The Effect of Window State on User Behavior in an On-Line Computer Mediated Conference

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Abstract

The goal of this study was to investigate the effect the window state and management on the ability of users to maintain coherent interaction within an on-line mediated conference. Industry design practice suggests that users should be able have direct control of the windowing display system. In order to conform to industry practice the IdeaWeb was redesigned from a single window display system to a modeless tiled window display system. It was assumed that a modeless windowing system would be preferable because the underlying graphic display system was dynamic.

The results indicate that the students generally opted for a single window display system which is consistent with much of the previous research. Sequence data from the event logs demonstrate that students chose to treat the modeless window as static or modal. It appears that the students were concentrating on the cognitive task of managing the on-going computer mediated discussion.

This study has important consequences for screen and window design not only for developing on-line conference systems, but within multimedia systems that have dense cognitive material. If the cognitive requirements of the main window are high, then a titled windowing system that requires little user intervention appears to be the design choice. However, if the requirement to recall information from window to window is low then a single window system display system is more appropriate. This would reduce not only the cognitive but the design and programming overhead as well.

Keywords — windows, computer -mediated communication, small group discussion.

1. Introduction

Collaborative learning as an instructional method has a long history. It can be found in the Academy of Plato to the one room school house of the 19th century. The positive effects of the many different forms of collaborative learning have been well documented. [1].

Social learning environments create situations in which schoolwork is perceived not as a "task" or "chore" but as an opportunity to interact on issues of personal importance. The advantage of authentic interaction provides not only individual cognitive development but also creates an important social environment with far reaching consequences. One of the many benefits of collaborative learning is that it requires students to challenge, reject or integrate the new information [2] which leads to deeper understanding. In a social environment students engage their peers with talk that informs, explains, persuades or even entertains. This process is provides what Stasser and Davis [3] terms knowledge building and is accomplished when one tests an understanding against the "common authority" and requires access to multiple perspectives other than one's own.

Even though collaborative learning is viewed as a legitimate method for classroom instruction, experts suggest that less than 10 percent of the nations schools regularly use cooperative learning techniques [4]. Implementing a change from the traditional classroom to one that values discourse, therefore, is not a simple matter. However, networking technology may provide a solution to this dilemma. In fact "Technology is a great Trojan Horse... It is a great way to get cooperative learning in the door" [4, p. 27]. By providing the opportunity for authentic peer interaction, each student will development an awareness of authorship and the need for rhetorical competence. However, most computer systems were initially not developed for the more dynamic simultaneous multi-channel interaction of group interaction. Typically, "E-mail is a great tool for person-to-person messaging but it fall flat when you're coordinating a discussion... Traditional E-mail packages just weren't designed with work groups in mind: [5]. R. L. Bangert-Drowns [6] suggests that "different communication interfaces might be suited to different instructional tasks. In situations where students are not just discussing, but collaborating on goal-focused work. . .different interfaces might be needed". Levin, Kim and Riel concur and speculate that "once we have a more detailed understanding of the nature of the interaction, we will be in a good position to address the issue of which medium is effective and for what purpose" [7,p.185]. Consequently, group interaction is hampered by the design of the user interface.

One area in which the typical social computing application breaks down is in its inability to manage the development of coherent discourse over time. McGrath [8] observed that when members can choose when to participate an unpredictable lag in feedback is created in contrast to typical face-to-face. In real time interaction an individual has the ability to index multiple speakers by tracking who-said-what-to whom-when. The ability to keep track of an ongoing conversation is accomplished through the use of turn-taking rules where one participant takes control of the floor and continues until they relinquish it to another which results in an orderly "distribution of talk among the various members" [9, p 296]. This indexing mechanism allows an individual to cogently and appropriately respond to a variety of different speakers at different times [9 p 296].

In a typical on-line system, however, individual responses are managed linearly making the thread of a discourse sequence difficult to follow. This break down in the ability of members to engage in a coherent interaction leads to "individual reasoning, not collective reasoning" [10, p.149] However, by merging the pragmatic needs of interaction with a conventionalized graphical representation participants in a collaborative learning system are be able to locally manage turns. This results in sustainable, coherent interaction.

The IdeaWeb© addressed this need by merging the pragmatic principles of conversation with a visually oriented interface. [11,12]. A salient feature of the IdeaWeb is the user display system which requires each group member to map their interactions visually thereby enabling group members to quickly determine not only to whom a message was intended but also the position of that message in an on-going sequence of messages [12] .

