

ClassChat
A Tool for Visualizing Backchannel Discussions

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Abstract

Since the fall of 2004, students at the University of California Berkeley's School of Information (iSchool)¹ have engaged in online discussions in a synchronous chatroom backchannel. Interactions occur both inside and outside of class, when users are co-present or in separate physical locations. Conversations sometimes augment class discussion, allowing for different types of in-class participation, as well as the sharing of relevant material and resources.

We have created a web-based software visualization chatroom tool in order to explore the benefits of such a tool for both students and teachers. Students can learn from one another through a different communication medium while educators can use the tool to gain more insight into what and how their students are learning. Some questions we have addressed include:

- What can chat data say about classroom interactions?
- How can this information be used by educators?
- In what ways does chat augment class discussion?
- Which dimensions of chat are most useful for learning?

Introduction

Over the past year, leaders in education, academia, and mainstream media have discussed the role of the backchannel in presentations, conferences, and the classroom. Internet Relay Chat (IRC) is an online, synchronous chat environment that enables groups of people to collaborate and chat from any physical location in the world (Harris, 1995; Dewes, Wichmann, & Feldmann, 2003). The definition of the term backchannel varies with context and usage. To some it suggests an intangible, clandestine community. To others, it suggests an empowering toolkit for participation, collaboration, and interaction. The central function of the backchannel is its use as a secondary or background complement to an existing frontchannel. The frontchannel may consist of a professor, teacher, speaker, lecturer, conference panel, or other similar environment containing a centralized discussion leader. The frontchannel usually implies a single focus of attention. The backchannel is then designed to enhance the frontchannel discussion by encouraging user participation and interaction. The backchannel changes the dynamics of the room from a strictly one to many interaction to a many to many interaction. Activities in the backchannel may include establishing guidelines, inviting participants, excluding participants, posing questions, providing answers, critiquing what is being said in physical or digital communication channels, or sharing information and resources (McCarthy et al., 2004).

In recent years, as wireless networks have been introduced in hotels, university auditoriums, and conference halls, participants with laptops have realized that they can interact with this backchannel during the presentations. Some people ignore speakers entirely by surfing the web or checking their e-mail but others are genuinely interested in a lecturer's topic and want to hold a concurrent discussion about what is being said. They may also like to pass around links to web sites that relate to or refute a speaker's point. Wireless technology allows a backchannel of communication that can reveal thoughts and feedback for future reference. The advent of wireless technologies simply creates new opportunities for using these collaboration tools by people sharing physical spaces in real time (McCarthy et al, 2004). "Passing notes in the

¹ Since the original paper submission, the school changed its name from the School of Information Management & Systems (SIMS) to the School of Information (iSchool)

classroom is probably as old as formal education itself, but the advent of cell phones and other sophisticated handheld devices has elevated this communication to a digital art form” (Cohen, 2005). The backchannel therefore offers a unique new communication medium as a novel toolkit through which people can create, identify, and filter new modes of interaction.

The recent surge in interest has generated a number of conference-based case studies that attempt to study the implications of backchannel chats. Participants in these conferences expressed a wide range of opinions about the usefulness of the backchannel in context of the frontchannel discussion. A number of educators have similarly considered the effects of unrestricted wireless access in the classroom, some of whom have attempted to incorporate these technologies into their lectures and lesson plans (Anderson, Anderson, VanDeGrift, Wolfman, & Yasuhara, 2003; Campbell & Pargas, 2003; Franklin & Hammond, 2001; Jacobs & MacFarlane, 2005; Karabenick, 2003; Ratt, Shapiro, Truong, & Griswold, 2003; Hembrooke & Gay, 2003; VanDeGrift, Wolfman, Yasuhara, & Anderson, 2002). However, research on how chatrooms affect learning experiences and environments is only in its formative stages. Chatrooms could transform how students learn, course content, learning behaviors and practices, and interactions between students and teachers, fundamentally changing the ways in which teachers and students create and disseminate ideas, knowledge and understanding.

Related Work

Three related research groups, in particular, are conducting parallel studies through which we can correlate and contrast ClassChat results and methodologies. The studies we summarize below are drawn from a cross-section of existing chat environments as well as experimental classroom chats which use a hybrid of qualitative and quantitative methods. Because the researchers are closely involved with the iSchool community, the research is inevitably partial and biased, in some ways, and the comparison studies, described here, are therefore useful because they employ a variety of methods across a wide scope of users, providing a means in which to establish a set of “control” findings – commonalities across all four research groups. Furthermore, differences in findings suggest many variations in scope and need for future research in this domain.

Justin Hall, a PhD student at the Interactive Media Division at the University of Southern California’s School of Cinema-Television, is experimenting with ways networked communication could augment and amplify the content of classroom education (Hall & Fisher, 2006). His research group set up screens and projectors in the Zemeckis Media Lab and used chat clients, image sharing software, and web browsers to examine the dynamics of collaborative, communicative backchannel learning situations. They found that increased literacy and familiarity in the backchannel and with collaborative note taking technologies in general could increase its usefulness. However, it is ultimately technology independent, relying more on social practices and personal discipline for a successful collaborative learning experience.

At the Georgia Institute of Technologies’ College of Computing, James Hudson performed several case studies of a French IRC chat in the classroom. His early case studies showed that although many students avoided talking in the classroom, they actively participated online, suggesting a sense of disinhibition and lack of control within the chat environment (Hudson & Bruckman, 2004). His dissertation assessed the value of conversations for students in the chat

room in a professional ethics education class. He found that the quality of discussion was comparable in face-to-face and online discussions (Hudson, 2006). Other factors, such as group dynamics, appeared to have a more profound effect than communication medium in discussion quality.

Last, we explored the Virtual Math Teams² (VMT) project at Drexel University. The VMT project offers a useful contrast in methods from the above mentioned projects as well as ClassChat because of its more structured focus and roots in rigid educational instruction. In particular, its experimental design of highly structured math problem solving allows us to compare students' collaborative uses of technology in different domains. The Virtual Math Teams (VMT) project is an NSF-funded research program that investigates the innovative use of online collaborative environments to support effective K-12 mathematics learning.³ VMT implements a multidisciplinary approach to research and development, using quantitative modeling of students' interactions online and ethnographic and conversation analytical studies of collaborative problem solving. It is looking to address issues of how to group students for effective online collaboration, how to design rich mathematical problems that foster collaboration and deep mathematical reasoning, how to structure the online collaborative experience, and how to study the forms of collaboration and reasoning that take place in such online environments. "The aim of the VMT Project is to catalyze and nurture networks of people discussing mathematics online. It does this by providing chat rooms for small groups of K-12 students and others to meet on the Web to communicate about math. The vision is that people from all over the world will be able to converse with others at their convenience about mathematical topics of common interest and that they will gradually form a virtual community of math discourse."⁴

This paper presents a study of a real backchannel community in a natural academic setting, located at the University of California at Berkeley's School of Information. It will first describe the physical and virtual community. It will then analyze the characteristics of the chatroom and users' interactions and behavior. Finally, it will suggest hypotheses and implications for the role of the chat in educational communities. What sort of new virtual communities does it enable? What types of interactions occur in this backchannel and how do they contribute to the academic learning community? How does this communication medium change techniques for information and knowledge sharing? Is there a compelling story to be told or is it simply noise – wasted bandwidth that distracts participants from the face to face environment they are in? In light of the increasing role of technology and computer-mediated communication as ubiquitous tools in our everyday lives, there is a need for a better understanding of how these tools can be incorporated into the classroom environment to facilitate enhanced teaching and learning.

² <http://mathforum.org/vmt/>

³ <http://www.mathforum.org/vmt/researchers/orientation.html>

⁴ <http://mathforum.org/vmt/>

Background Work

iSchool's Internet Relay Chat backchannel

This study, conducted in the fall of 2005 in an iSchool Information Visualization course⁵, analyzed the iSchool Internet Relay Chat (IRC) logs from October 2004 to October 2005⁶. IRC is an online chat environment that enables groups of people to collaborate and chat from any physical location in the world. IRC is one of the most popular real-time chat systems in the world and has been used in over 60 countries around the world. IRC is a multi-user chat system where people meet on channels to talk in groups or privately (Dewes, Wichmann, & Feldmann, 2003). There is no restriction on the number of people who can participate in a given discussion or the number of channels that can be formed on IRC. Popular IRC clients include mIRC, Virc and Pirch. Chatroom conversations tend to be thought of as ephemeral and impermanent due to their synchronous nature. The interaction is rarely thought out in advance and conversations occur spontaneously and real-time. Just like in face-to-face conversation, there is no archiving practice in effect; chats happen and then dissipate (Donath & Viégas, 2002).

The iSchool chat logs contain over 200,000 user entries, with an average of over 400 user postings per day. Software visualization tools are used to plot chat statistics over time in order to highlight trends in adoption and usage within the classroom. In Figure 1, user count is plotted versus the first six weeks of the spring 2005 academic semester, showing a general increase in user participation. This suggests that students become more engaged in the chatroom community over time. Figure 2 shows total user entries by user. The curve shows a power log trend in behavior, indicating that a few users participate most often. Educators will need to facilitate and construct a classroom environment that enables equal access and participation.

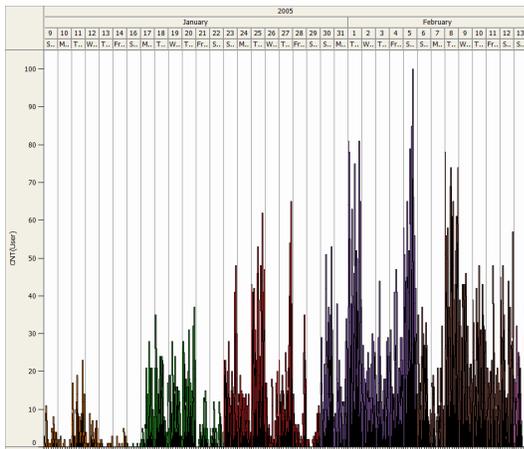


Figure 1. Number of Chat Entries Over First Six Weeks of Spring 2005 Academic Semester

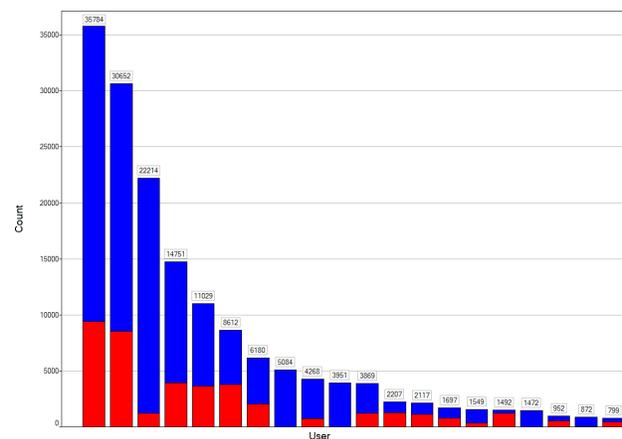


Figure 2. Total Chat Entries By User Between Oct 2004 and Oct 2005

⁵ <http://www.sims.berkeley.edu:8000/academics/courses/is213/s05/>

⁶ These specific logs were obtained for the purpose of frequency analyses and visualizations as a text formatted electronic document containing message timestamps. Logs were obtained with permission from Matthew Rothenberg, an iSchool graduate student researcher who is studying the iSchool IRC channel. Message content was stripped from the log before being made available to the ClassChat research group. The log has not and will not be distributed outside of the research group.

