will be if they just have to quickly find out how to calculate a rate (or multiply decimals) so they can get on with the rest of the problem. [rest of posting deleted]	CURSORY OVERVIEW OF ARTICLE.

Figure 21: Doug's virtual margin comments in 'the teachable moment and unraveling' posting.

This virtual margin comment appears to be of a similar kind as the 'transient' thoughts recorded by Carol. What is different here is that whereas Carol's comments were mostly reminders to herself, this comment registers an opinion of the note. It is the kind of to-the-point summation that a reviewer might make in the margin of a paper while critiquing an essay. Because these notes are private to him, he could say what he was thinking without having to consider how it would be received by the other members of his cohort. Here are two more examples of Doug making similar comments which are reproduced in the following two figures.

For the adventurous only?	**virtual margin**
(this long posting is to endeavour to make up for my silence of late !) Jasper sounds like an ineresting approach to the eccuational reform that most of the group at Vanderbilt are seeking to influence. The problem, as usual, is what to do with all the knowledge a child and adolescent learns over 12 or 13 years of 'schooling'. Full of facts but no inkling of how to integrate them into real life and transfer skills to other domains. [rest of posting deleted]	JUST A CURSORY OVERVIEW OF ARTICLE - soome insights...not worth the time (alison - avoid future postings)

Figure 22: Doug's virtual margin comments in the 'For the adventurous only?' posting.

The three teaching models	**virtual margin**
I've also been wondering about the questions you raise. I was struggling as I read this to decide which of the three models of teaching I thought were best. It's a 'conudrum' - do we 'bore' the children with the skills first, or do we allow them to forge ahead on the problem only to have them unequiped with the skills to successfully solve it. Particularly in a classroom, where there are bound to be a few groups, working on different aspects of the problem, taking different routes to the answer, it's difficult for a teacher to be where they need to be at all times. And yet something about the middle way, 'structured problem solving' (as I interpreted it, giving the children worksheets to fill in while they work out the best way from a variety of answers) didn't sit well with me either.	repeatiing Alexa's comments - NTHING NEW

Figure 23: Doug's virtual margin comments in the 'The three teaching models' posting.

In order to determine if a note is worth reading, one must read it. As the number of notes and views grows it becomes increasingly difficult to remember which notes, and to some extent, which authors are worth reading. It's impractical to re-read enough of each note to remember one's previous assessment, or do a re-evaluation. Upon reopening the notes that contain these short summary comments, Doug is very quickly able to determine their importance to him and can decide what action he wants to take based on that. In Knowledge Forum without the virtual margin, the process of re-reading at least part of a note would take longer than reading a short virtual margin comment, and so is less time efficient.

It is not known how much re-reading students typically do, however, re-reading is undoubtably required by some knowledge building tasks and it seems the presence of the virtual margin could influence how students approach re-reading in two ways: First by providing a way to make the importance of a note readily obvious, and second by giving students a quick and convenient method to access that information. Quick and convenient access to information leads to changes in behaviour, and application usage, to exploit that information. This highlights the importance of adding a flag to note titles in the views to indicate the presence of virtual margin comments.

The next sample of Doug's virtual margin comments is actually his second usage of the virtual margin. It is presented out of order so that the ones above can be grouped together. This note exemplifies the usage originally envisioned for the virtual margin. It shows Doug "talking to the note." He is engaging with the ideas in the note and developing his responses to them. Those responses are still incomplete, requiring further exploration and expansion. They are not at a point where they could be used as a build-on or top-level note. However, they are preserved in the virtual margin where Doug might come back to them, develop them further or use them in forming his thoughts for another posting.

culture and assessment	*virtual margin*
Yes, I agree that sometimes understanding comes long after mastering the skill. I see that I value skills everday, because I do teach kids to do math my way... I admit it. Teaching children a skill and then having them practice that skill with Jasper-like software would be valuable. It is valuable in part because we can see that they are using a skill which they were taught. Dare I say that it is also a classroom management, an assessment, and a cultural decison that I make. Is there not also value in a child being able to find his/her own way to the answer of a question? I think creators of the Jasper series hoped that teachers would use their software to inpsire "generative thinking". Creating 'thinkers' sounds better than creating students who can compute. When you really get down to it, why do we teach "skills" in the first place? Assessment. Culture. You said it yourself. You asked how many of us learned how to do long division and still know how to do long division. [rest of posting deleted]	False dicotomy: Creating 'thinkers' sounds better than creating students who can compute. Jargon seems to kill this philosophical conversation. To think is to compute - in some structured environements - but the negative conotation for those with 'free will' seems to detract from the usage of technology. Cultural discourse: as static - we teach the way we learned...exppectation that this way is superior to others

Figure 24: Doug's virtual margin comments in the 'culture and assessment' posting.

In the next example of Doug's virtual margin usage, he comments that the note should end the thread. However, the thread does not end there. This note has two build-ons to it, and one of those build-ons in turn has two build-ons as well. So this virtual margin comment seems to be not so much a comment on the note itself, but more of a statement about the note's position in the thread hierarchy. That is, his comments in this location, are aimed at the notes that came after this one, or those note's authors. Doug seems to think that this note completely answers the questions posed by Angela. The ideas do not need to be "built-on" any further, and yet, other members of his cohort disagree. They added four more build-ons.

The virtual margin provided Doug with the opportunity to comment on this disparity between reality and his expectations in a safe location. Posting this comment as a build-on involves a certain amount of risk in how it would be received by the other students (the author of the note in particular). With the virtual margin, he was able to say what he was thinking to address the tension raised by the contradiction between his expectations and his fellow students' actions without worrying about defending his words. This ability highlights the potential for anyone

to say anything without justification. But if the only audience for these "unjustified" thoughts is oneself, then one has the freedom to express things one would normally choose not to express. Further, students have the ability to choose which of those ideas can support justification, be developed and be shared. The virtual margin provides students with another option than self-censorship.

Model three doesn't necessarily preclude direct instruction.	virtual margin
Angela wrote: "The ideal model (#3) is that they learn these things on an 'as needed' basis. So the kids are merrily working on their problem and the teachable moment has come, but is the teacher available at that moment? Maybe not." If all the classroom work done was in groups, I can see what you're saying...the teacher might be with another group at the time when one group suddenly needs to know how to do X. [rest of posting deleted]	This should end the thread - as this post has clarified the questions posed by Angela. ie. instructional model - what the Jasper usage might/should look like in the class

Figure 25: Doug's virtual margin comments in the 'Model three doesn't necessarily preclude direct instruction.' posting.

Doug wrote the longest virtual margin comment of all the participants in response to the note titled "Deja vu all over again. ;-)" which is reproduced in the next figure.

Deja vu all over again. ;-)	***virtual margin***
Lesslie, I'm very suprised that you didn't mention that the idea of "inert knowledge" came up in the Schank reading. You'll have to pardon me, I'm at work and my Schank reading is not so I can't supply a reference at the moment. In fact, the term looks and feels really familiar. I'm sure that Anderson also mentioned it and Papert talked about "dissociated" knowledge--which sounds to be the same thing. I was curious about this concept and so I googled it and discovered a charming paper written by a fellow named Whitehead in 1929. Incidentally, he is attributed with first mentioning inert ideas or knowledge. Whitehead Paper. Fascinating read. I highly recommend it. So, to grossly oversimplify...inert knowledge is bad because it doesn't allow knowledge to be used or transferred. Transfer is something we want to foster because it makes people better problem solvers--and life is purportedly all about solving problems. So, generative learning seems to be the prescription here for dealing with the problem of inert knowledge. When the students themselves are the ones who are figuring out what the problem is and then determining their primary goal and all the necessary sub-goals, especially in a complex problem requiring many steps, then kids brains will be set up to be able to transfer skills from one problem to another. I agree, that the ideas are all very much the same between Schank and co. and Bransford and co. In fact...there is a whole lot of the same ground being covered in all of them. Instruction models number 1 and 2 violate the Schankian "students must learn by doing" commandment. But Papert and Anderson were all about doing. WEll, okay, for Papert it was all about playing turtle. It's interesting that the idea of learning by making mistakes is also presented here as it was in Schank and in Papert. The notion is expressed here in the reason why model number 2 where the teacher structures things is a no-no because it doesn't allow for the trial and error concept.	systems theory: simplistic def'n - all structures are inherently grounded by simple choices - and the entire structure accounts for all oof these possible choices - hence, when we argue that a learner is gaining an understanding of the steps required to solve a problem - it can be argued that the structure of the environment is guiding the learners 'step-by-step' development So inert knowledge - and the need to make it relevant (transfer) can be see as something that is predetermined as ONE POSSIBLE choice of the structure. Why is inert knowledlge 'problematic'? Assumption seems to be that active = good, inactive = inferior. However, active is associated with outward action in this learning environment, wherre does the inward 'reflective' aspect of learning find an avenue in this construct. The bias of this logic seems hard to escape. I'm starting to see that the differences between the various traditions lies in the role in learning that technology plays. THIS MEANS: Learning and Technology are in a dialectical interaction. However, by Faith's statement, Learning remains at the centre of and the focus for this interaction - the technology's ***'interface'*** / contribution to this interaction determines the varying traditions.