The intial version of the IdeaWeb used a single window display system. However, it was assumed that the visual display system played an important role in helping the user to contextualize previous messages. With the current design, the graphic display is obscured while the user is reading previous messages. Consequently, in order to improve performance within the system and to conform with current interface practice the IdeaWeb was redesigned in order to implement a multiple window system providing the users with more control [13].

Previous window design research indicates that user performance is effected not only by type of the window display system but also by the cognitive requirements of the task. For example, in a study that explored the ability of users to find information in a single text window in contrast to multiple overlapping windows, it was found that novice users performed much better on the task using the single window display. However, as the users became more proficient in the task and more efficient in using the interface, the readers "benefited more from multi-windowing displays because these helped them locate the information they have just read" [14, p. 613]. Further, Aspillaga [15] investigated the effect of window location in conjunction with the overlapping of graphic information in a language tutorial. She found that a consistent window position had a significant effect on performance than the overlapping of a graphic illustration. Benshoof and Hooper [16] in a study using a CAI tutorial found that high ability students performed significantly better in the single window treatment than all other students.. They suggest that the single window display may have helped the students to process information more deeply. They caution however, that these results may be due to the superior cognitive skills of the high ability students who were able to overcome the higher processing memory requirements of the single window display. In a more recent study this caution seems to be well founded as Benshoof, Graves and Hooper [17] report that all students performed significantly better in a tiled multi-window display system because it acted as supplementary memory aid in support of the main window.

Modern windowing systems allow for not only the positioning of windows such as overlapping and tiling but also different window states. The primary state for most applications has the foremost window active and is considered the top window. If other windows are simultaneously open, they are inactive and are located behind the main window. To activate a background window, a user would choose a window by clicking the mouse somewhere within its boundary. This action changes the state of the current main window to inactive and moves it to the background while bringing the selected window to the top. Normally, a user could perform this action at any time. However if the top window is in a modal state, the user must first complete a task in order to either dismiss, activate or manipulate another window. On the other hand if the top window is in a floating, modeless state, moving between windows does not require activation or result in a state change because all windows are active.

Schneiderman [18] suggests that a "general problem for computer users is the need to consult multiple sources rapidly, while minimally disrupting their concentration on their task." [18, p. 337]. The IdeaWeb was designed to enhance coherence by inhibiting the breakdown of interaction by supporting context building through the graphic display of the links between messages in an going sequence of interaction. It was assumed that maintaining coherence in the IdeaWeb would be enhanced by allowing the user not only to read continuous sequences of comments but also to reposition or resize the window in order to be able to view the position of the current node in a sequence of nodes. Therefore to conform with current interface design principles a modeless window system would permit the user to reposition, resize the window thus would allowing the user to view the underlying graphic with minimal interference from the system.

In contrast, Shneiderman [18] also argues that dense, crowded and complicated displays are difficult for novices to use, the typical student in most instructional situations. If Schneiderman is correct then the high cognitive requirements of managing asynchronous interaction in a computer mediated system would suggest a single modal window system would be preferable. The system would require each user to view a sequence of interaction without the distracting interference of the graphic display or the need to mangage the window such as resizing or repositioning. Consequently this study investigated the effect of the window state on user's behavior in an on-line mediated coherence.

2. Method

2.1. Subjects

In order to investigate the effect of window modality 32 undergraduates in a self-paced introductory computer literacy course at a major southwestern university volunteered to participate in this study. The students had little previous computer experience. Students who met the minimum requirements of participation received bonus academic credit for the course.

2.2. Materials

As indicated before the salient feature of the IdeaWeb is the displaying of previous comments as a web of interactions. (Figure 1).

The IdeaWeb was modified so that there were two conditions. The first condition used a floating, modeless tiled window display system which could be repositioned, resized or closed at any time by the user. (Figure 2).