Pre-Interviews

First Round Interviews: Needs Assessment

We conducted three interviews with iSchool professors to determine their perspectives on a backchannel discussion. We wanted to acquire a general idea of professor's view of the backchannel before beginning our design process. Some key excerpts from our discussions are highlighted in the table below. Primarily, professors were excited about the potential of the backchannel but expressed significant concern about the potential lack of control that they might have.

Excerpts from Interviews with Professors:

- “When a whole bunch of people start smiling broadly or snickering, you sometimes wonder if you said something weird or what.”
- “It can be disconcerting sometimes because we don't know what's happening in that backchannel.”
- “The usefulness of it depends on style of course, if there are 200 people in a lecture style versus a small discussion seminar.”
- “It could elicit certain kinds of problem solving skills that might be valuable.”
- “Should it be anonymous?”
- “Don't want it to stifle legitimate discourse, but want to stifle illegitimate discourse. What would be the right metrics for this? ”
- “How can it encourage more class discussion?”
- “Students could double-check references on google”
- “It could be a good measure of coherence based on density and bandwidth of class. A student might ask, for example, ‘Would you explain that in English?’”
- “It might be useful. It is an interesting possibility that people can actually combine lecture and debate at the same time.”
- “Why would you need a backchannel? Is there a communication void?”
- “There might be a disconnect between the student and the professor and knowing what's going on.”

Second Round Interviews: Prototype Testing

We then conducted three more interviews with iSchool professors as well as teaching assistants using our initial visualization prototype⁷ (see Figure 3). Again, we compiled their feedback into a set of key points in an anonymous format.

Excerpts from Interviews with Professors:

- “I like seeing total participation in black.”
- “It is hard to distinguish between overlapping pastel lines.”
- “It would be useful if hovering over a line would make it brighter and larger, or more easy to visualize than an individual line.”
- “I don't like drop-downs!”
- “Drop-downs would take too many clicks.”
- “You could have clickable calendar with time and duration selection options.”

SIMS IRC Channel Traffic

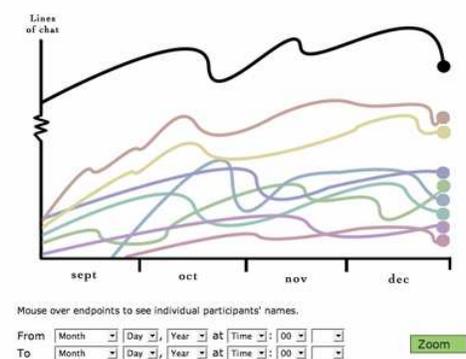


Figure 3: Visualization of chat tool designed in Photoshop

⁷ See <http://www.sims.berkeley.edu:8000/academics/courses/is247/f05/projects/ircchat/#Visualizations>

- “You could have sliding scale that adjusted real-time, ie between month/day/hour, etc. ”
- “A sliding scale could have beginning time on left end of scale and ending time on right end of scale.”
- “It would be useful to have average participation rates to provide some context for this lecture or time frame as compared to average usage.”
- “You could use NLP to visualize patterns, such as when a students posts a question and others post links to URLs as answers.”
- “You need to better indicate what high and low participation rates actually mean.”
- “Will the lines always be as smooth as they are here? What if a student only contributes one comment? Perhaps they can be compiled over a particular scale, such as 8 15-minute sample points in a two hour period or 4 week-long sample periods over a month.”
- “How can you visualize discourse?”
- “It is difficult to track or make a judgment about what's going on with a particular user.”
- “I would like to be able to drill down through the visualization to see the logs, as in, drill down into a particular time period to get to actual log entries.”
- “You could zoom in on context, slice by time, such as a two minute period with a lot of activity and remember ‘oh, that was that joke I did!’ ”
- “How could it be used to run real-time in the classroom and displaying what's happening?”
- “We need more context to know what students are talking about.”
- “If it's more like an official IRC then people will stay more on topic.”
- “It could be helpful to indicate if people understand the material.”
- “Teachers could use to help determine grades based on class participation.”

Social Network Visualizations

We used a prototype pipeline to generate a social network graph as a proof of concept for a browser based social network visualization. The algorithm we used to infer the social network is based on the temporal proximity of messages to each other; a message from a user is derived in response to earlier messages posted by other users (see Appendices B and C for algorithm code). The closer the messages are to each other in time, the more likely they are to be related. When messages contain the name of another member of the chatroom, it is inferred to be directed at them or about them, and the proximity score between the speaker and the person mentioned in the message is increased. A similar algorithm was used by PieSpy, an IRC bot that also generates social network diagrams (Mutton, 2004). We realize that this method introduces flaws; when threaded conversations are co-existing in a single chat channel, multiple users may post simultaneously about different topics. However, this is an ongoing challenge in conducting semantic analyses of conversations and our algorithm was an attempt to generate an overall social network visualization, where statistical outliers would be minimized as much as possible. We will briefly explain how the algorithm operates, examine an interesting feature of the proximity matrix generated by the algorithm, and then explore some graphs that we created based on the scoring matrix using the CCVisu graph visualization tool⁸ (see Appendix D for detailed scoring matrix).

⁸ <http://mtc.epfl.ch/~beyer/CCVisu/>

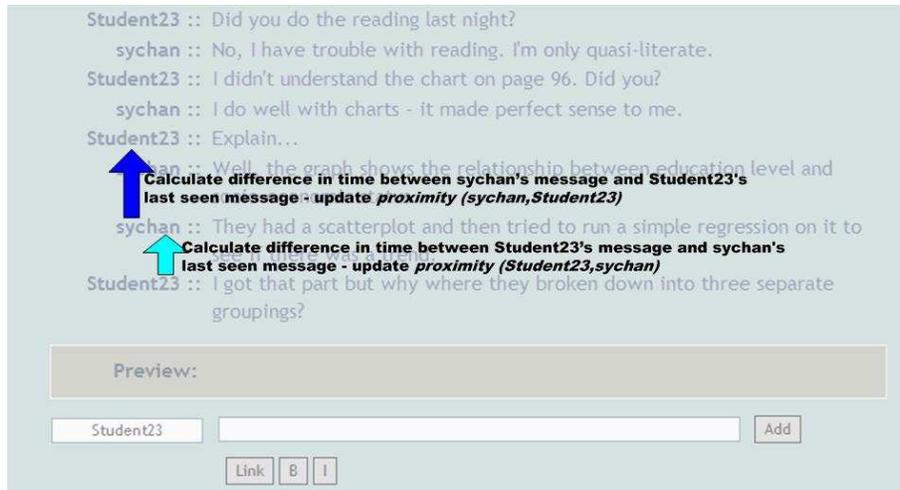


Figure 4: Diagram showing how proximity scores are calculated.

The figure above shows two arrows where the dark blue arrow corresponds to the scoring of a message from sychan to a message from Student23 and the lighter blue corresponds to the subsequent remark from Student23 in response. For the first message, we examine the time stamp of sychan’s message and the timestamp of the last seen message from Student23. We use an exponential decay function to determine an addition weight to the proximity score between (sychan, Student23) – messages which are closer in time to each other have an exponentially higher score than those which are further off in time. If there were other users in the chatroom, we would compare sychan’s message with the last seen times for all other users as well and update the proximity scores between them. The timestamp of the next message from Student23 is then compared to the timestamp for sychan’s most recent message and the proximity score (Student23, sychan) is updated again. Our algorithm conveniently requires only needs a single pass in which to calculate the proximity.

However, as it is currently presented, it only calculates the score between two users for looking “backwards” at the messages that preceded it. In this example, the dark blue arrow represents sychan’s proximity to Student23. In order for the proximity graph to also capture the fact that Student23 responded to sychan, we need to add in the score from the second arrow, the score from Student23 responding to sychan. The final score between any two users, user1 and user2, must be the sum of proximity (user1, user2) and proximity (user2, user1). A particularly interesting property of this algorithm is that there are two separate scores for any given user X:

- The weights for user X in response to messages from all other users
- The weights for all other users in response to User X

In a very rough sense, this gives us an idea of whether a user tends to respond to others, or tends to generate responses from others. This distinction is brought out in the scoring table in the figure below. The table shows the output from the chat analysis script and contains the contents of the proximity scores for all users (using their anonymized names).

	thetick	elmerfudd	stimpyp	elmo	hobbes	sailormoon	flintstone	pinky	bugsbunny	spaceghost	cartman	nerdbox	emie	batgirl	l33thaxxor	bert	zorak	Total
thetick		8.031	0.129	6.188	0.001	2.582	1.000	4.782	1.156	1.375	0.044	1.250	5.531	3.000	1.000	0.000	0.195	36.265
elmerfudd	19.246		14.009	29.933	6.235	31.999	5.656	66.230	10.594	14.755	28.130	1.768	70.623	12.347	8.625	10.946	19.428	350.525
stimpyp	0.047	5.031		0.094	0.000	1.001	0.000	5.129	0.000	2.089	3.750		4.984	3.002		0.045	0.124	25.297
elmo	6.516	25.250	1.489		2.500	13.359	1.559	20.509	7.375	8.407	1.888	0.188	23.273	2.691	2.016	2.000	8.260	127.280
hobbes		6.250		1.318		1.596	0.000	6.766		0.000	4.251		1.164			1.290	2.281	24.916
sailormoon	3.563	27.000	1.481	8.526	3.602		0.605	18.836	2.313	2.064	9.065	1.063	22.281	0.004	0.516	1.501	5.752	108.171
flintstone	2.500	4.000	0.016	0.750	0.000	0.875		4.000	3.008	0.625	0.003	0.875	4.000	0.000	6.000	0.000	0.031	26.683
pinky	12.354	82.219	13.210	25.715	8.001	27.990	5.821		14.211	20.785	27.643	3.239	65.100	16.818	9.250	7.025	21.003	360.383
bugsbunny	0.766	3.750	1.006	1.313	0.000	0.345	1.516	5.000		0.314	1.142	0.314	2.516	0.254	3.016	0.000	0.012	21.263
spaceghost	1.933	11.625	5.199	2.397	0.000	1.795	0.000	12.505	1.063		0.024	0.000	7.211	4.060	0.016	1.500	2.563	51.890
cartman	2.582	28.906	6.726	4.087	2.563	10.873	0.095	20.195	5.188	4.035		0.010	23.883	4.262	2.055	0.068	6.513	122.039
nerdbox	0.500	1.000	0.031	1.000	0.000	0.250	0.000	1.000	0.063	1.000	0.004		1.000	3.000		0.000	0.063	8.910
emie	10.744	49.656	10.988	22.380	4.518	21.570	2.690	44.193	6.250	9.827	23.011	1.059		12.095	7.000	2.628	10.038	238.646
batgirl	0.563	2.000	0.001	0.750	0.000	1.250	0.625	2.000	1.250	0.039	0.000	0.078	2.000		0.750	0.000	0.002	11.309
l33thaxxor	3.125	6.500	0.019	2.750	0.000	2.625	5.688	5.875	3.523	0.797	2.503	0.959	8.500	3.500		0.000	0.042	46.406
bert	0.002	2.500	0.251	0.004	0.000	0.250	0.000	3.000	1.000	0.500	1.000		2.000	0.000			0.512	11.019
zorak	0.010	6.250	1.813	4.524	1.750	3.000	0.001	7.000	1.000	2.500	4.127		5.438	3.000		2.750		43.162
Total	64.450	269.969	56.369	111.730	29.169	121.361	25.255	227.018	57.993	69.113	106.584	10.802	249.504	68.034	40.242	29.752	76.819	