Relevance and context are other key points here and I guess that results from the fact that both Anchored Instruction and GBS fit into the realm of Situated Cognition. In fact one could argue that GBS is in fact a form of anchored instruction that is manifested in the form of a simulation rather than a video disc.

I'm starting to see that the differences between the various traditions lies in the role in learning that technology plays.

This week is going to be a challenge to summarize as there are so many interesting ideas!

Figure 26: Doug's virtual margin comments in the 'Deja vu all over again. ;-)' posting.

What is interesting about these virtual margin comments is that with some editing they could have been published as a build-on to this note. Yet Doug chose to keep them to himself, at least for now. Possibly, he is just testing his own understanding and isn't ready to defend it against the other members of his cohort. The virtual margin provides him with the freedom to do this. In a longer study it would be instructive to learn what happens to virtual margin comments such as these. Do they become build-ons, or material for some other note, or upon reflection are they rewritten? The important point is that the virtual margin provides for all these possibilities equally well. It enables new dialogues that create opportunities for new insights and greater understanding that wasn't previously possible.

The last virtual margin comment Doug made is reproduced in the following figure where he responds to, but doesn't answer, the question posed in the note, "to what degree do or should theories have to be practical?"

Anchors away!	*virtual margin*
What's interesting (well, okay, to me anyway) was that when I first read about the Jasper Adventures a while back, I must confess to picturing it as a practical exercise to follow up learning the basics. So...I think the whole point of the illustration is simply to caution us against missing the boat (like I initially did) about how the very nature of the anchor and what theoretically makes it work.	Necessity of theoretical relevance: "it raises a large question in my mind...to what degree do or should theories have to be practical?"
I have a sneaking suspicion that all we are simply meant to take away from the whole Model 3 bit is the point that the Jasper Adventures can't be really be anchors unless they are watched prior to or at the same time as the basic skills are covered.	Major theme of course - but far to influential in critiques of the technologies.
Do you think the horse is dead yet? *grin*	
Kidding aside, it raises a large question in my mind...to what degree do or should theories have to be practical?	

Figure 27: Doug's virtual margin comments in the 'Anchors Away!' posting.

The "Anchors Away!" posting appears in the Anchored instruction view as a 3rd level build-on. It does not have any build-ons itself. No one else in the cohort responded to this question. But it was important enough to Doug for him to create a virtual margin comment specifically to address that question. The comment doesn't directly answer the question which is puzzling because he only has to defend his response to himself. Is it possible that he wrote what he was thinking without thinking further about it? This could be another one of those 'transient' thoughts that the virtual margin was intended to capture. However, Doug references this posting, among others, in the top-level note he contributes, which is presented in the next figure. So it seems that Doug's virtual margin comments represent more than just a transient thought. They are part of his thinking process that lead directly to his top-level note.

Problem solving and the need for guidance

◖ Putting our knowledge together ◗

I found myself laughing and at times shaking my head as I read my peers' posting this week. This is not to say that I was being judgemental in any way - but rather I was perplexed by the need to continually repeat the points made - over and over again.

I think this might be fitting of the problem identified by Anne - the teachable moment and missing it. Far too often - really think all we needed was for Kevin too jump in and say - yeah, you got it! I think Faith tried to get at this a few times: 1 Model three doesn't necessarily preclude direct instruction., but alas, I think we all overlooked her contribution as being 'more information' rather than an insight that we were beating a dead horse.

At the centre of the Jaspper experiment, is the theory that a complex problem can be broken down into its sub-problems, and then worked through by students who learn the 'basics' from a teacher. Now this is a sound theory - but putting it into practice can be difficult - which is why I wanted to bring everyone's attention back to Faith's post entitled: 2 Anchors away!.

I think that the way we went about this entire discussion on KF is a microcosm of some of the problems inherent to the Jasper project - we attempted to break the theory down to its component parts - but seemed to get caught up in these component parts - endlessly revisiting issues addressed thoroughly by our peers. I would like to think this is a very succinct example of theory not translating directly into practice.

And finally, and sorry (& kudos) to Faith for me referencing her so heavily - her post about the nature and biases of inert knowledge seem to play out quite readily in our own experiences on KF: 3 Deja vu all over again. ;-). The KF system is set-up to encourage posting and building on - it is essentially supposed to anchor our ideas to one forum, and then let us build them collectively through they sub-parts. However, a false dichotomy is created by the forum and the technology - that inert knowledge - which translates into inaction and sparse to no posting, is inferior to generative learning which in this forum, encourages multiple postings regardless of their 'value' to the dialogue. It seems unfortunate that KF has, by its very affordances limited the important reflective - inactive knowledge construction.

Figure 28: Doug's posting: a top-level note.

Doug's posting is by far the most complex contribution of the participants. He references three other notes and draws from the virtual margin comments he has made in order to write this posting. The question naturally arises, is this a better posting then he would have written without the virtual margin? It is impossible to know with certainty, but the "pre-processing" work he did in his virtual margin comments prior to composing this note was influential in directing his thinking. Whether this is a better posting because of the virtual margin is probably the wrong question to ask. The goal of knowledge building is to improve ideas – to build on them to make them better in some sense. If the presence of the virtual margin leads people to evaluate their ideas multiple times before presenting them to the rest of the participants, then that in itself is probably a valuable thing.

6.4   Participants' Perspectives on Their Virtual Margin Usage

After completing the Knowledge Building assignment, the participants were interviewed in a semi-structured setting using a series of questions designed to obtain their perspective on their experience in using Knowledge Forum with the virtual margin.   In this way the researcher's analysis of their actions could be balanced by the participants' own interpretation of their actions. The questions were:

1.   What did you use the virtual margin for?
2.   Did it help? In what way?
3.   Did it hinder? In what way?
4.   Was there something you wanted to to but couldn't?

The following sections describe the participants' responses to these questions. Included in the discussion are some comments from the researcher on points raised by the participants.

6.4.1 Andy

Andy described his use of the virtual margin as "collecting thoughts and specific passages or paragraphs from several postings in order to choose the best one to reply to. I was actually correcting my response as I was doing it." He said that the virtual margin helped him in composing his posting because he could record the things he collected and attach them to Knowledge Forum. Where the affordances of the system hindered him was in locating where he had made a virtual margin note. There was no indication at the view level of which postings had a virtual margin note attached to them. That meant that finding a virtual margin note he had made earlier entailed opening each of the notes he had read earlier until he found the virtual margin note for which he was looking.

Knowledge Forum already has an indicator at the view level next to each note's title to show which notes the participant has read. Andy's request could be handled in one of two ways. Either another icon could be added next to the existing one, or the existing one could be replaced by another one of a different colour. Perhaps a two colour icon would be appropriate to indicate the presence of public and private content.

Another area of concern for Andy was when he wanted to refer to two windows side-by-side. He observed that the width of the note windows, each with a virtual margin, would make it impossible to view two windows side-by-side on a smaller screen. (The computer monitor used in the study was a 17-inch LCD screen with a resolution of 1440x900 pixels.)

Andy raises an interesting point. A screen with more available 'real estate' affords interfaces and interactions that smaller screens do not. The Knowledge Forum note and view windows fit comfortably on an 800x600 size screen, which was a very common size for many years. However, the Knowledge Forum note and view windows with the virtual margin added do not fit on that size of monitor. At minimum, a 1024x768 size monitor is required. Even with that, two note windows, each with a virtual margin, would not fit on the screen at the same time. It takes the larger 1440x900 size screen to make that possible.

When this study was being planned, little thought was given to the appropriate screen size to use. The only consideration was that the screen should be comfortably large to accommodate the Knowledge Forum windows with the virtual margin in them. By being generous on the screen size, additional, unanticipated interactions became possible, as Andy demonstrated.

6.4.2 Bob

Bob said that he used the virtual margin as a way of "putting stickies on the fridge door." He made notes to remind himself what he should go back and look at, or add to, or publish. He believes that the addition of the virtual margin was especially helpful in a Knowledge Forum view with a threaded discussion because "you can't really read a whole lot into the (posting) titles." The virtual margin gave him a way to remember which notes were important. He could write down reminders that he knew would stay there like a sticky in a book. Bob believes that the virtual margin didn't hinder him at all because it was optional and unobtrusive. He didn't have to use any more keystrokes or click any buttons. He remarked that he didn't explicitly have to save his annotations and "that's kind of nice actually."

Bob remarked that he would like to be able to make comments in another colour, like the 'track changes' feature in Word documents does. The functionality for this already exists in the features provided by TinyMCE (the library that provides the rich text editing capability). However, that feature and many others were turned off

in the interest of providing a simple and uncluttered interface. The choice of which features should be re-enabled, and perhaps which should be disabled, will require further investigation.

Another thing Bob said he would like to be able to do, but couldn't, was to click on the links in the virtual margin so he could go directly to the note or document. He specifically mentioned wanting to be able to link to Wikipedia. This is possible, but raises the question of where the target of the link should appear.