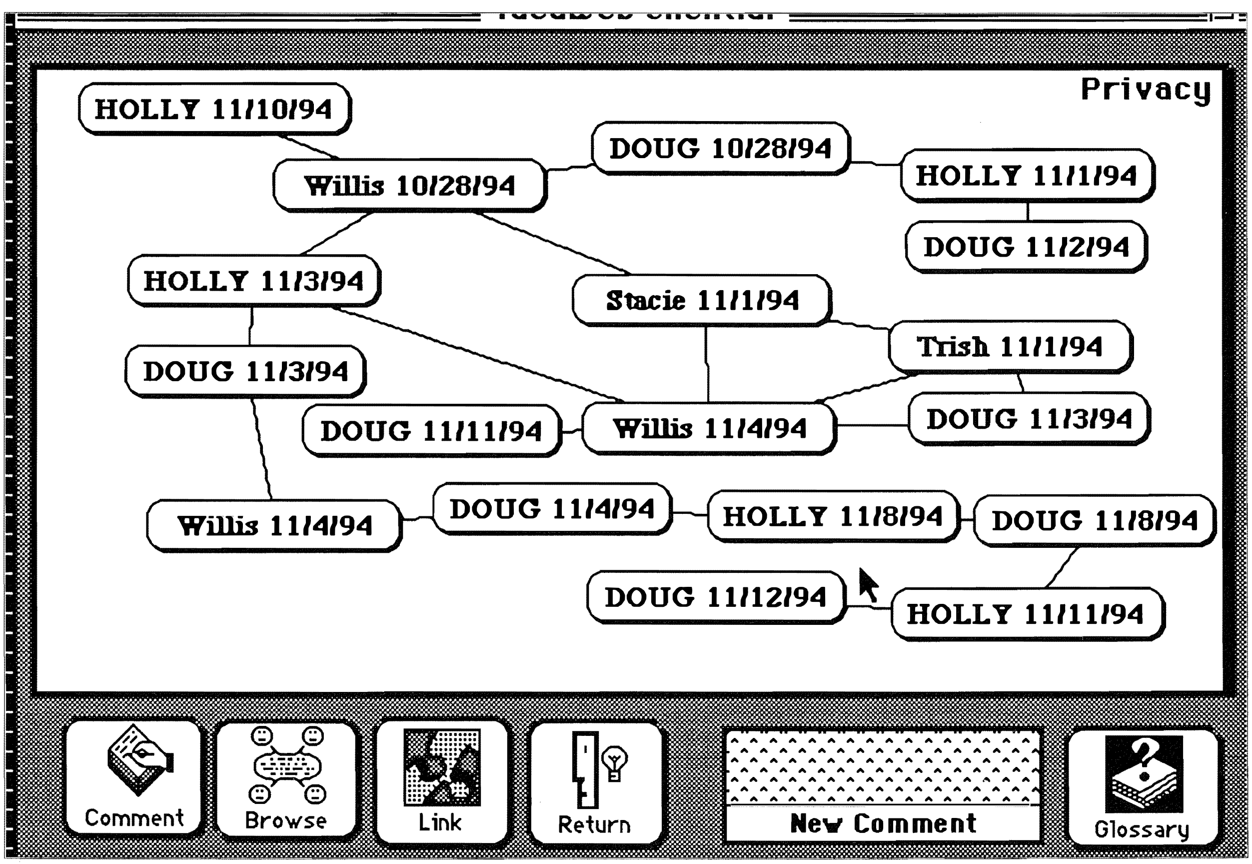

Figure 1. Web of interactions.