Figure 5: Scoring table with weights for all user pairings

If we examine the intersection of the elmerfudd row and the thetick column, we see a score of 19.246. However, if we look at the row for thetick and the column value for elmerfudd, we see a score of 8.031. This indicates that elmerfudd was far more likely to say something after thetick than vice versa. This may indicate that elmerfudd tended to comment on things thetick said than vice versa – or else it may simply mean that elmerfudd was generally more active on the chat than thetick and consequently had more messages in general, with a correspondingly higher score for responses. After looking at the total column for thetick versus elmerfudd, we suspect that it is more likely that elmerfudd is simply chattier. This table has two different sets of totals:

- the total column has the total score for all the times that a user responded to others
- the total row is the sum of all responses to that user

For example, when we look across the row for pinky, we see the total is 360.383 in the final column. However when we look down the column for pinky, we see the last row has a score of 227.018. This suggests that pinky is more likely to respond to others than to be responded to – this may mean that pinky simply posts more messages to the chatroom. This seems to be a reasonable guess given that pinky has high total scores in general.

The actual contents of this table would not be apparent in the social network diagram that we generated. By creating this visualization, we are able to explore alternative possibilities. Asymmetries in communications patterns become more apparent through this table than through the visualization, which has only a single value for the bi-directional relationship between user1 and user2 instead of having the uni-directional user1 to user2 and user2 to user1 broken out individually. In the images that follow (see Figures 6 and 7), we use the user1 <->user2 values to create social network visualizations for two different chat sessions, on different days. In addition to the proximity weights, we also included scores for the relevance of each user's comments to the class materials. This information was coded for each message sent by users, using a classification scheme described later in this paper.

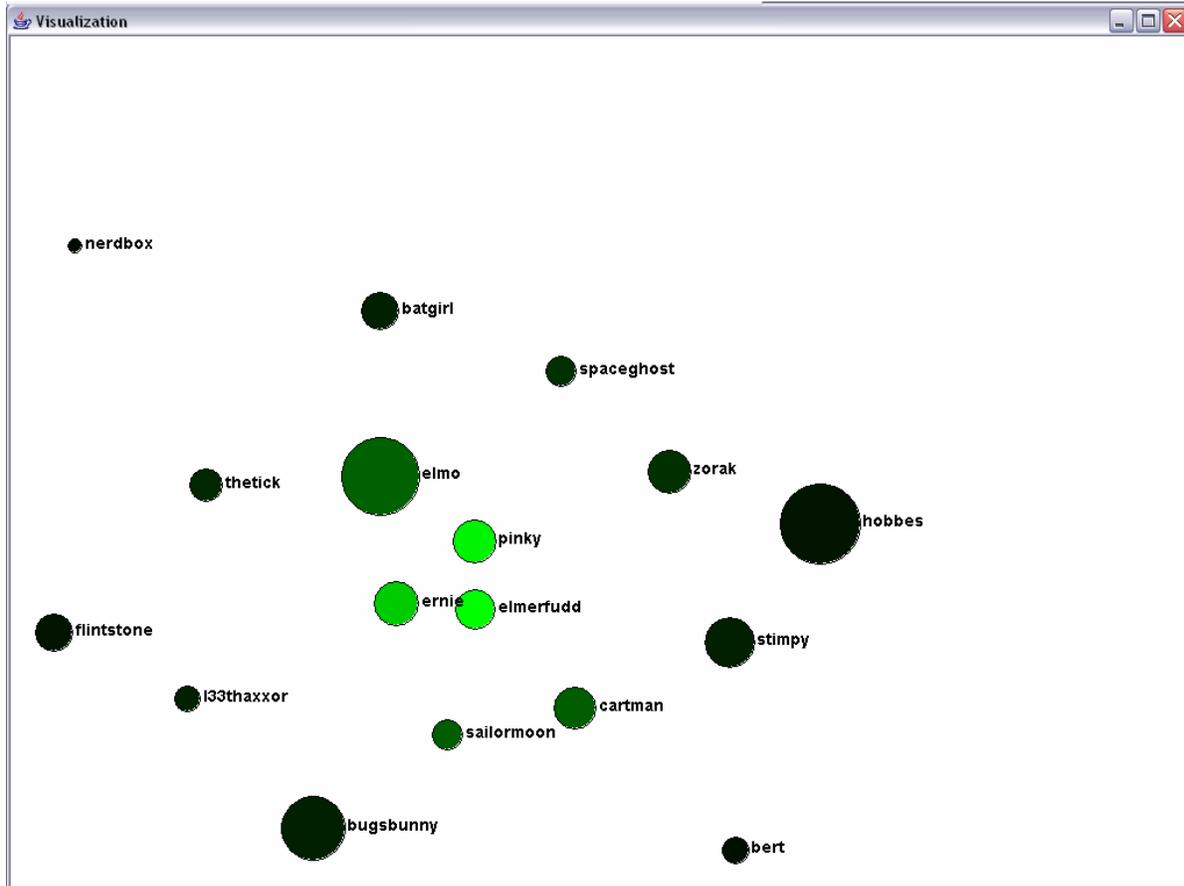


Figure 6: Social Network: activity clustering based on time-proximity of messages - session 1

This visualization includes 3 different parameters:

1. The **proximity scores** described in the previous section are used to cluster the nodes based on a force directed graph layout algorithm – with the proximity value between each pair of users as an attraction force. The *distance* between nodes indicates the proximity score between them.
2. The **overall activity level** for each user is represented by the *color* of each node on a black to green gradient. Black indicates low activity, while green indicates high activity. The color shading is relative: the brightest green is the most active user, and all other colors are proportional to that value. The overall activity is calculated as the sum of all weights associated with that node (analogous to the totals columns in the matrix)
3. The **average relevance** of that user’s comments to the class topic is indicated by the *size* of the node. The relevance scores are on a linear scale from 1-5, with 1 being most relevant to class material, and 5 being entry and exit messages such as “hello” and “goodbye”. The details of the coding scheme are described later. In order to make the relevance more apparent, a logarithmic scale was used to magnify the differences in average relevance.

What we see is a cluster of very active users at the core of the network: pinky, elmerfudd and ernie. However, their comments are often less relevant to the class discussion as the comments from users elmo, hobbes and bugsbunny, who are not as centrally located in the cluster. We also see some outliers, such as nerdbox, an IRC robot, and bert. This graph indicates that there exists a core of very chatty individuals, who are not the most relevant in terms of average relevance to the discussion, and then there is a group of more relevant. but less active users who, perhaps surprisingly, do not cluster together. It is interesting to note that the most active users are not the most irrelevant users, in terms of class content. Rather, their relevance scores are relatively average, with peripheral users such as bert, 133thaxxor, and nerdbox contributing the least relevant content to the discussions.

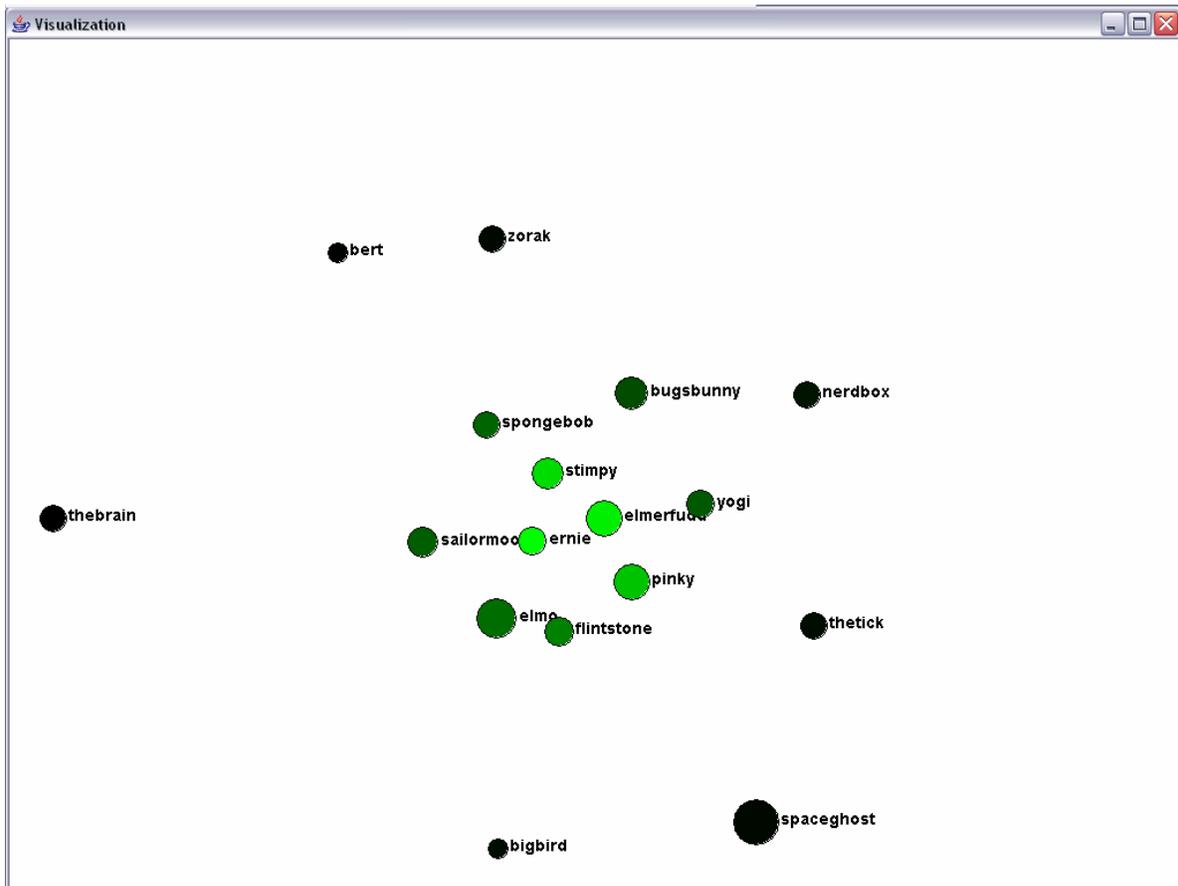


Figure 7: Activity Graph based on time-proximity of chat messages – session 2

In this second graph, we see that the average relevance has gone down somewhat but with ernie, elmerfudd and pinky still the core of the discussion, this time joined by stimpy. Spaceghost, elmo, pinky and elmerfudd are contributing the most relevant material. Elmo and spaceghost are the obvious examples of participants with highly relevant content, who are not at the core of the discussions, nor are they the most prolific. The prototype social network visualizations seem to be successful; however, they have not been implemented in the browser. While the calculation of proximities is simple and straightforward, the rendering of a graph is somewhat complicated. The package we used for the prototype, CCVisu, provides the necessary force directed graph

layout features and could conceivably be embedded in a browser. Another option would be using the Prefuse Visualization Toolkit⁹.