The natural place to display the target page is in the browser window containing the link which is a Knowledge Forum note or view window. Because it is not a full browser window, some browser features are suppressed, it is a poor choice. As well, rendering the target page in the Knowledge Forum window would hide the virtual margin when it could be highly beneficial to have the virtual margin available for note-taking purposes at the same time has the content to which it refers.

The assumption when the virtual margin was being designed was that the virtual margin comments would refer to content in the same window as the virtual margin. However, Bob's request makes clear that this is not always the case. It is evident that there is no reason to arbitrarily limit the usage of the virtual margin in this way. Indeed there is value in being able to make notations that reference works outside of Knowledge Forum. In order to do that, the virtual margin must remain visible; so the target of a link in a virtual margin must be rendered in a separate pop-up, window.

Bob also stated that he would also like to be able to attach virtual margin comments to a paragraph in a posting. This is a very tricky problem for a couple of reasons. The first is that the positioning of any particular phrase or paragraph is dependent on variables that are subject to change at any time. For instance, the browser window could be resized or the reader could choose a different font face or size. Either of these things could cause the text to be reformatted resulting in the margin comments losing their position relative to their intended text. There are ways in which this problem could be handled (World Wide Web Consortium [W3C], 2001). However, there is still the issue that Knowledge Forum view contents are dynamic and Knowledge Forum notes are editable by their authors.

A view's contents change as new postings are added to it. These new postings can occur at the end of the hierarchy as new notes, or any place between the first and last posting. This will necessarily cause the relative positions of the pre-existing note

titles to change, which has the potential to cause the relative position with some virtual margin contents to be lost. Similarly, because a note's contents are editable, any positional relation a virtual margin's content might have to them will be lost if the author decides to change that particular content. It should be mentioned here that the note author has no way to know what virtual margin notes might exist and be affected by a change to a note's content. (Except in the case where authors have made comments in the virtual margin notes of their own notes of course.)

One more thing that Bob wants, just as Andy does, is some indication at the view level of which postings have margin notes attached to them.

6.4.3 Carol

Carol said that she primarily used the virtual margin for creating reminders for herself, and also for expressing her feelings. She used the virtual margin space for reminding her what she wanted to do further, e.g. that she might want to contact someone, to remember something to discuss in class, or compose for her project portfolio. She feels that the virtual margin helped because it's easy to see by the side of the window and she didn't need to click anything; she can immediately see what is in it. Carol said that the presence of the virtual margin didn't hinder her in any way.

What Carol couldn't do that she wanted to be able to do, is flexibly organize the notes in the view window. She said that it is not easy to organize a view and that it would be great if she could use the virtual margin to organize, sort or categorize the notes within a view. This is an interesting idea, especially considering the way that Bob used the virtual margin for a similar purpose. It is possible to drag text, with links, into the virtual margin and arrange them however one likes. The disadvantage of this is that because the contents of the virtual margin are not dynamic, they are not automatically updated with the view content. Thus, the student has some "house-keeping" to do if she wants to maintain the organization. This could quickly become tedious in an active view.

6.4.4 Doug

Doug described his use of the virtual margin as a means to record interpretations of other people's postings. Upon reflection, he thought perhaps he was trying to describe what their assumptions were. Doug also said that he was trying to identify a ranking system and make notes of what he was thinking. When

asked if the virtual margin helped, he replied that it did because when he went back to revisit a posting, he didn't read the posting, but the comments that he had made in the virtual margin as "that's all that was relevant." He as also able to see several virtual margins and read them at the same time to see if there was a common theme that he was subconsciously building as he made his virtual margin notes. In particular, Doug said, regarding his posting, that he "probably would not have come to that realization, if [he] wasn't making comments to [himself]." If the virtual margin was to hinder him, Doug said that it might be in the way he used it to read his own comments rather than the postings because he "was just picking out one or two minor bits and writing to that." His rationalization for this is that at least he read it once and so "[found] the one flaw or positive in their argument and [built] upon that."

When Doug was asked if there was something he wanted to do but couldn't, he replied "Well, if you put audio in there, that'd be great." This is a very interesting idea that that was not considered in planning for this study. Audio annotations, suggested by Doug, would require a very different type of interaction than the text-based virtual margin, and that would require some interface changes.

Audio annotations could be implemented as an additional optional feature. Supporting audio annotations is complicated by the absence of any provision for manipulating or playing audio streams in Javascript. This means that adding support for audio annotations will require some kind of plug-in mechanism to provide the necessary access to the computer's microphone and speakers. While using a plug-in would violate the 'no plug-ins' design constraint (Section 4.1), the system can be designed to degrade gracefully in the absence of support for the audio enabling plug-in. That is, while browsers that have the audio plug-in would have audio annotations, browsers that did not have the plug-in, or have it disabled, would not. In the event that a student had audio annotations, but was using a browser without this functionality, a message could be placed where the audio controls would normally be located to indicate their presence and explain that they can't be played.

The last thing Doug asked for (as Bob did) was the ability to link out to other documents.

In the next section we consider the virtual margin from a quantitative point of view to gain an appreciation of the usability of the feature.

6.5   System Usability Scale

The System Usability Scale (Appendix 3), SUS, is a questionnaire designed to be very easy to administer, and to yield a quick assessment of a system's usability. It was administered to each participant after the completion of their task. Brooke explains the System Usability Scale this way:

> The SUS yields a single number representing a composite measure of the overall usability of the system being studied. Note that scores for individual items are not meaningful on their own.
>
> To calculate the SUS score, first sum the score contributions from each item. Each item's score contribution will range from 0 to 4. For items 1, 3, 5, 7, and 9 the score contribution is the scale position minus 1. For items 2, 4, 6, 8 and 10, the contribution is 5 minus the scale position. Multiply the sum of the scores by 2.5 to obtain the overall value of SUS. (Brooke, 1996)

It can readily be seen that System Usability Scale scores range from 0 to 100, with higher values indicating a more usable system.

In the following table are the SUS questions and the responses of the study's participants. Each individual's responses (Andy, Bob, Carol and Doug) are indicated by the first letter of their name.

Question	Strongly Disagree				Strongly Agree	Scores			
	1	2	3	4	5	A	B	C	D
1. I think I would like to use this system frequently.		A		B	C D	1	3	4	4
2. I found the system unnecessarily complex.	B C D	A				3	4	4	4
3. I thought the system was easy to use.				A	B C D	3	4	4	4
4. I think that I would need the support of a technical person to be able to use this system.	A B C				D	4	4	4	0
5. I found the various functions in this system were well integrated.		A	B	C D		1	2	3	3
6. I thought there was too much inconsistency in the system.	A B C	D				4	4	4	3
7. I would imagine that most people would learn to use this system very quickly.				A	B C D	3	4	4	4
8. I found the system very cumbersome to use.	B C D	A				3	4	4	4
9. I felt very confident using the system.				A A D	B C	3	4	4	3
10. I needed to learn a lot of things before I could get going with this system.	B C D	A				3	4	4	4
Totals:						28	37	39	33
SUS scores:						70	92.5	97.5	82.5

Table 2: Summary of the System Usability Scale responses.

Computing the average of the SUS scores yields a score of 85.6 which indicates a high degree of usability. While this is not conclusive (the SUS is a "quick and dirty" assessment after all) it does provide some assurance that the virtual margin interface element as implemented in the Knowledge Forum application is very usable.

6.6   Summary

While the four study participants used the virtual margin for a wide variety of purposes, they did not have any trouble with how the virtual margin worked and they were able to use it to achieve their goals without difficulty. Their SUS scores reflected this ease of use. The following table provides a quantitative overview of the virtual margin's usage by participant.

Participant	time for task (minutes)	number of comments	number of words in comments	number of notes	SUS score
Andy	34	2	159	1	70
Bob	37	9	209	3	92.5
Carol	22	6	43	0	97.5
Doug	49	8	386	1	82.5

Table 3: Summary statistics of each participant's virtual margin usage.

The unique way in which the virtual margin operates led some participants to start their session by checking if the virtual margin really does save and restore their comments as described. Once past this initial exploration phase the participants wrote contrasting opinions to notes' content, reminders of updates to make later, assessments of notes, and one used it to record her feelings. The affordances of the virtual margin enabled them to quickly make comments that might not have survived an interface that required more thought or awareness to use. From the ease of use and the types of virtual margin comments that participants made, it appears that the virtual margin was successful in achieving the goal of interface transparency.

Even though the participants were able to use the virtual margin as a memory aid and use it to develop their ideas, there were several things that they wanted to be able to do that the virtual margin does not currently support. These are things like

choosing from multiple text colours to easily differentiate between their own words and text copied into the margin, working links so they can easily access other referenced works, adding audio comments as another way of expressing their thoughts, and having indicator icons at the view level so they can easily find their margin notes again. All of these features are possible and could be incorporated into a future version of the virtual margin.

7 Discussion

Before you become too entranced with gorgeous gadgets and mesmerizing video displays, let me remind you that information is not knowledge, knowledge is not wisdom, and wisdom is not foresight. Each grows out of the other, and we need them all.
— Arthur C. Clarke

The intent of the virtual margin is to support people's thinking by aiding their remembering. This can only work if the virtual margin does not interfere with their thinking (it does not distract them). The design tries to achieve this by making annotations as easy to create as possible so that annotators will be able to focus on what they want to remember rather than the means to make that happen.