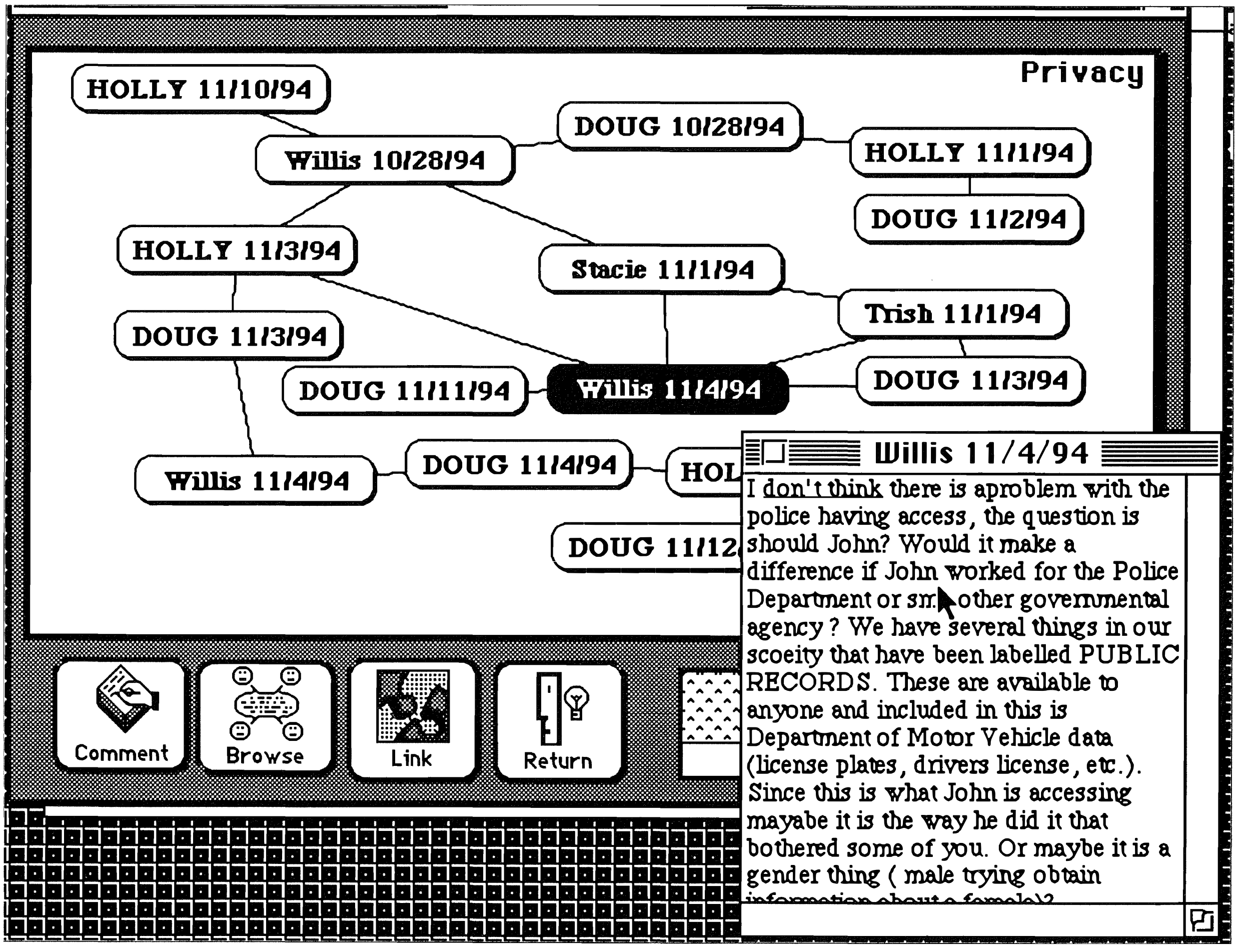

Figure 2. Modeless window moved and resized.

The second condition used a single window modal display system that not only obscured the graphic, but also required the user to review a sequence of messages prior to returning to the graphic display.

2.3. Procedure

Experimental conditions were based on the window display system. The students were randomly assigned to 8 discussion groups of approximately 5 members per group. They were to participate in a laissez-faire discussion concerning some topic. In addition, other topics provided an area for announcements of interest to members of the group and another for the users to voice concerns about the study, credit, and problems with the software etc. The students were required to use the system at least twice a week during study.

2.4. Data Collection

This study used a mixed design with an within-subject independent variable of window state [modal and modeless window] and a between subject independent variable of group. Each group was randomly assigned and trained in the use of a particular window condition. At the end of a two week period, each group was re-assigned and re-trained during an interim week on the use of the new window condition. The study continued for a second two weeks and maintained an event log for each member each time they logged on.

3. Analysis

The dependent variables of participation, time, number of messages, and length of messages were analyzed using a completely randomized block design with repeated measures. There was no main effect for groups. However, there was a main significant (WILKS' LAMBDA [3,22]= 62.5251775 P=0.000) effect within subjects by interface. However, subsequent univariate investigations were not significant for number of visits, length of messages, number of messages or number of words per message.

Table 1. Repeated Measures Table

Between Subjects					
Source	SS	DF	MS	F	P
Group	2393.61	7	341.9	1.3	0.288
Error	6263.29	4	260.9		
Within Subjects					
Interface	79528.7	3	26509.5	154	0
Interface * Group	7886.3	21	375.5	2.2	0.007
Error	12367	72	171.7		

Link data was modeled using directed graph theory. Initially, the individual messages by window state were arrayed into an adjacency matrix for each group's subtopic. Formally, an adjacency matrix A(D) = (a_{ij}) is defined as a square matrix in which a_{ij} represents each individual message as defined by the intersection of row i with column j [19,20,21]. If a message in row (v_i) is linked to a message in column v_j the resulting value of a_{ij} is scored 1, otherwise the value of a_{ij} is scored 0.

An adjacency table allows for the investigation of additional information. The outdgree or row sum indicates the number of directed links a particular node makes to any other node.

The outdegree data was found to be was significant (χ^2= (3,N=292)=9.167, π = 0.027) by window type. The modal window environment produced more multiple node links than the modaless windowing system.