Designing the Tool

We used our interview results and social network diagram analyses to design a process model, which we used as a sample scenario from which to create our tool (see Figure 8). Our goal was to understand the interactions between the primary users of ClassChat to develop a set of specifications and requirements to be built into the tool.

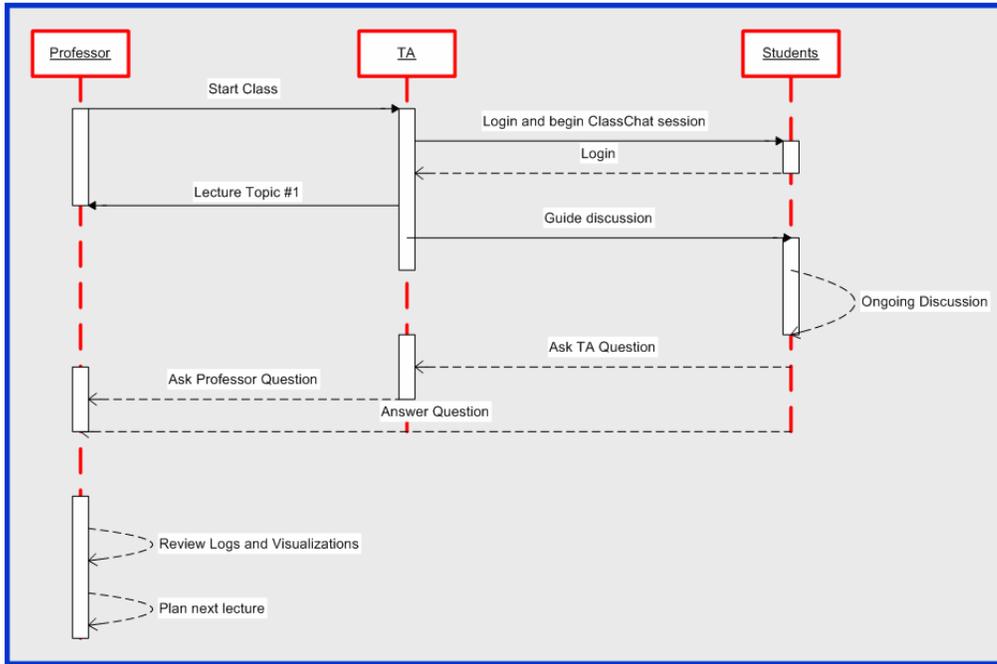


Figure 8: Sample process model of chat environment within the classroom

ClassChat was built using powerful new web technologies, enabling a highly interactive and flexible design. The code backbone is coded in PHP¹⁰, a popular open source scripting language that is designed for use in web development and can be embedded into HTML. The front end component is coded with AJAX¹¹ technologies. AJAX, which stands for Asynchronous JavaScript and XML, is a web development environment for creating interactive applications. Web pages are highly responsive because data is exchanged with the server behind the scenes, enabling web pages to be highly responsive. Because the web page does not have to be reloaded each time the user makes a change, it becomes more interactive, fast, and usable. This makes it an ideal tool for a chat client browser, such that postings are refreshed real-time whenever a user makes a change with minimal tradeoff in speed. ClassChat was tested for browser compliancy in most major recent popular browsers, including Internet Explorer, FireFox, Opera, and Netscape Navigator. By designing a browser based tool, we were able to avoid many of the limitations

⁹ Prefuse Information Visualization Toolkit by Jeff Heer, <http://prefuse.org/>

¹⁰ <http://www.php.net/>

¹¹ <http://www.adaptivepath.com/publications/essays/archives/000385.php>

imposed by the IRC chat environment, which requires that download a chat client engine¹² to their computers and learn how to join a specific channel. However, one tradeoff in using AJAX is that users must have JavaScript enabled in their browsers in order for the chat tool to refresh automatically.

Because we designed the chat tool ourselves, we were able to design our data storage framework for maximal flexibility in displaying and visualizing the data in useful ways. The chat data is stored, as a backup, in a .dat format text file. It is also stored as an xml document, where one xml file contains the entire history of the chat log and an additional xml file contains the log of the last 24 hours of behavior. In this way, we can enable quick search of recent activity as well as long-term comprehensive trends over time. Furthermore, xml tags allow us to maximize the potential for reusability and manipulation of data.

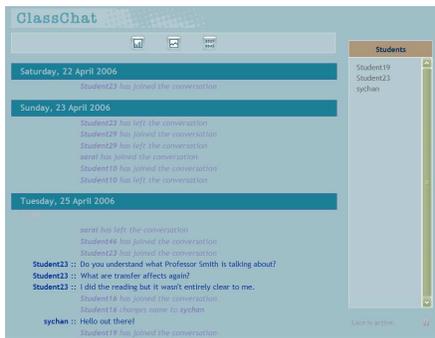


Figure 9: Sample ClassChat screenshot showing chat discussion and text box entry form

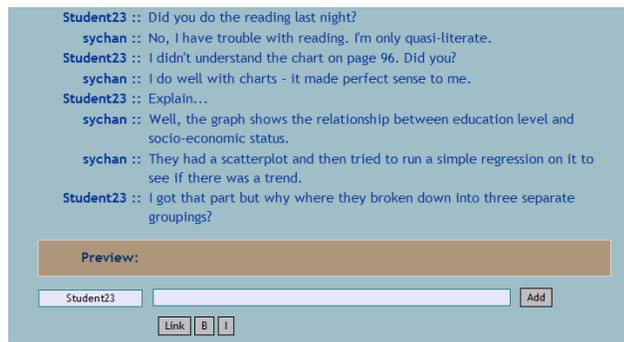


Figure 10: Sample ClassChat screenshot showing chat discussion and student list

We designed a visualization based graph with an AJAX-based sliding scale through which a professor can view chat log behavior over time. The graph displays overall participation by user. Mousing over an individual line reveals specific student details.

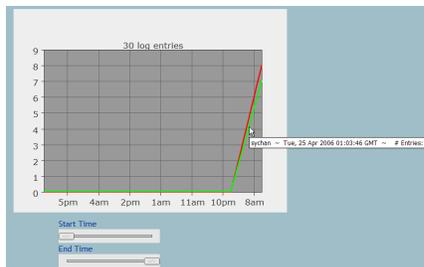


Figure 11: Graph of User Activity

¹² A number of chat clients can be downloaded for free, listed at: <http://www.ircreviews.org/clients/>

We designed a mini visualization graph, which a student or professor could leave open in the corner of his computer window, enabling him to monitor chat activity with minimal visual interruption that might be caused by leaving the entire chat tool browser on the screen. This is beneficial particularly when chat discussion is inactive and the student has little to gain by leaving the window up on his screen, as it would only serve as a distraction.

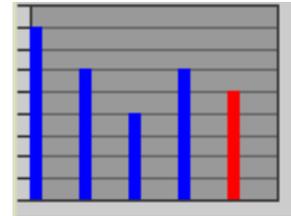


Figure 12: Mini Graph of User Activity

We built in a word frequency counter with a list of the 4571 most common stop words, such as ‘is’ or ‘and’. This list is word-stemmed from a published frequency list for the English language¹³. The original list of 7725 distinct words was stemmed using the Porter word stemming algorithm¹⁴ and stripped of numbers and redundant entries, resulting in a list of 4571 entries. The list is coded as a single JavaScript array that is loaded into the client browser. This list is then used to identify terms that are infrequently found in common language, on the premise that rarely encountered terms have more semantic content. The use of this frequency counter allows a professor to quickly determine the key topics that are being discussed in the chatroom over a particular lecture, allowing him to gather a sense of what students are discussing in the backchannel, with only a quick scan of the frequency counter.

The word frequency counter examines all the words used in the chat, stems them and then looks them up in the internal word frequency table. The number of times a word occurs in the chat is multiplied by the *inverse frequency* ($1/\text{frequency}$) of the word found in the table to get a ranking value for that word. The uses of the inverse word frequency causes rarely encountered words to become more prominent. The list is then sorted by the rank value and displayed in a scrolling window.

Testing ClassChat

ClassChat was tested in a graduate level course at the iSchool. The class is composed of one professor, one Teaching Assistant, and eleven graduate students, all but one of whom were in the Master’s 2006 and Master’s 2007 classes at the iSchool. The remaining student was a PhD student in Mechanical Engineering. There were five males and six females. All students had prior awareness of the existing iSchool IRC chat room. Approximately 75% of the class had actually logged into the chatroom before, and about 40% could be considered heavy users¹⁵. The students were sent the link to ClassChat and requested to test it on their laptop



Figure 13: Professor Glushko lecturing in Document Engineering class while students are using ClassChat in the background

¹³ Leech, G., Rayson, P., Wilson, A., “Word Frequencies in Written and Spoken English: Based on the British National Corpus”, 2001, Longman, London. The frequency file can be found at <http://www.comp.lancs.ac.uk/ucrel/bncfreq/flists.html>

¹⁴ Jones, K., Willet, P., “*Readings in Information Retrieval*”, 1997, Morgan Kaufmann, San Francisco:

¹⁵ A heavy user is considered one who has logged into the chat room at least once a week over a period of several months and/or has participated extensively in the chatroom on more than five occasions.

before coming to class. The majority of students brought their laptops to class during both sessions. Students were given the option of maintaining anonymity in the chatroom or changing their user name to something identifiable. We explicitly clarified that we would not be tracking their IP addresses or any other identifiable information. They were also clear that any participation, or lack of participation, would not affect their grade in the class in any way. They were told that the instructor would be able to review the chat logs after class, although any student who wished to have a comment stripped beforehand was allowed to make such a request. All participants signed consent forms agreeing to use of the chat logs for research purposes. The lectures were videotaped to enable a time sequenced comparison and analysis of the professor's lecture topics and the backchannel discussion. The video camera was placed in a position in the room that made it clear to the students that only the professor and PowerPoint slides could be caught on tape. Their computer screens could not be seen from where the video camera was positioned. The intentional freedom and anonymity of the experiment was designed to encourage student participation without any fears of retribution in any way. The first test occurred in class on Monday, April 10 during a 90 minute lecture. The second test occurred at the next class meeting on Wednesday, April 12.