The virtual margin implements annotations very differently than any previous web annotation feature. In summary, the major differences are:

1. there is no dialogue to navigate, not even a "save" button,
2. the annotation input area is relatively large,
3. annotations are always visible in the context that inspired them, and
4. annotations are private to their author.

Once a reader has decided to create an annotation, or edit an existing one, merely positioning the input cursor is all that is required before the person's thoughts can be written. Rather than making annotators navigate a dialogue to create their annotations, the virtual margin simply requires a single mouse click within the large input area, and the annotating can begin. The annotator does not have to decide, or remember, to save the annotation. That is done automatically. In this way readers would be able to make the kinds of "unstructured" annotations that people make when they want to remember something that interests them. The goal of the virtual margin's design is to remove the annotation interface as an inhibitor in the process of creating annotations. From the results of this study, it appears that the virtual margin was successful in achieving this goal.

7.1 Implications

In Chapter 1, it was noted that the practise of making annotations used to be taught as a part of formal schooling, but the practise fell out of favour when libraries and shared books became common. Even so, people still find it a useful thing to do. They make photocopies and annotate them, and with the advent of the World Wide Web, they print web pages and annotate those. Annotating paper copies of web pages is problematic, as discussed earlier. With the virtual margin however, web annotations become practical. Because web interfaces have not provided a means for private annotations, introducing them as an integral part of knowledge building is likely to have unforeseeable consequences.

Given the short duration of this study, it is difficult to say with any certainty how the virtual margin would impact knowledge building in a semester long course or longer term project. The manner in which participants used it to complete the task assigned for this study suggests that the presence of the virtual margin could be very useful not only in aiding people's remembering, but also as a place where people can work with their ideas and explore new lines of enquiry. This study indicates that adding the virtual margin to the Knowledge Forum interface provides knowledge builders with another tool that they can use to improve their ideas. It would be very interesting to see whether the potential implied by the virtual margin usage in this study is realized in an actual knowledge building class.

The presence of the virtual margin allows knowledge builders to pose and answer questions to themselves that they otherwise would not. This gives them the opportunity to think about them in greater detail. By giving people a place whey they can gather their ideas, thoughts and evidence for their arguments in private, they are able to develop support for a position without the burden of having to justify it to their peers until they are ready to do so. Similarly, they can question anything they see in a note without then having to worry about how the question will appear to the other Knowledge Forum participants. Therefore, it seems likely that the virtual margin could also lead to greater meta-cognition in the people that use it.

7.2   KF with VM does not impose 'total publicity'

There are two main differences between Knowledge Forum without the virtual margin and Knowledge Forum with the virtual margin. The first is the ease in which new ideas can be saved using the virtual margin because there is no waiting for the system to get itself ready to accept the keystrokes and no dialog telling the system to remember them. The second difference is that Knowledge Forum with the virtual margin does not require total publicity. The virtual margin introduces a private space adjacent to the public space. The two are connected but completely independent. People can very quickly and easily write whatever they want in the private space, take some time to think about what they have written, and then decide whether they want to contribute it to the public forum. Even if they chose not to publish it, as a note in a view, the virtual margin comments still remain available. A decision not to publish can be revisited at any time. As a result, the system no longer imposes a "post it or lose it" ultimatum. The lifting of this ultimatum means that people are likely to write more, and do so more freely. The expectation is that as a result they will think more about what they are reading.

7.3   Public vs. Private spaces

The relationship between public and private spaces is reminiscent of the "cave and commons" characterization attributed to Marvin Minsky. The general idea is that people need a private place to work and think, but we also need a public place in which to share ideas and to contribute to shared projects. The cave is a private place where one goes to practice, prepare and investigate. The commons is a public place where one goes to share, view and participate. The two places are complementary. It appears that excluding either leads to dysfunctional interactions. For example, if everything is public people become self-censoring, and if everything is private people can not share and learn from each other. From this perspective, the virtual margin is an attempt to attain a balance between the public and private spaces in knowledge building.

Just as it is the lack of privacy that leads to self-censorship, it is the expectation of privacy that leads to the lack of self-censorship. If the expectation of

privacy is violated, for instance, by an instructor reading and commenting on virtual margin comments, then a large part of the value of the virtual margin is undermined.

7.4   Future of Virtual Margin

In the course of performing this study several new features for the virtual margin were suggested by the participants and research advisors. They also proposed some ideas for a longer term study. These features and ideas are briefly discussed in the the next two sections.

7.4.1 Potential New Features

The following is a list of some major enhancements that have been suggested for the virtual margin. Some of these are fairly straight forward and have obvious benefits. Others will require some investigation to determine how best to approach them and even whether they should be added to the virtual margin.

1. Make links in the virtual margin active, or "hot".

   This seems like an obvious thing to do. Probably the best way to address the implementation would be to have the target of a link in the virtual margin appear in a new, full-featured pop-up window. There are two major problems with having the target appear in the window containing the virtual margin. The first is that the Knowledge Forum view and note windows are not fully functional. For instance the location bar and other features are disabled. The second is that it is likely to be very useful to have the virtual margin comments and the target they refer to available at the same time.

   While one can put links into the virtual margin using drag-and-drop, it should also be possible to add links without using drag-and-drop. It should also be possible to edit the links in order to change their label and target. The library of code that the virtual margin uses has this ability, so this would be an easy feature to add. Doing so will require the addition of a link edit dialog and some mechanism to activate it.

2. An indicator in the view next to notes that have virtual margin comments.

This feature was requested by a couple of participants so that they could more easily find the virtual margin comments that they had made.

Adding this feature is somewhat harder because it requires parsing the HTML in the view to obtain all the note URLs, checking each note for comments and altering the HTML for the view to include the icon as necessary. Getting this right could be tricky. However, based on the participants' feedback, it is an important feature to add. The question arises what should the indicator be? A note that has not been read has a turquoise icon, a note that has been read has a red icon. Perhaps a note with comments in the virtual margin should be red on the left side and a contrasting colour on the right side. Some colour theory investigation would be appropriate here.

Given that the HTML for the view needs to be modified to set the icon, and that the system has to know of the virtual margin comments to set the icon correctly, it would be possible to create a mouse-over effect that contains at least part of the content of the virtual margin. That is, instead of the person having to click on the note title and waiting for the pop-up to load in order to read the virtual margin comments, simply moving the mouse over the icon could cause the browser to reveal them (or a portion) in a tool-tip or similar device. This could be very useful time saving technique to refresh one's memory of the note and margin comments.

3. Search the virtual margin contents.

Knowledge Forum has a feature that searches the contents of the posted notes, but it does not know about the virtual margin. In an active Knowledge Forum system with a large number of notes and views, it would be very useful to have a way to search one's virtual margin comments without having to view each one separately. Adding a search feature imposes several design questions: where should the search box go, where should the results be displayed, what happens when a person clicks on a search result? To answer these questions will require creating a prototype and testing it to understand the interactions and how they can best be integrated into the system.

4. Should the history of changes to the virtual margin comments be preserved?

Currently each virtual margin update replaces the previous virtual margin contents. Effectively, the new contents erase the old. This seems natural and maps nicely to the experience of writing and erasing in the confined space of a paper margin. However, the space in the virtual margin is not so confined. It can grow as large as the system resources can support. This means it is not really necessary to delete the old contents to make way for the new. The old can be preserved as well. The new comments would appear in the virtual margin and a means could be added (search?) to make previous versions accessible as well. There are potential advantages to a system that never forgets, but what does it mean when deleting virtual margin comments does not really delete them? It is unknown what impact that could have on people's expectations and experience in using the system. Taking away the ability to delete virtual margin comments is probably a wrong thing to do. Perhaps a balance could be struck where the virtual margin comments are preserved, but could be deleted by an explicit command to do so. This behaviour could be modelled in the paper realm by using "stickies" to place notes. Each new note is placed on top of the previous one. Yet notes could still be deleted by removing the appropriate sticky.

5. Add audio notes.

One participant suggested that being able to make audio annotations might be useful or desirable. This is very interesting because it is something that is not possible with paper annotations. The NCSA browser back in the early 1990's had this feature so there is precedent for it. Audio annotations could be an option in addition to, rather than a replacement for textual annotations. It seems natural to use the rewind, record, play/pause and fast forward controls people are familiar with. However, the real design questions are how best to include the audio controls and indicate the presence of an audio annotation. Could there be more than one audio annotation on a page, and if so, how would that be managed, for example to select one to play or delete? These are questions that will take prototyping and experimentation to explore and understand.

Audio annotations are likely to suffer from some of the same limitations as voice-mail messages. Audio messages are not searchable or easily scannable. When there are several of them, it becomes difficult to remember what is in each one. Remembering things is a problem that the virtual margin was intended to help solve. So if an audio annotations feature is added it will need to be done carefully to prevent re-introducing old problems.

6. Move the button bar to the top of the input area.

The virtual margin's button bar in the study was placed at the bottom of the input window. However, the button bar for most applications is usually placed at the top of the application window. For consistency sake then, the virtual margin's button bar should be moved to the top as well. This would also have the added advantage of shortening the mouse travel distance between the buttons in the bar and the text on which they operate.