Table 2. Link Frequency by State

	1	2	3	4	Total
Modeless	10	89	26	9	134
Modal	18	117	21	2	158
Total	28	206	47	11	292

Statistic	VALUE	DF	P
Chi-Square	9.17	3	.03

The adjacency matrix also allows for the construction of a distance matrix [19] which tabulates the length of interconnected nodes. By raising the adjacency matrix to a power indicates the length of the path between the nodes. If an integer appears in any of the cells, it indicates that the row node is a specific number of links away from the column node as determined by the power to which the matrix was raised. Therefore, if the adjacency matrix is squared (A x A) the data can be arrayed in a distance matrix for further analysis. The resulting analysis indicates that there was no statistical difference between the two window states in the length of discourse sequences (see table 3).

Finally, a tally matrix according to events was constructed out of the sequential data as recorded by the event log. A first order Markov process was found in the sequence data (see table 4) as indicated by the transition probability matrix.

This table shows the events and the probabity of an event following an event. For example a window opening followed by a node was 100%. Additionally it indicates that a node followed by a window occured almost 42% of the time. The window-node-window or

Table 3. Frequency of Sequence Length by Window State

	1	2	3	4	5	6	7	8+	Total
Modeless	170	141	107	58	30	15	11	12	544
Modal	167	150	123	86	40	18	7	6	597
Total	337	291	230	144	70	33	18	18	1141

Statistic	Value	DF	P
Chi-Square	9.010	7	0.25

Table 4. Event Probabilities

Event	Window	Node	Resize	Move	Comment
Window	0	1	0	0	0
Node	0.417	0.386	0.020	0.020	0.155
Resize	0.571	0	0.142	0	0.285
Move	0.078	0	0.026	0.842	0.052
Comment	0.446	0	0	0	0.553

Statistic	Value	DF	p
Chi-Square	377.7	16	.000

window-node-node-comment were typical sequences within the modeless environment. These sequences mimic the modal environment which was controlled by the system. Notice that it illustrates that the participants chose to manipulate the modeless window system a litle more than 2% of the time either to reposition or resize the window.

4. Discussion

The goal of this study was to investigate the effect the window state and management on the ability of users to maintain coherent interaction within an on-line mediated conference. Industry design practice suggests that users should be able have direct control of the windowing display system. In order to conform to industry practice the IdeaWeb was redesigned from a single window display system to a modeless tiled window display system. It was assumed that a modeless windowing system would be preferable because the underlying graphic display system was dynamic.

Previous research on user performance in using different types of window display systems indicate that the cognitive task is an important design factor. Benshoof et al. (in press) found that when the main window was cognitively important, the tiling of the window provided a useful device to help recall important information. Aspillaga (1991), discovered that an overlapping window did not diminsh performance when the data being displayed was more important than viewing an underlying graphic on the main window. However, when the overlapping window was inconsistently located created a higher cognitive load with a subsequent decrease in user performance.

The results indicate that the students generally opted for a single window display system which is consistent with much of the previous research. Sequence data from the event logs demonstrate that students chose to treat the modeless window as static or modal because they so infrequently moved or resized it even though they were permitted to do so. It appears that the students were concentrating on the cognitive task of managing the on-going computer mediated discussion. This explains why there were no significant differences between the two window systems in terms of amount or length of the messages or in the length of the interaction sequences. The underlying graphic display of the link nodes served as a orienting device which once viewed could be obscured without disrupting the comprehension of the ongoing discussion.

Nonetheless, by only partially obscuring the underlying graphic (see figure 2) may have interfered with the students' concentration. This may explain why there was a significant difference in linking data between the systems. Users in the single window modal system were significantly more likely to link a comment to multiple nodes . Because the modal system forced students to review comments linked to a node prior to returning to the discussion screen the students could read previous comments without the visual interference of the graphic display. Even though this did not result in any significant improvement in the length of the interaction chains, it appears that the students had a better grasp of individual comments.

This study has important consequences for screen and window design not only for developing on-line conference systems, but within multimedia systems that have dense cognitive material. If the cognitive requirements of the main window are high, then a titled windowing system that requires little user intervention appears to be the design choice. However, if the requirement to recall information from window to window is low then a single window system display system is more appropriate. This would reduce not only the cognitive but the design and programming overhead as well.

This study also suggests further research. It would be of important to investigate if the users' performance or behavior would be altered as their expertise within the system improved. Additionally, if a tiling system was adopted, what is the saturation limit on the number of windows open simultaneously. Finally, what is the effect of a moveable, modal window system on user behavior. If social learning systems are to become integrated within the school we need not only an understanding of mediated interaction but also the most appropriate interface design for the task.

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