Experiment Design

We conducted a between-subject quasi-experiment design. The design is a hybridized nonequivalent group and time series experiment. By conducting two tests of each experiment, we were able to compare variations in behavior between the two different systems (IRC and ClassChat), lessening the risk of sampling variability. We are therefore able to compare results across different classroom settings, enabling us to isolate factors that might be unique to a particular classroom ecology as well as to suggest those that might be common across most learning environments. The benefit of this design is that we can compare student group behavior within two sets of groups, where the students, professor, and physical classroom environment are the same within each set. However, testing a chatroom in a classroom setting is inevitably constructing a scenario that is unique, organic, and difficult to measure quantitatively. We therefore do not attempt to assert any of our four test cases to be a control case, nor do we claim our samples to be generalizable in way. Our goal was to trade internal validity for a better understanding of a more natural and compelling case study in chatroom use.

iSchool IRC Logs*	ClassChat Experiment Logs
Log 1	April 10
Log 2	April 12

Figure 14: Design Experiment Using IRC and ClassChat

*where Log 1 and Log 2 are taken from consecutive instances of a core iSchool class, with the same set of students and the same professor

Experiment Results

We first describe high-level trends in user participation and behavior over the two experiments. In the following section, we develop a more comprehensive statistical coding method in which to compare the two ClassChat experiments with two recent iSchool chat logs in a core iSchool

class. Last, we describe interviews conducted with iSchool IRC and ClassChat users to provide a qualitative assessment and context in which to better understand our quantitative analysis.

The bar charts below (see Figures 15 and 16) show differences in user participation between the first and second user experiments. The difference between the left and right columns, April 10 and April 12, respectively, show that user participation dropped off significantly from the first experiment to the second. Furthermore, a few heavy users contributed more frequently in the second class while light users dropped off almost entirely. However, we suspect that this behavior was largely due to usability obstacles after the first test. Our long-term analyses of the iSchool IRC log suggests a similar trend over time –a few core users participate the most and peripheral participation trails off at the end.

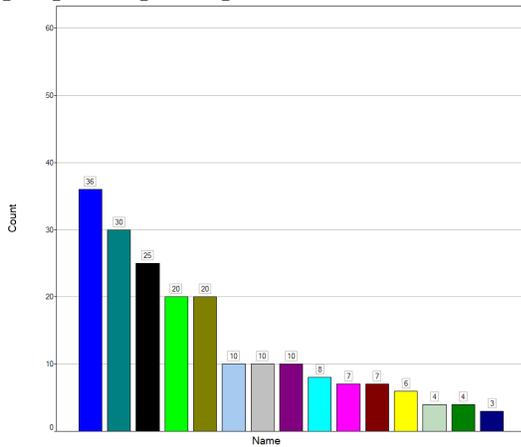


Figure 15: Student Participation in ClassChat on April 10 by Count

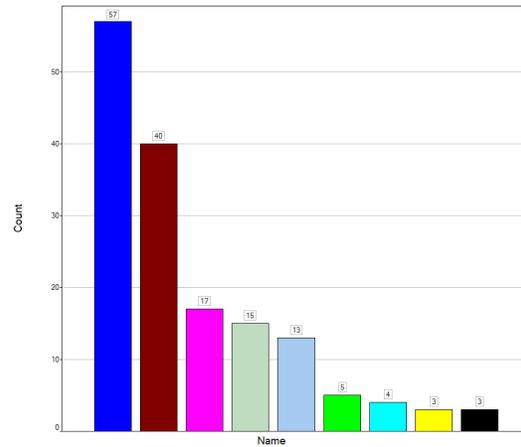


Figure 16: Student Participation in ClassChat on April 12 by Count

The scatter plots below show the significant learning curve students experienced over the two days of experimentation. On the first day over half the students experimented with changing their username, some choosing a different anonymous name while others chose to identify themselves. On the second day, only two students changed their names. The rest kept their assigned names or the saved name that they had registered on the first day. The scatter plot reveals that students tested the name change feature at the beginning of the class but after the first 30 minutes, none chose to experiment with name changes in either the first or second experiment. The decline in experimentation actually suggests a model learning tool for the classroom. Students should be able to quickly experiment and learn how to use the tool, then divert their attention to actually engaging in the class itself.

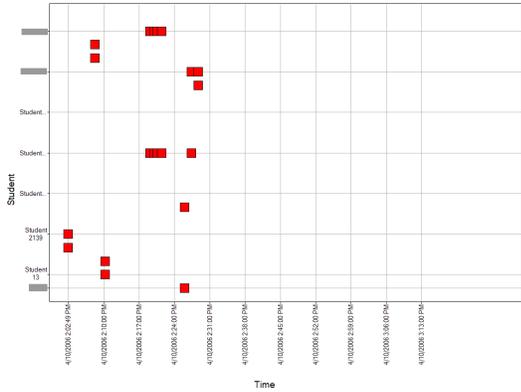


Figure 17: Students Test Changing ClassChat Names on April 10

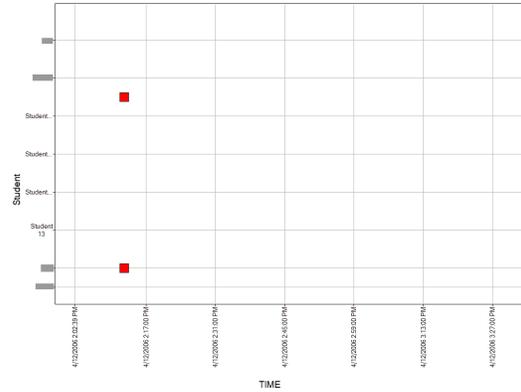


Figure 18: Students Test Changing ClassChat Names on April 12

Comparison of iSchool Chat and ClassChat

The pie charts break user participation into percentage of overall class participation. It should be noted, however, that users experimented with name changes more actively in the first class, which breaks the April 10 pie chart into more user percentiles than actually existed in the class. Regardless, as the bar charts (Figures 17 and 18) above suggested, the second test of ClassChat showed that core users participated far more frequently while peripheral users dropped out entirely.

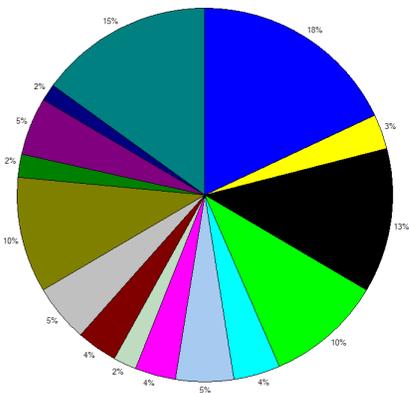


Figure 19: Student Participation in ClassChat on April 10 by Percent

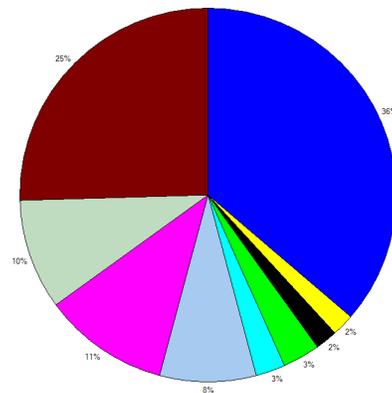


Figure 20: Student Participation in ClassChat on April 12 by Percent

The two pie charts below, taken from two highly active core iSchool 90 minute courses, reinforces our theory that core chat users participate frequently and continuously, while peripheral users contribute infrequently or not at all. This suggests to us that an online learning community may simply perpetuate an in class environment, where a few students participate frequently and most students are less actively engaged. On the other hand, the backchannel could be enabling an enriching medium through which students who are not participating in the frontchannel discussion can find a space to become more engaged.

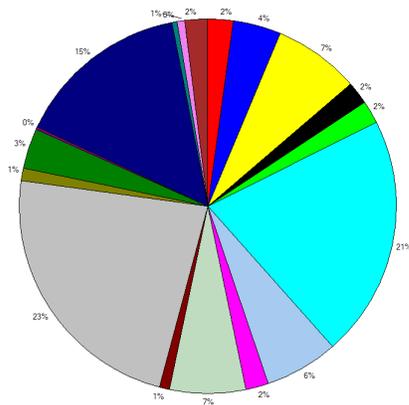


Figure 21: Student Participation in IRC by Percent, Log #1

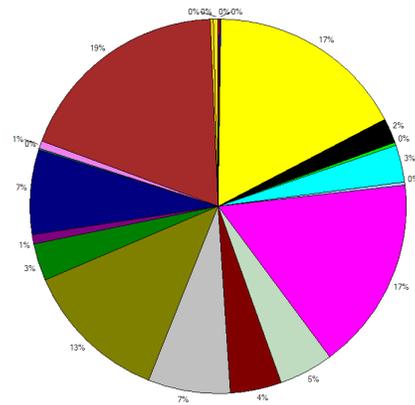


Figure 22: Student Participation in IRC by Percent, Log #2

Coding the Results

Based on a qualitative study of the backchannel chat logs, we developed a method in which to code users’ postings. Our initial goal was to visualize patterns in order to better understand the semantics of the backchannel discussions. Many studies have looked to analyze chat discussions through discourse analysis, natural language processing, and visualizations. We hoped to utilize a simple coding system that would reveal the academic value of a particular posting at any given time. The system we designed is described in the table below.

	1	First Order On Topic	Comment is directly related to class material
	2	Second Order On Topic	Comment is an off-shoot from class material, but is not directly related to the topic
	3	Physical Space	Comment about physical presence in classroom (describing other students actions, seating locations, activities)
	4	Social	Social discussions, unrelated to class discussion
	5	Entry/Exit	Entry/exit info from system and hello/goodbyes from other chat participants

Figure 23: Coding System for Chat Discussions

The two experimental lectures using ClassChat were coded based on these five different categories. The same coding was then performed on two recent iSchool chat lectures. The latter two lectures involved iSchool graduate students in an active core required class, taken from anonymized logs between the fall of 2004 and present. This class was often active in the backchannel, with discussions ranging from being on-topic with the professor’s lecture to purely social or otherwise unrelated discussions. Each log was coded manually, where an individual message was assigned a code from 1-5. It is extremely important to note that the two IRC logs are NOT representative of overall IRC behavior. They were selected as highly social backchannel discussions, not indicative of the overall academic engagement within the

chatroom. Because each log must be coded manually, it would be impractical to try to code the entire chat log, with its 300,000+ entries. Therefore, we do not attempt to generate a statistically valid comparison, recognizing that we would need to also test and code ClassChat over an extended period of time in order to make useful comparisons. Our study serves as a revealing jumping block from which to develop interesting parallels and contrasts that could then be tested with further long-term studies. The two selected IRC logs indicate that the backchannel can, on occasion, be heavily used, but with only minimal relevance to the academic environment. When designing a learning environment, such a potential will need to be recognized and minimized.