One feature of the virtual margin that none of the participants discovered (it was not demonstrated to them) is using images in their annotations. Images can be dragged into the virtual margin, similar to the way text can be dragged in. Once an image appears in the virtual margin it can be resized and repositioned. While this study did not lend itself to this kind of annotation usage, the ability to include images in one's annotations seems potentially very useful.

7.4.2 Longer Term Study

A short term study such as this provides only a peek at the potential of the virtual margin. For this study the participants had only one period of interaction with Knowledge Forum and the virtual margin. A knowledge building exercise however, normally takes place over the course of a semester or a year. During this time the students would return to the same views and notes multiple times. The participants' interactions with the virtual margin during this study indicate how their virtual margin notes *might* be useful in a later session. It still remains to be seen how *in fact* the virtual margin comments are used in subsequent Knowledge Forum sessions.

Over a period of longer usage, my expectation is that participants would develop more complex uses and that these uses would change over time. We have already seen several examples of how the virtual margin supports people's thinking

and it is highly unlikely that these are the only possibilities. As people gain familiarity, and accumulate a body of virtual margin comments, they will develop new patterns of usage that have not be anticipated. This raises the question of whether, and how, older virtual margin comments could lead to and support later comments.

In EDUC 809, students were given an assignment to put together a portfolio that demonstrates how their understanding developed over the duration of the course. Essentially, the elements of the portfolio were limited to the work that had been submitted for grading and Knowledge Forum notes (some of which were also graded). Students' virtual margin comments would be fair game for inclusion in this portfolio, which highlights the question, how might the presence of the virtual margin affect the long term development of students' understanding? Annotations on paper have been shown to aid understanding and contribute to retention. My supposition is that annotations in the virtual margin could have similar beneficial effects.

The virtual margin has been shown to affect participant's posting behaviour. This was expected. However, the virtual margin also has the potential to affect student's reading behaviour as well. As Hewitt discovered, "... threads can die unintentionally as a by-product of a seemingly unrelated activity: reading new notes and ignoring older notes" (Hewitt, 2005). One of the effects of the virtual margin is leading people to return to notes that they have read before. Could the virtual margin then cause people to change from a "single pass" strategy in reading Knowledge Forum notes to some other kind of strategy based on the content of their virtual margins?

If people can skim their virtual margin comments as suggested in the previous section, might that lead them to revisit an earlier note and decide to continue the discussion? Could simply the act of making virtual margin comments, even without the ability to skim them, be enough to inspire people to make additional build-ons? Could the presence of the virtual margin mitigate early thread death? A longer term study could provide some clues to answer these questions.

7.5   Summary

Knowledge Forum is a tool for knowledge building in which a group of people work together to understand new ideas and help each other to improve them. In an active Knowledge Forum discussion there can be a large number of notes and threads of conversation. As a result, it becomes difficult to maintain a coherent picture of which notes are important from one session to the next. The virtual margin was conceived as a simple means to support people's knowledge building by aiding their remembering. The hope was that by making it easy for people to remember relevant ideas and comments in the context that inspired them, knowledge builders would be able to develop their ideas more effectively. Instead of having to remember the content of multiple notes simply by the reminding prompted by their titles, the virtual margin provides the means for knowledge builders to record their nascent thoughts in an always visible location (the view virtual margin) so they don't have to go looking for them. People can also be reminded by seeing their commentary again even if they had forgotten it. Private virtual margin comments in a note can later serve as the basis for a public build-on or a rise-above posting. However, instead of having to commit to contributing such a note immediately, people can stop and return knowing that they won't lose anything by doing so.

The act of annotating can turn passive readers into active readers. Because annotators are more engaged in what they are reading, and as they develop a better understanding and better retain what they have read. While the ability to annotate web pages was part of the original design of the World Wide Web (Berners-Lee, 1989), the feature has fallen into disuse. It is now rare to see annotations supported in web applications. That Knowledge Forum has annotations is quite surprising. Unfortunately, Knowledge Forum's implementation is not conducive to remembering because it increases cognitive load, and the enforced publicity provides an incentive to self-censorship. The virtual margin has been designed specifically to address these concerns by making the interface extremely easy to use and keeping annotations private.

The participants in this study benefited from a personalized introduction to the virtual margin. In a longer term study, with a larger number of students, such an introduction would be impractical. Some thought needs to be given to how to make the function and features of the virtual margin discoverable. Currently, placing the mouse over one of the button bar icons reveals a tool-tip which indicates the purpose

of the button. This is fine as far as the button bar goes, but the virtual margin input area itself did not provide any hints as to its purpose. There are a couple of things that can be done to address this. For example, a background graphic could be added to the virtual margin, providing its name and a short summary of its use such as "Virtual Margin: whatever is placed here will automatically be saved and returned." Another thing that could be done is relocate the virtual margin's button bar to the top of the input area. This would make the virtual margin look like more a familiar word processing application interface which would help people to understand what it is. These two things would greatly contribute to people understanding the virtual margin on their own.

In this study the virtual margin was used effectively by the participants to facilitate their completion of a simple knowledge building task. The participants demonstrated a variety of uses for the virtual margin beyond simply as a memory aid. Some of these ways were surprising that had not been anticipated. Potentially, the benefits we have seen in the participants' sessions would be compounded over the course of a semester, or a year, and lead to greater understanding and insight into the forum topics. An updated version of the virtual margin that includes the changes discussed has the potential to do an even better job of supporting knowledge builders' thinking.

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Appendices

Appendix 1 – Consent form

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Informed Consent By Participants In A Research Study

Title: Usability Testing Virtual Margins

Investigator: Carl Forde, cjf@sfu.ca

Department: Faculty of Education

Purpose:

       To investigate the relative usability and utility of adding a virtual margin to the interface of a web forum.

Procedures:

       Each participant will use a web browser on a computer to access a discussion forum. Participants will be able to view the postings and record annotations directly on the screen. (Each participant's annotations will not be viewable by any other participant.) The researcher will take notes on the participant's interaction with the web page components. The computer screen during the sessions may be video taped and audio recorded, subject to the participant's approval.

Risks to the participant:

There is minimal risk to participants. The activities are non-threatening and non-invasive. Any participant who feels uncomfortable may choose to stop participating at any time and have the record of their session destroyed.

Benefits of the study to the development of knowledge:

The information obtained will help to improve the researcher's understanding of the affordances of virtual margins for annotations in Knowledge Building.

A copy of the results of this study, upon its completion, may be obtained by contacting Carl Forde at cjf@sfu.ca

The University and those conducting this research study subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of participants. This research is being conducted under permission of Cheryl Amundsen, Associate Professor ofSimon Fraser University's Faculty of Education. The chief concern is for the health, safety and psychological well-being of research participants.

Should you wish to obtain information about your rights as a participant in research, or about the responsibilities of researchers, or if you have any questions, concerns or complaints about the manner in which you were treated in this study, please contact Kevin O'Neill by email at koneill@sfu.ca or phone at 604-291-3476.

Any information that is obtained during this study will be kept confidential to the full extent permitted by professional ethics. Knowledge of your identity is not required. You will not be required to write your name or provide any other identifying information on research materials. Materials will be maintained in a secure location.

Having been asked to participate in the research study named above, I certify that I have read the procedures specified in the Study Information Document describing the study. I understand the procedures to be used in this study and the personal risks to me in taking part in the study.

I understand that I may withdraw my participation at any time. I also understand that I may register any complaint with Kevin O'Neill or Carl Forde.

Participant Last Name   Participant First Name
Participant Contact Information
Participant Signature   Date: (mm/dd/yyyy)

Appendix 2 – Session Protocol

Task:

Use the Knowledge Forum web application to review a collection of forum postings, use the virtual margin to make notes, and make your best contribution to the discussion.

Through each session the researcher will answer questions posed by the participant. The intent is to assist the participant in finding an answer rather than telling the participant a particular answer.

--- camera aimed at participant & camera aimed at screen ---

Pre-Assignment questions:

1.   M / F

2.   What was the first language you learned to speak?

2.   How many years have you used computers?

3.   How many computer operating systems are you familiar with?

--- Review Virtual Margin ---

--- Introduce the assignment ---

4.   How have you approached this kind of assignment previously?

What tools did you use?

What frustrations did you experience?

--- Perform assignment ---

Prompt the participants if they get "stuck" or
appear confused.
e.g.   what are you thinking? what it is you want to do?
Record observations of participant's behaviour.

--- Post assignment questions ---

5.   What did you use the virtual margin for?

6.   Did it help? In what way?

7.   Did it hinder? In what way?

8.   Was there something you wanted to do but couldn't?

Appendix 3 – System Usability Scale

System Usability Scale

	Strongly disagree				Strongly agree
	1	2	3	4	5
1. I think that I would like to use this system frequently					
2. I found the system unnecessarily complex					
3. I thought the system was easy to use					
4. I think that I would need the support of a technical person to be able to use this system					
5. I found the various functions in this system were well integrated					
6. I thought there was too much inconsistency in this system					
7. I would imagine that most people would learn to use this system very quickly					
8. I found the system very cumbersome to use					
9. I felt very confident using the system					
10. I needed to learn a lot of things before I could get going with this system					

Usability Testing Virtual Margins

by

Carl Forde

Simon Fraser University

IKIT Summer 2005

Toronto, Ontario

Abstract

This study explores the feasibility and usability of a "virtual margin" feature in a knowledge building environment by comparing two possible implementations in a simulated discussion forum. The subjects were graduate students in an Education and Technology program. The paper contains a explanation of the motivation and key design considerations concluding with a discussion of the study results and suggestions for further exploration.