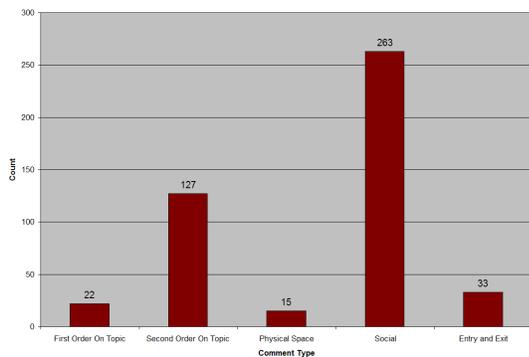


Figure 24: Student Participation in IRC by Percent, Log #1

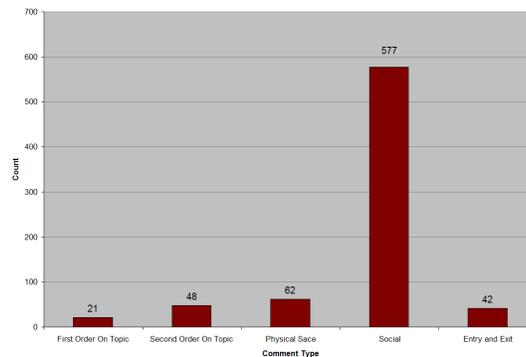


Figure 25: Student Participation in IRC by Percent, Log #2

In addition to these graphs, the social network diagrams described earlier were also based on these two chat logs. The size of each user’s node, representing relevance, was based on the relevance coding described here. What should be clear between the graphs above, and the social network diagrams is that some students tend to be more on-topic than others, and derive more educational benefit from the chatroom. At the variation in the number of first and second order on topic messages in Figures 24 and 25 shows that the relevance of the chatroom varies. No clear generalizations can be drawn from the data, aside from the fact that there *is* discussion in IRC that is relevant to classroom topics, and that students vary in relevance with respect to how they use the chatroom.

Our assessment of the ClassChat logs revealed that a sixth code type should be added to our system. Because we designed ClassChat ourselves and were testing a beta prototype, there were a number of usability issues, particularly on the first day of testing. Therefore, a number of postings were related to the usability of the tool and environment, which we felt was an important factor that should be incorporated into our coding method. Aside from the higher percentage of usability postings in the first day of testing, we see that there was a fairly consistent breakdown of comment types over the two days. We suspect that particular trends would continue consistently over time within a particular classroom environment and context. However, we also hypothesize that trends are unique to classroom dynamics, varying with class size, student ages and grades, student maturity, lecture type, professor personality, and the actual lecture content. This would be a rich topic for further study.

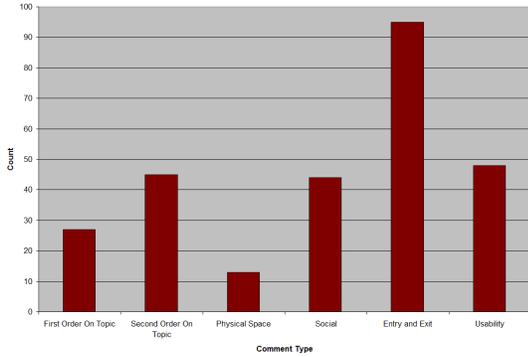


Figure 26: Student Participation in ClassChat by Percent, Log #1

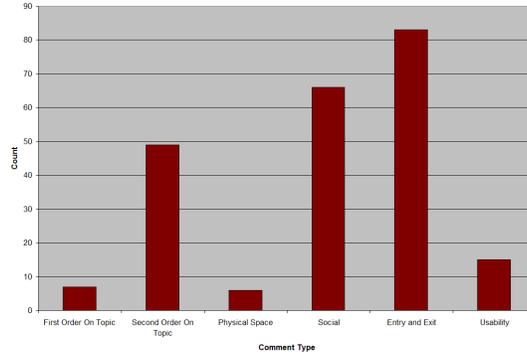


Figure 27: Student Participation in ClassChat by Percent, Log #2

The benefit of our coding system is that it can be roughly correlated to an academic relevance scaling. For example, “first order on topic” refers to strictly academic messages, whereas “second order on topic” comments are less so, and onwards in decreasing order (see Figure 28).

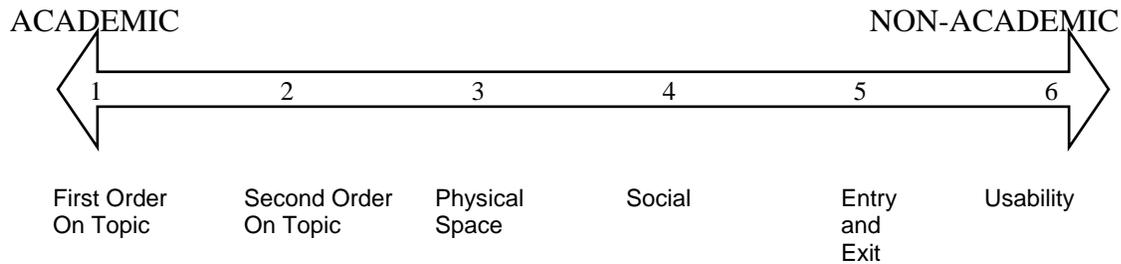


Figure 28: Comment Types on Scale of Relative Academic Value

We averaged coded message types by student which gave us an approximation of the academic value of a particular student’s overall contributions in the backchannel. For example, if <student44> posted nine messages, four of which were Second Order On Topic (2), one of which was First Order On Topic (1), and four of which were Social (5), our average code for that student would be 3.22. This method allowed us to compare the relative value of student’s postings. Because we are maintaining student anonymity, in the graphs below we plot the average code versus a particular student’s overall number of contributions. The x-axis is ordered from highest number of postings to lowest. In this way, we hoped to reveal any potential correlations between overall activity (based on total postings) and academic value of that student’s postings. An overall decrease in coded average as we move along the x-axis would indicate that heavier users contributed less academic value to the discussion. Conversely, an overall increase would suggest that heavy users were contributing academic postings. However, as the graphs below indicate, there is little or no significant correlation between academic activity and student activity. Because we only generated these graphs for these four samples, we cannot speculate on how representative they are of overall backchannel behavior. We suspect core backchannel participants probably have a high contribution of social and non-academic messages, but they might also have a high contribution of academic messages. Further work in assessing the relationship between core participants and the relative academic value of their participation would be an exciting topic.

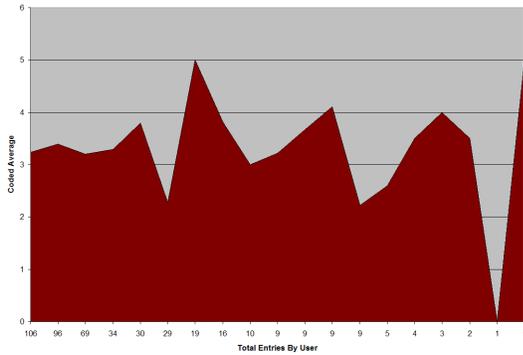


Figure 29: Average Coding by Student in IRC, Log #1

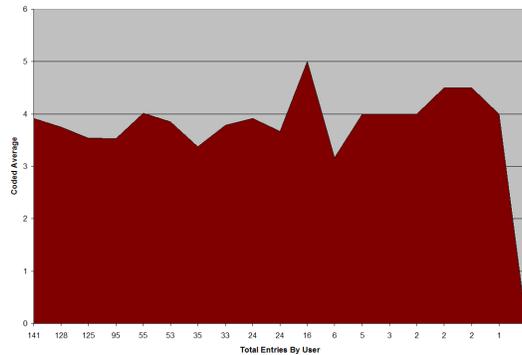


Figure 30: Average Coding by Student in IRC, Log #2

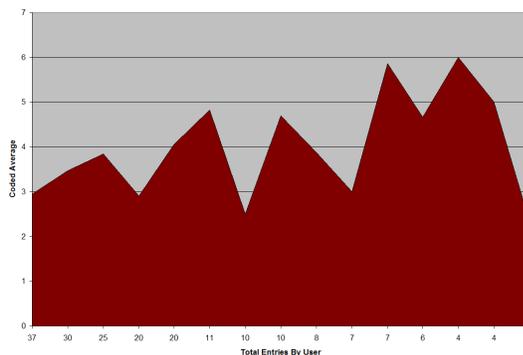


Figure 31: Average Coding by Student in ClassChat, Log #1

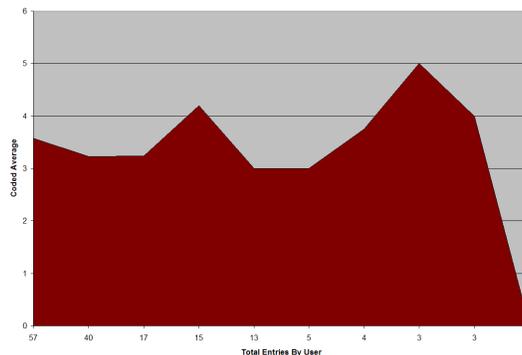


Figure 32: Average Coding by Student in ClassChat, Log #2

We compiled the data from the above four graphs into a single chart to visually compare the relative academic value of messages posted in each of the four logs (see Figure 33). We then analyzed those results by averaging the two IRC logs and averaging the ClassChat logs to compare between the two test environments (see Figure 34). Again, because these are individual examples, we do not draw general conclusions from them. Instead, we found that there were a number of interesting questions to be generated from these comparisons. For example, we noted that the ClassChat logs had much higher postings related to entry and exit, however, this was in part because the ClassChat design facilitated these types of postings, whereas IRC does not necessitate such greetings in the same way. We see how the tool itself can significantly affect the dynamics within the backchannel. Some other questions that these graphs revealed include:

- How does usability affect participation in the chatroom?
- What learning curve with the chat tool will generate active participation and a maximum number of students?
- What is the relationship between first order, second order, and social comments? Can discourse analysis reveal threads and correlations between these types?
- Does a professor's awareness and involvement with the backchannel alter the types of messages posted within the channel? How?

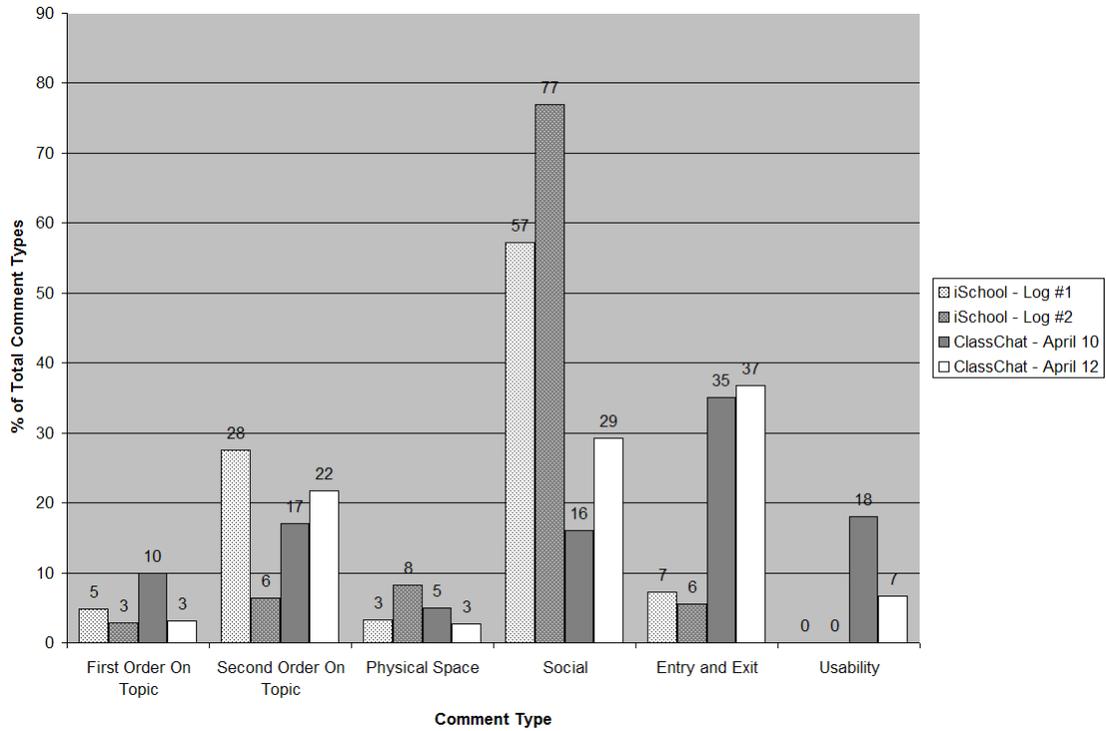


Figure 33: Comparison of Coded Comment Types by Percent of Overall Contribution Between the Four Logs