Introduction

Knowledge building (KB) applications are intended to enable people to share and build on each other's ideas. A guiding concept is "improvable ideas". Because it takes time to improve one's ideas, it is often desirable to be able to easily associate a thought or piece of information with something one has read so one can come back to it at a later date. Ideally, the KB application interface would supply the means to do this because people's memories are far too fallible and managing pieces of paper is far too cumbersome. Unfortunately, in KB applications annotations are difficult to use and everything one writes is immediately shared with the rest of the community. While sharing ideas is central to KB, often people have ideas that they aren't ready to share. They want some time to work with them and consider multiple perspectives. Yet, with no convenient way to record these thoughts, the ideas aren't put into words and so are easily forgotten—lost to the people who had them originally, and their KB community.

In the physical realm of books and journals, margin notes, or annotations, provide an easy way for people to record their thoughts for later reference. When a person returns to a page, any comments made earlier are also present. The comment automatically retains its context and so supports the person's remembering what prompted it. This allows the person to collect information and privately reflect on their ideas.

By adding a "virtual margin" to a knowledge building environment, the members of the community will be able to save their thoughts in a convenient location without giving them the weight and visibility of publishing them for everyone else to see. This gives people the ability to better consider their thoughts

and "talk to themselves" before they talk to others. This removes the anxiety of exposing their nascent ideas to the KB community before they are ready to do so. Implicit in this, is that a virtual margin is a private area for each person. No one can see the contents of anyone else's virtual margins. This allows people the freedom to say things to themselves that they wouldn't allow themselves to say to anyone else. As a result people have the ability to express things they otherwise wouldn't which enables them to come up with ideas that they otherwise wouldn't.

This study explored the feasibility of the virtual margin feature. The idea was to enable "writing in the margin" as in a real book or journal. There were three key design decisions. The first decision was that the virtual margin would allow editing web pages without opening a new interface element to do so. By not presenting a new interface element, people would be able to focus on what they wanted to record, without having to also think about how it is being recorded. The second key design decision was that clicking in the virtual margin should not cause the presentation of the web page to move in any way. The reason for this is that if the margin were to scroll partly out of the viewable area, then clicking in it could make the browser scroll the web page down so the input cursor would be visible. Additionally, allowing the virtual margin to scroll completely out of the viewable area would defeat its purpose. Either result would be distracting. In effect, this means that the virtual margin must remain fixed within the browser window. This led to the third design decision; to make the virtual margin as tall as possible to make the best use of the viewable space. The margin had a fixed width of 200 pixels which takes up approximately ¼ of the horizontal space on an 800x600 monitor. On monitors with higher resolution, this would be proportionately less space. This seemed a reasonable compromise for the purposes of this study.

With the basics of the virtual margin decided, the issue became how to present the actual page content next to it. The study compared two possible implementations to learn which of the two is more usable. Usability is a relative concept indicating how easily used an object or feature is. The intent was to discover which virtual margin implementation works more in the way people expect the feature should work. Or to put it another way, which implementation is more predictable and less surprising [Raymond, 2003; Wikipedia, 2005].

Literature Review

The idea that it would be useful to be able to associate comments with an arbitrary web page has been around from the earliest days of the World Wide Web [NCSA, 1993]. Yet the web as we know it today, does not have this feature. This seems strange considering the time and effort that has gone into developing web browser and web server functionality. It seems the annotations feature has almost been ignored until very recently.

The Firefox web browser provides a facility for 3rd party developers to write extensions to it which can provide additional features. One of these extensions, called Wikalong, provides a wiki environment that enables people to associate comments with web pages. A wiki is a web site that allows its visitors to edit its web pages as well as read them, typically with no editorial review before the changes are made public. [Wikipedia, 2005]. Comments written in the Wikalong extension are stored on the wikalong server that makes them available to everyone who is using the Wikalong extension and viewing the web page associated with the comments. The developers characterize it as a "wiki-margin for the internet" [wikalong, 2005]. It is very much in line with the approach described by the NCSA. All comments are public and can be edited by anyone. Both the Wikalong developers and NCSA talk about provision for private group servers.

The key design points here are that the comments are stored completely separately from the web pages—it is the browser that brings them together, and all comments are publicly editable.

Knowledge Forum is designed to support knowledge building communities. It has a completely different style of annotation. In this application, annotations are created by opening a dialogue window that contains a small text input box, entering the comment and choosing the text with which to associate the annotation. Once the input box is closed, a small yellow icon is placed next to the selected text to indicate the presence of an annotation. These annotations are publicly viewable and can be seen by clicking on the yellow icon. In this way, the comments remain hidden until the reader chooses to see them. This process of creating and viewing annotations is somewhat cumbersome and tends to be used for short comments that don't merit their own posting note.

Fle3 is another application intended to support knowledge building [Leinonen, 2002]. In this application annotations are added by clicking on an "Add annotation" link at the bottom of an article. This presents a page where annotations can be read and new annotations can be added. Again, annotations are hidden until specifically requested to be seen, and then they are all publicly viewable. While each annotation is associated with a particular article, they are not viewed in the context of their articles. This creates a separation between them that weakens the relationship between an article and its annotations.

COSE is a Virtual Learning Environment [COSE, 2003] that took another approach to adding comments to web pages. The COSE interface has a margin in which a variety of features are located. Among them is an icon which activates the Margin Notes annotation interface. It opens a dialogue box in which the comments may be entered. Once a comment has been entered and the dialogue box closed the icon then indicates the presence of a comment. This comment may be kept private or shared publicly [Stiles, 2003]. Entering and viewing of the annotations is again a multi-step process.

Under active development is an annotation feature for Moodle which "... is a software package for producing internet-based courses and web sites ... designed to support a social constructionist framework of education" [Moodle, 2005]. The approach the developer has taken is along the lines of a physical margin which contains the annotations. The main content of the page is on the left side of the browser window and down the right side of the page is a grey box where the annotations are placed. An annotation is created by selecting some text and clicking the "New" button. This creates a numbered entry in the margin with a small input box into which the annotation may be typed. The annotations are publicly editable and may be hidden or visible at the viewer's option by clicking an appropriately labeled button. The grey margin is always present.

All of these annotation and commenting systems require the person to perform several actions before starting to type the their thougts. The risk with this is that every step in the process is a decision point where the person can decide not to bother. In most cases once the process of making a comment is complete, the comment is hidden until it is specifically requested to be seen. In only one case does the system support private comments. As a result these systems only tangentially support people's remembering. In contrast, the desire for the virtual margin

proposed in this study is to get as close to "no interface" as possible. That is, to make the barrier of use so low that it won't be an inhibitor. People would be able to focus on what they want to express – not the mechanism for doing so. The goal is for the means to be "transparent".

Methodology

The study took place over two days in the Centre for Education Technology in the Education building at Simon Fraser University. Four graduate students of a Masters of Education and Technology program used a prototypical web forum application, that has a virtual margin feature. They read forum postings and made notes using the virtual margin.

The web forum application was written in two parts: A Linux server running an Apache web server using Perl and Mason (a suite of Perl libraries) accessing a MySQL database, and a browser interface written using HTML, CSS and JavaScript. For purposes of the study, the participants used the Firefox web browser on Mac OS X. Other browsers, and operating systems, could be used, but this was not pursued due to time constraints.

The web forum was "pre-loaded" with views and notes from a Knowledge Forum database that the graduate students had created in a previous course. This provided the participants with content on familiar subject matter and a familiar structure. The names in the forum (author names and names in the postings) were anonymized by using the list of the 10 most popular boys and girls names in 2004. The assignment of real names to new names was done at random.

The participants, two men and two women, were asked to review postings of their choice and make notes in the virtual margin as they went. The expectation was that this would take about 5-10 minutes for each person. Instead the sessions lasted 25-35 minutes as the participants read and took notes avidly.

For each page request the server randomly chose one of two presentations as represented in the diagrams below. The blue-grey (left) is the document text area, the light-grey (right) the virtual margin (annotation) area, and the dark grey areas are the scroll bar controls. As usual, the scroll bars only appear as needed to view content outside the viewable area.

<div style="display: flex;">
<div style="width: 50%;">

Two Boxes:
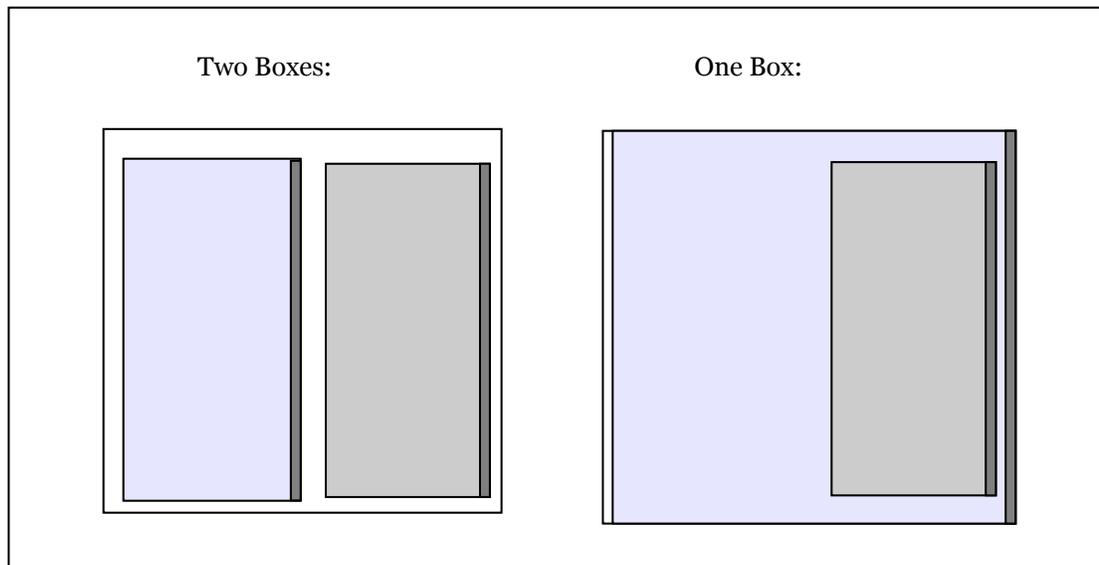
The document and virtual margin areas are fixed in the browser window, the areas scroll independently. The scroll bars are adjacent to their respective scrolling areas

</div>
<div style="width: 50%;">

One Box:

The virtual margin area is fixed while the document area scrolls in the browser window. The effect is that the margin "floats" next to the document. The scroll bar for the document is in the usual location, however it appears to be distant from the area it controls.

</div>
</div>

Figure 2 Comparison of the two virtual margin implementations

While the participants were using the web application the observer took notes on a survey form (Appendix One) which was designed to capture some basic demographics and record observations about the participant's interactions with the web forum application. The demographic information was intended to provide context for understanding each participant's responses/behaviours in the expectation that these might correlate with one or more of computer experience, web comfort level or gender. Another possibility considered was that there could be a demographic split, which would suggest that in a real application it would be appropriate to provide both interfaces and allow people to choose their preference.

Each session took place in the Centre for Education Technology in the Education building at Simon Fraser University using an eMac computer with a Firefox web browser. The first session was video taped. The recording captured both the audio and interactions on the computer screen. Unfortunately, the result was unusable because the video images of the computer screen were so severely distorted. For the remaining sessions, a tape recorder was used instead.

Virtual margin notes are associated with a username so before the start of each session the observer loaded a "log in" page in the web browser and pre-filled the username and password fields. The observer also readied the tape recorder to record the audio of the session. At the start of a session the participant sat in front of the eMac with the log in page displayed while the observer sat on a chair where he could easily see the screen and make notes. The observer then explained that the web application would display the EDUC 804 postings with a virtual margin in which they could write whatever they wanted. He did not mention that there would be two different presentations. The observer filled out the demographic information on the survey and asked them to ask any questions and voice any confusions they had while they used the application. Next the participant signed the consent form. (Appendix two) With that done the tape recorder was started and the participant clicked on the log in button. The first page after logging in presented a list of views next to the virtual margin. Selecting a view displayed a threaded list of postings in that view. Selecting a posting displayed the content of that posting. The participants were not able to alter or edit the views and postings – only the contents of the virtual margin displayed on each page after logging in was editable.

For the data analysis, the intent was to group the observations according to what particular feature caused difficulty. This turned out not to be useful. Instead, the observations and responses were grouped into four broad categories: Comments, Questions, Requests and Difficulties. While there is some overlap between them an effort was made to classify each response according to how it was expressed by the participant.

Results

The primary result of the study is that difference between the two virtual margin interfaces was of no consequence. None of the participants noticed that there was two different presentations. Until it was pointed out to them that sometimes the page was constructed one way and sometimes another, no one noticed. After the difference was pointed out to them, two participants said that they preferred the two boxes format with one person offering that he felt more control with that presentation. One person said that both formats were easy to deal with.

In addition to this result, much feedback was received that hadn't been expected. This was grouped into the categories: comments, questions, requests and difficulties.

Comments:

The comments centred around the usefulness of the virtual margin: What it is and what it is good for. As Ryan (names are fictitious) said "this is a place to collect my thoughts," or as Hannah put it, "It's a thinking pad. Whenever a thought comes I can get it down." Olivia voiced the idea that she "...could use this to code my own thoughts." Olivia and Hannah both voiced the opinion that the virtual margin would have been useful in 804, with Hannah adding that "it would probably improve my posting quality and quantity."

Questions:

The questions fell into two categories. The first could be characterized as "trust." Hannah was concerned about the presence of public and private information in one web page. She wanted to understand how content of the private space, the virtual margin, could be moved into the public space, the web forum. Olivia wanted to know "How long do the comments stay?"

The second category is questions about features for working with the text within the virtual margin. As Matthew asked "Why is the input position always at the top?" and "How do I move the text down?" Ryan and Olivia were more specific and asked if it was "...possible to relate a comment to a specific point in a note?"

Some feature questions had a "word processing" flavour to them. Two people asked if there was a spelling checker. Another asked if it was possible to use italics or colour to differentiate text pasted into the virtual margin. Hannah asked if graphics and tables were available.

Other feature requests related to working with virtual margin comments on their own. Hannah wanted to be able to take notes from one page to another. Taking this idea a little further, Olivia asked if she could ".. look at all the comments in one spot?" She also wanted to be able to sort her comments.

On the interface element level, Ryan asked if he could have the margin on the left and Hannah asked if it could be resized. Matthew wanted to know if it was possible to "apply this to an arbitrary web site."

Requests:

There were two things that were specifically asked for. That is these were not just expressed as questions, but put forward as essential functionality that should be present. The first one is a "margin-note" indicator attached to the view and note titles. That is, if a note or view has a margin note associated with it, some visual indication should be added to their titles. The second request was for a "summary" view or some means for the "margin note to 'bubble-up' to the next level" as Hannah phrased it.

Difficulties:

The participants did have some difficulties. Two things gave them pause. The first concerned the ability to use cut and paste within the virtual margin. Initially the participants were hesitant to use this feature. It took a couple of usages before they gained confidence that it worked in the usual fashion.

The second issue that the participants had trouble with was that the "content" and margin notes reflow and scroll independently. Some of this was hinted at earlier in the questions around positioning the cursor within the virtual margin. The virtual margin contents are not "fixed" to the page text as in a physical document. This break in the metaphor requires some conceptual re-adjustment.

Discussion:

This study looked at the usefulness and usability of a virtual margin feature in the context of a Knowledge Building forum. Gratifyingly, all the participants thought it was very useful and were enthusiastic about the idea. One person liked it so much that he asked if it was possible to use it in conjunction with arbitrary web sites.

The usability issues that were anticipated were completely missed by the participants. They simply did not notice the variations in presentation. The fact that

the content scroll bar was sometimes to the right and sometimes to the left of the virtual margin seemed to be of no consequence until it was pointed out to them. The observation recorded during Matthew's session was that the vertical scroll bar was a "strong attractor". That is, whenever he wanted a vertical scroll bar; he found one and used it. This was consistent with the behaviour of the other participants. This strategy was successful because there was only the one scroll bar—there wasn't enough text within the virtual margin to cause a scroll bar to be displayed there. It could be then, that the presence of a vertical scroll bar on the virtual margin might cause the kind of usability problems that were anticipated at the beginning of this study.

The subtext heard from Olivia's question about how long the virtual margin notes last and the separation between public and private content is "can I trust this thing?" This is a valid concern with any new interface. It is likely that the question of trust is also behind the participants' apprehension over using cut and paste. The virtual margin is an unknown quantity. It will take people some acclimatization time before they become comfortable with it. This means that the issue of trust is of central importance. Before people will use it to record their unvarnished private thoughts, they must trust that those margin notes will not show up in some unexpected place. People also need to develop the confidence that what they put in the virtual margin will come back. Any failure in either of these areas is liable to jeopardize its acceptance and thus its usefulness.

An unexpected benefit of this study is an awareness of the ways people envision using a virtual margin. This has broadened the scope of its applicability. It is capable of much more than just supporting people's remembering. It provides a new way for people to work with their own ideas. The implications of this are worth exploring further. How would people really use this feature, and what would they actually use it for?

Another unexpected benefit is the list of features that the participants desired in a virtual margin. Some of these would be easy to add, such as aggregating margin notes for postings to their view level. Others such as word processing features are more difficult, but are still possible in some browsers. The challenge here is how to provide this kind of functionality in a confined space without introducing a degree of clutter that compromises the basic functionality and interface transparency. Some lessons from the development of wiki markup languages could be useful here.