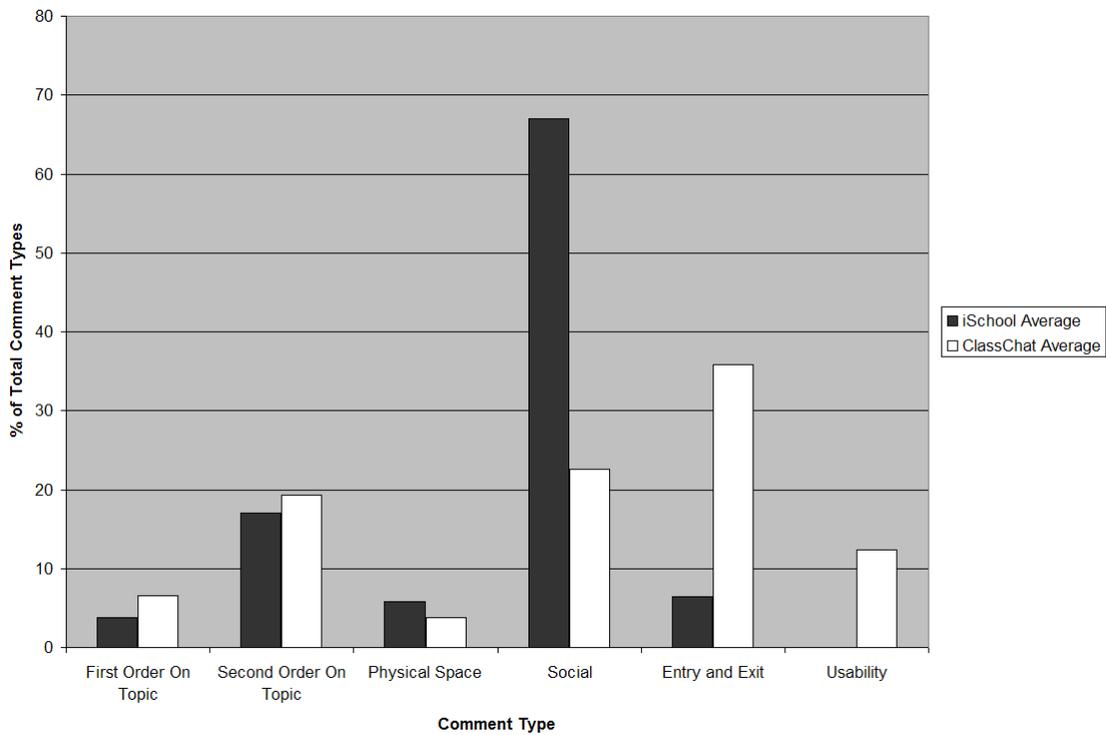


Figure 34: Comparison of Coded Comment Types by Percent of Overall Contribution, Between the Average of the Two IRC Logs and the Average of the Two ClassChat Logs

Post-Interviews

Coding can help us to acquire some meaningful insight into statistical trends in participation, but do not provide sufficient descriptions of how students make sense and meaning of concepts through their interactions. Individual postings do not reveal greater context about who the poster is responding to and how the comment fits into the larger shared group experience. Past postings and interactions provide insight into the meaning and context of the current activity. Following the testing phase of the ClassChat prototype, we conducted interviews with four students (see Appendix A for Interview Protocol). Interview subjects were chosen across a range of backchannel participation levels. The purpose of the interview sessions was twofold. First, we hoped to draw out more specific data regarding students' attitudes toward classroom chat, along with its wider context within the iSchool social community. Second, we gathered information regarding the usability of the prototype system within the classroom.

Laptop usage

All subjects stated that they bring their laptops to class on a daily basis and use them for a variety of purposes during class time. This includes activities related directly to the class (taking notes, following along with slides) and other activities such as email and chat (either private chats through an IM client, or IRC). The level of laptop activity varied among the subjects, and did not seem to have any correlation to their overall levels of participation in classroom discussion; that is, laptop usage of subjects who stated that they are vocal during class did not differ from those who are less vocal. However, students who participate more in backchannel group discussion specifically did also identify as being more vocal during class. In addition, all subjects stated that their individual laptop usage was inversely related to their own engagement and participation in the class.

Types of use:

Email: All subjects mentioned email as an in class activity. Responses ranged from “watching email” throughout a class to periodically checking but never actually writing emails.

Web: Three of the four subjects mentioned “surfing” as an activity. One stated that he uses the web to look up material relevant to the course, but does not surf.

Chat: Chat use varied across subjects, from none at all, to IM only, to high levels of participation in the IRC channel. One subject stated that he has used chat in the past, but now has specifically configured his machine not to.

Factors contributing to increased laptop usage:

Location: Access to a wireless network is not reliable outside of the iSchool, so usage may be limited in certain areas.

Class size: Subjects were more likely to engage in laptop activity in larger classes, where the activity would be less obvious, and in class discussion less crucial. One subject also stated that larger classes mean that more people will be available on the channel.

Lecture type: If the instructor uses PowerPoint slides and makes them available on the web, students prefer to view the slides on their own laptops.

Level of engagement: Subjects stated that the more engaged they are in a lecture, the less they will choose to use their laptops.

Attitudes toward the backchannel

Subjects who do not use the channel stated that they would find it too distracting. They are aware of it, but feel it would interfere with concentration during class time. Frequent users of the channel described its use as primarily social, but also course related. They tend to see the social aspects of participation as being integral to the classroom or school experience, rather than peripheral. They often express ambivalence about its use, seeing it as both useful and distracting. One student stated:

“I do occasionally feel kind of guilty about it, I should be paying attention to the class. Especially when things ‘get out of hand’ people start laughing, I think, ‘we shouldn’t be doing this...’ I try not to let it overtake my attention. I don’t feel like it’s a problem. If I can concentrate, it’s helpful. If not, I probably wouldn’t be paying attention anyway.”

This subject emphasized that he found the quality of the lectures to be a bigger factor in his level of attention than the types of distractions available.

“Some professors think, ‘if you don’t have anything else to do, then you’ll pay attention.’ I feel like it’s almost insecurity, that professors are worried that people aren’t paying attention, they get a little pissy about it.”

Another student emphasized the role of informal chat in the learning process:

“You hear an idea, make a joke of it, you’ve just used something you’ve just got. Most professors over the age of 40 might not like something going on outside of their ideas. Being able to form a joke means you’ve got it. Some people think it’s funny, some don’t, it fuels the social network.”

Relationship to iSchool social community

Subjects who participate in the channel stated that they first heard about the channel directly through a social contact. In these cases, they were approached and specifically told about the channel’s existence and how to access it. In contrast, those that do not participate said they had heard about the channel in public spaces, but did not know much about it. Non-participants also stated that their social circle does not use the channel or do not use laptops in class at all. This suggests the possibility of a relationship between *existing* social networks and chat participation. It is not necessarily the case that chat participation mirrors social networks within the school, but they may reinforce one another in a strong way.

One participant stated that he originally viewed the channel as a way to meet people and when he first started school and didn't know anyone in the area. In this case, he used the channel as a way to actively seek out friends. He sees the channel as open to everyone:

“Different kinds of people. I don't think there's anyone that's unaware that it exists. Some people think they'd have trouble concentrating or whatever. I feel like not that it's excluding people, but INCLUDING people. I don't know if that makes sense. People who are on IRC are more of a group. It's building group cohesion where there wouldn't be one otherwise, but I don't think it's an exclusion.”

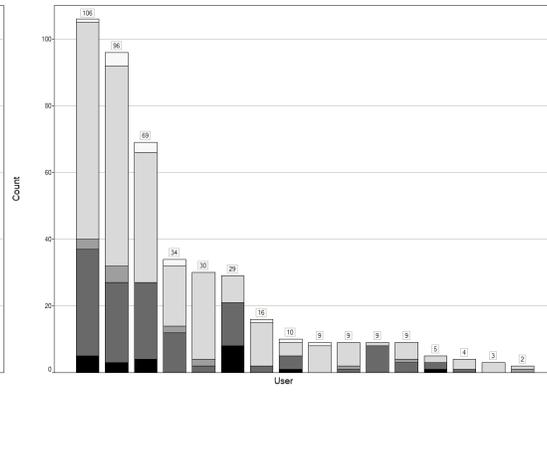
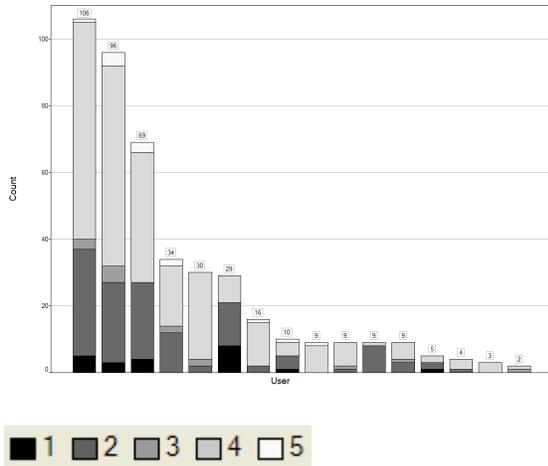


Figure 35: Overall Student Participation in IRC Separated by Comment Type, Log #1

Figure 36: Overall Student Participation in IRC Separated by Comment Type, Log #2

Discussion

What Works

Peer to Peer Learning and Seeking Help

Situated learning describes learning as a function of the activity, context and culture in which it occurs (Lave & Wenger, 1991). This contrasts with many classroom learning environments that are abstract and out of context, in which a teacher may structure a lesson plan based on an activity which is not personally relevant or meaningful to the students. Social interaction is a critical component of situated learning. Learners become involved in a "community of practice" that embodies certain beliefs and behaviors to be acquired. As the beginner or newcomer moves from the periphery of this community to its center, he becomes more active and engaged within the culture and assumes the role of expert, a process described as "legitimate peripheral participation" (Lave & Wenger, 1991). Brown, Collins, & Duguid (1989) describe the need for a new epistemology for learning that emphasizes collaborative social construction of knowledge over rote memorization of facts and concepts. There exists an immense potential and opportunity for incorporation of this backchannel into the classroom to enhance situated learning. The social cohesiveness among students increases in proportion to their levels of communication and interaction within the group. iSchool students affirm that one source of great value in their iSchool education arise in their interactions with other students. In this light, incorporating the

backchannel into the iSchool community augments and enhances a student's ability to actively and intently learn from his peers in a positive manner (Rogoff, Paradise, Arauz, Correa-Chavez, & Angelillo, 2003). The section below elaborates on ways in which this peer-to-peer learning can occur.