Conclusion

A knowledge building environment is defined as "[a]ny environment (virtual or otherwise) that enhances collaborative efforts to create and continually improve ideas" [Scardamalia & Bereiter, 2003]. Adding a virtual margin to a web forum application opens up new ways for people to interact with their own ideas as well as the ideas of other community members. By supporting individual people's remembering, the expectation is that virtual margins have the potential to improve a community's knowledge building.

The differences between two virtual margin implementations went completely unnoticed. In addition, the presence of a virtual margin next to typical forum content (notes and views) did not cause the participants any difficulties. The response of the participants enthusiastically supported the virtual margin idea and offered many suggestions for improving its usefulness.

This study was fairly limited in scale and scope as the participants were merely reading and recording their thoughts. There was no expectation, or pretense, that they would revisit their virtual margin notes at a later date. An expanded study could add a virtual margin, designed with some of the feedback obtained, to a knowledge building environment to learn how this feature would be used in a real knowledge building effort with more participants.

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Appendix One: Survey Form

Task:

      Use the web application to review a collection of web forum postings and use the virtual margin to make notes.

Questions:

1. Sex: M / F

2. Computer experience: 1-5 5-10 10-15 15-20 years

3. Web comfort level: low 1 – 2 – 3 – 4 – 5 high

4. Initial reaction to the format of the postings?

5. Any trouble understanding the interface components?

6. Able to add/alter margin notes?

7. What "issues" arose?

8. Participant questions?

Appendix Two: Consent Form:

Simon Fraser University

Faculty of Education

8888 University Way

Simon Fraser University

Burnaby, BC V5A 1S6

Informed Consent By Participants In A Research Study

Title: Virtual Margin Annotation Interface Comparison

Investigator: Carl Forde, cjf@sfu.ca

Department: Faculty of Education

Purpose:

      To investigate the relative usability and affordances of two methods of adding a virtual margin to the interface of a web forum.

Procedures:

      Each participant will use a web browser on a computer to access a discussion forum. Participants will be able to view the postings and record annotations directly on the screen. (Each participant's annotations will not be viewable by any other participant.) The researcher will take notes on the participant's interaction with the web page components. The computer screen during the sessions may be video taped and audio recorded, subject to the participant's approval.

Risks to the participant:

      There is minimal risk to participants. The activities are non-threatening and non-invasive. Any participant who feels uncomfortable may choose to stop participating at any time and have the record of their session destroyed.

Benefits of the study to the development of knowledge:

      The information obtained will help to improve the researcher's understanding of the affordances of virtual margins for annotations in Knowledge Building.

A copy of the results of this study, upon its completion, may be obtained by contacting Carl Forde at cjf@sfu.ca

The University and those conducting this research study subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of participants. This research is being conducted under permission of Cheryl Amundsen, Associate Professor ofSimon Fraser University's Faculty of Education. The chief concern is for the health, safety and psychological well-being of research participants.

Should you wish to obtain information about your rights as a participant in research, or about the responsibilities of researchers, or if you have any questions, concerns or complaints about the manner in which you were treated in this study, please contact Cheryl Amundsen by email at cheryl_amundsen@sfu.ca or phone at 604-291-4853.

Any information that is obtained during this study will be kept confidential to the full extent permitted by professional ethics. Knowledge of your identity is not required. You will not be required to write your name or provide any other identifying information on research materials. Materials will be maintained in a secure location.

Having been asked to participate in the research study named above, I certify that I have read the procedures specified in the Study Information Document describing the study. I understand the procedures to be used in this study and the personal risks to me in taking part in the study.

I understand that I may withdraw my participation at any time. I also understand that I may register any complaint with Cheryl Amundsen or Carl Forde.

Participant Last Name   Participant First Name

Participant Contact Information

Participant Signature
Date: (mm/dd/yyyy)

Appendix 5 – EDUC 804 Outline

SFU Graduate Programs

Year:	2003-3
Semester:	Fall Semester
Course	EDUC 804-5
Number:	Cat. # 80984

Instructors:		
	Name:	Dr. Kevin O'Neill
	Office:	EDB 8667
	Phone:	604-291.3476
	Email:	koneill@sfu.ca

Course title:	Selected Problems in Educational Uses of Technology
Time and Location:	Thursdays 16:30 - 21:20 in EDB 8501 /CET Instructional Lab
Prerequisites:	Admission to Education and Technology Master's or permission of instructor

Course Description:

This course offers an introduction to the field of Education and Technology, with an emphasis on efforts to reshape schooling and professional education through the use of computers. Through readings, project work, and a combination of on-line and in-class discussions, we will survey several major traditions of research and development in this field, and attempt to make sense of the whole. One emphasis will be placed on understanding the arguments and assumptions that each tradition of work in Educational Technology makes about how learning happens, what constitutes a valuable educational outcome, and how we would know if it was achieved. Another focus will be the question of how and why technology-based innovations for learning spread or fail to.

Assignments:

Grades will be assigned on the basis of the following:

20% Contributions to between-class discussions (on-line)

40% 'Tradition' paper

10% Peer reviews of two other student's 'Tradition' papers

30% Personal inquiry (oral presentation and brief written summary)

Each of the above items will be assigned a letter grade, according to criteria that will be discussed in class. The weighted average of the components listed above will become your final grade in the course.

Late Policy

If you are late in submitting something for class, marks will be deducted from what you earn for the assignment at a rate of a half letter grade per day. This formula means that it is possible to get an A on a perfect assignment which is one day late. After three days, a perfect assignment could only receive a B+. At five days late, the best a perfect assignment could get is a C.

On-line Discussions

Our on-line discussions each week start with each student making a short written reaction (about 200 words) to the assigned readings for class, and posting it on our on-line discussion forum. This should be done by Monday evening at the latest so that other students can read it and respond. Your on-line reaction may be one or a combination of:

- your own reasoned stance on an issue or question raised in the readings an exploration of a theme that you observed in one or more of the readings

- a discussion of something in the readings that excited, confused, surprised or offended you

Since our class meets face-to-face each week, the purpose of the on-line discussion is to maximize what we get out of the face-to-face discussions in class, not replace them. Having some limited discussion on-line prior to class helps to ensure that everyone has thought a bit about the readings before we meet, and given consideration to how others thoughts about them differ. With this done, we can concentrate our face-to-face discussions on evaluating

the ideas that have been put forward, and working toward a more thorough and cohesive view of the ideas we are working on.

'Tradition' paper

Your major assignment for the course will be an 8-page paper that explores in depth one of the traditions of research and development on the syllabus. There is a lot to know about each of these traditions that we will not have time to cover in class, and you will get to choose which tradition is of greatest interest to you personally. For each tradition I can recommend some additional reading to get you started, but you will also need to spend time in the library and on the Net, finding additional resources yourself.

Your major project is meant to be more than a summary of sources. We've all written enough book reports for one lifetime! Your submission should, instead, offer a reasoned and persuasive view of what you've read. You can choose any angle you like on the material, but at a minimum, your paper will have to address the following questions, which may not be directly addressed in the resources you collect:

What 'big idea' (or ideas) about learning drives this tradition? What does this tradition assume a valuable learning outcome is?
How do the big ideas behind this tradition differ from those that drive other traditions?
What sort of "track record" does this idea have? Give a brief history of the work done.
Based on this track record, what do you think the future of this tradition will be, or should be?
What general lessons does this tradition offer to educational technologists about doing 'good' design?
(Note: You do not need to explicitly organize your text around these questions, so long as you directly address them somewhere.)

Peer reviews of other student's papers

As the introductory course for our Master's specialization in Education and Technology, this course should help establish a learning community within your cohort. Ultimately, your professors should not be the only ones offering you feedback on your work you should be able to rely on one another for feedback as well. To this end, when you prepare a draft of your

major paper for the course, you will submit copies to two of your fellow students, as well as to me. You will also write two brief, constructive reviews of other students! work, focusing on the most obvious ways in which they can improve their submissions.

Personal Inquiry

While this course is meant mostly to provide a base of knowledge for your future work in the program, I know that every student has personal and professional scholarly interests to explore in relation to Education and Technology. I do not want to make you wait until your second semester in the program to begin doing this. To this end, you will have some structured opportunity in this course to 'locate' your professional interests within the literature, in consultation with your peers, your instructor and other professors affiliated with the program. This is your opportunity to do some investigation to resolve (or at least open up) questions such as:

Who in the field has considered questions and problems like those that concern me?
How do they talk about these questions and problems?
What progress has been made on understanding and dealing with these questions and problems?

Your inquiry may have to do with specific technologies (e.g. PowerPoint) or teaching practices (e.g. Problem-based learning), or may be more oriented around ideas (e.g. motivation to learn). Like the 'Traditions' paper, this component of your grade will require some independent search of the literature on your part; but you won't be entirely alone, The class will work together on-line and in person to help you get a fix on what interests you, and find at least one or two publications that can serve as resources for you. Before the course is over you will make a short oral presentation to the class about your inquiry, and make available a summary of how your ideas developed through it. We will discuss evaluation criteria for both components of the grade in class.

Required Text / Readings:

There is no textbook for this course. Photocopies of all required readings will be distributed in class. A photocopying fee will be charged.