Peer-to-peer learning in the backchannel describes a type of collaborative learning in which students share knowledge through self-motivated participation and engagement. Mercer and Fisher (1997) describe three kinds of peer-group discussions: disputational, commutative, and exploratory, and argue that exploratory discussion has the highest educational value. Successful exploratory peer-to-peer discussions are characterized by brainstorming, challenges, hypotheses testing, consensus, and decision-making. For example:

14:40:40 Student66	what is an equivalence class?
14:41:12 TeachingAssistant	Things that are the same but may have different names

In the example below, we compared the current slide¹⁶ that Professor Glushko was presenting with his actual lecture transcription, based on the videotape record, and then look at the backchannel discussion. We found that the backchannel was a useful resource for providing a student with a quick reference in which to follow up with the professor's discussion. While the student may have been distracted while Professor Glushko was explaining what microformats were, at least the student had a medium through which to catch up, without feeling as though they would be publicly exposed for not paying attention or simply forgetting what microformats were. The student's question was posted just a few minutes after Professor Glushko's explanation of microformats, suggesting another use for the backchannel as a record keeping mechanism of important concepts that are discussed in class.

Tables [2]

- Most tables follow regular matrix or structural patterns in which the organization and presentation of information is *consistent with or reinforces the relationships between* the content of the cells or regions defined by the matrix
- A transactional document type is often little more than a table with some additional information about the parties to the transaction
- Many hybrid document types intersperse semi-structured components with structured sets of components in tabular format
- When should an embedded table be best understood as a "mini-document type" of its own?

Figure 37: April 12, 2006 Lecture Slide

From 2:10:38 pm - 2:11:55 pm, Professor Glushko says:

"That nutrition information as not part of a recipe, you could almost view it as a mini document type... now that should remind you of something, microdocument types, remember micro something?"

What are microformats? Remember microformats? It's a big buzzword now in Web2.0!

Microformats are things like little addresses or some other kind of highly conventional document type structure that is embedded in an HTML scaffold to facilitate streaming and extraction of these little content cores from otherwise less structure content types."

¹⁶ <http://www.sims.berkeley.edu:8000/academics/courses/is243/s06/lectures/20060412/243-20060412.htm>

About 15 minutes later, microformats comes up again in the lecture and Student13 apologetically asks what they are. Student 66 quickly responds with a link to a reading that had been assigned previously when microformats were being taught.

14:25:10 Student13	what is microformats again? sorry
14:25:59 Student66	http://microformats.org/about/

However, failed exploratory peer-to-peer discussions may occur when ideas are accepted unchallenged or because continuous disputation leads to a breakdown of communication within the group. Exploratory peer-discussions rarely broke down in this manner in the iSchool community. As a graduate student community, the learning context of the iSchool is different than that of K-12 or undergraduate classrooms. Failed peer discussions might occur far more frequently in younger learning environments where students are more susceptible to competition or immature group behaviors. In these environments, it would be important to have rules to minimize breakdowns in group communication. These might include guidelines that describe the information, assumptions, tasks, and evaluative criteria for constructive collaborative group work. This could be implemented through the presence of a teacher or teaching assistant within the chatroom or a post-mortem review of the chat logs on a regular basis in which the dynamics of the group could be studied and improved for future classes. In the example below, the teaching assistant helps to clarify a student's uncertainty, which the student would be very unlikely to ask out loud in the classroom.

14:19:26 Student44	sometimes when bob asks questions, i'm not sure he's asked a question - intonation?
14:19:59 TeachingAssistant	If you're not sure, he probably is

Increased Interactivity and Discourse

The backchannel offers participants the opportunity to interact with the speaker, the presentation, and one another, in a relatively unrestricted, open environment. Far from the traditional presentation environment where attendees are at the mercy of the presenter, chat offers the possibility for engagement through multiple modes of transmission. Students can experience a positive engagement with the backchannel, suggesting that they can conduct backchannel "discussions that are on-topic and can even lead to a more involved audience and better interaction with the presenter" (Golub, 2005).

Giving participants access to a public ubiquitous backchannel broadens the discourse within the shared physical space. Participants are able to ask questions, receive answers, and solicit information without having to interrupt the frontchannel presentation. "Providing pointers to information that augments the meeting topic(s) in useful ways and the ability to better organize and coordinate the activities of some of the participants in a meeting" (McCarthy et al., 2004). The backchannel is also a way to challenge and verify the authority of the speaker without actually challenging him or her explicitly. Participants may be more willing to brainstorm over chat when it is considered a backchannel and the social cost of failure or being wrong is low, or at least, is perceived to be low. The backchannel also allows people who have not had a voice, whether because of educational, economic, social or cultural barriers, to build an equitable reputation in the community by participating in the dialogue.

Classroom Environment

The context in which the backchannel is used plays a significant role in the dynamics and culture that will develop around it. A successful learning backchannel must be designed based on the classroom culture in which it is being used. For example, the ways in which a backchannel could be used in a 5th grade classroom will differ significantly from its use in a third year law class. Teachers may need to implement a more controlled and disciplined environment in younger grades whereas law professors could assume that a Socratic teaching method will effectively command their students' full attention and that the backchannel will therefore be used strictly as a knowledge resource, not as a source of distraction.

The size of the classroom also influences how effective the backchannel will be. In a small seminar, the backchannel will generally be unnecessary because students are supposed to interact in the physical classroom environment. In a large lecture hall, with hundreds of students, a backchannel could become swamped with too many simultaneous users and conversation threads to be of any use. An ideal class size might be between 20-50 students, where most know each other and are able to develop a community and sense of trust in their channel, but where there are not so many participants as to bog it down beyond any academic value.

The iSchool backchannel was used occasionally by students for structured study sessions, usually to coordinate review sessions before midterms and finals. This model worked well for many students, who were able to log in from their homes in the evening with little scheduling disruption to their standard activities while still benefiting from a collaborative study environment. For example, one student sent the email below to the class mailing list to initiate a review session:

From: [removed] <[removed]@sims.berkeley.edu>
To: [list name removed]@sims.berkeley.edu
Date: [removed]
Subject: [removed] Literature review sessions: [removed] for dummies

A number of us (Student2, Student95, Student24, Student4...) were discussing review sessions to help us all prepare for the final. Given the scope of the questions and the reading material, the consensus was that a single review session for all topic areas may not be terribly useful; nor would simply posting reviews of all articles to the wiki. Instead, we will be meeting on chat for topic-specific literature reviews organized around the questions, one hour each. The goal is to bounce ideas from the readings around so that we are all well prepared for writing.

The schedule we have developed is:

Question 1: Monday, 7 pm
Question 2: Monday 8 pm
Question 3: Tuesday 7 pm
Question 4: Tuesday 8 pm
Question 5: Tuesday 9 pm

In this email, the student takes advantage of the affordances offered by virtual chatting, which prevent students from having to arrange a particular location to meet, by simply creating a setting in which any student who has access to his or her computer (and is available during the suggested times) can join the study group.

In the email chain below, a student suggests a similar evening virtual study group session. A second student responds to the group and combines both her virtual and physical contexts through which to generate a collaborative study environment.

From: [removed] <[removed]@sims.berkeley.edu>
To: [list name removed]@sims.berkeley.edu
Date: [removed]
Subject: IRC [removed] Review anyone?

I was thinking a final review on IRC Monday around 6:00 pm. Sound good to anyone?

[name removed]

From: [removed] <[removed]@sims.berkeley.edu>
To: [removed]@sims.berkeley.edu
CC: [list name removed]@sims.berkeley.edu
Date: [removed]
Subject: IRC [class name removed] Review anyone?

Monday at 6 sounds good.

Also, I was thinking about hanging out in the basement lounge for a few hours after the Monday 10am drop...compiling notes...figuring out if I have any lingering questions...(since [Teaching Assistant] will be around). Anyone is welcome to join in the fun!

[name removed]

Both review sessions were deemed useful by most of the participants after they took place. In this way, the backchannel community offers an opportunity for sharing learning and knowledge production even outside of the classroom environment.

Social Motivations

There should be a reciprocal relationship between group members and the environment that the chatroom provides; the environment should fulfill the social desires of its members for sustained participation. Kirschner et al suggests the concept of “perception-action coupling” which is required for successful group learning in a chatroom environment. “Once a group member steps onto the social stage and becomes salient (perception), the social affordance devices will not only invite, but will also allow, encourage or even guide another member to initiate a communication episode (action) with the salient member. Saliency depends on factors such as expectation, focus of attention, and/or current context of the fellow member” (Kirschner, Strijbos, Kreijns, & Beers, 2004). A chat room environment devoid of social affordances will likely lose participants and isolate the remaining users from one another within the virtual environment. Social presence is defined as the “degree of saliency of the other person in the interaction and the consequent saliency of the interpersonal relationships” (Kirschner, Strijbos, Kreijns, & Beers, 2004). Social presence is high in the iSchool backchannel. Because participants share a physical space on a regular basis, their ability to build and recognize other

people with whom they are conversing virtually is significant. In fact, all regular users on the backchannel know the real identity of any other user at any given time. If a username is present that is not recognized by the backchannel core community, users will immediately query the unidentified user to reveal his or her true identity.

Participants in the iSchool chatroom are driven by a desire for a sense of community. People are “searching for a feeling of community that’s been lost as many “third places” (not work, not home, but a third place where people congregate and interact) have closed down” (Kaplan-Leiserson, 2003). Indeed, many parents and community members have lamented children’s declining participation in community activities, such as Boy Scouts, local Park and Recreation teams, and hobby-inspired clubs, which have instead been replaced with participation in online communities, such as MySpace, Friendster, Doom, Neopets, and countless others. Similarly, adults are participating in online card games, chatrooms, and other virtual communities in place of knitting clubs, poker gatherings, or Tupperware parties, as may have been the tradition thirty years ago. For this reason, many chatroom participants are using their virtual community as a replacement for the camaraderie and support system previously offered by membership in community organizations. The virtual community offers a home away from home.

There are many indicators of the iSchool backchannel as a third place. Participant usage increased during class time but also in the evenings (see Figure 38). For example, participants often share their physical location with other participants, creating a sense of shared physical space, even when participants are not actually co-located. “It was found that students who used Instant Messaging (IM) services found it easier to communicate, felt a stronger sense of community, and had more venues for informal and social communication about not only class material, but also information about the school and their common degree program. In traditional classroom buildings, the common spaces such as hallways provide the venue for this informal communication; IM services can enhance the distance education environment by providing the “virtual hallways” for students and instructors to meet” (Nicholson, 2002).

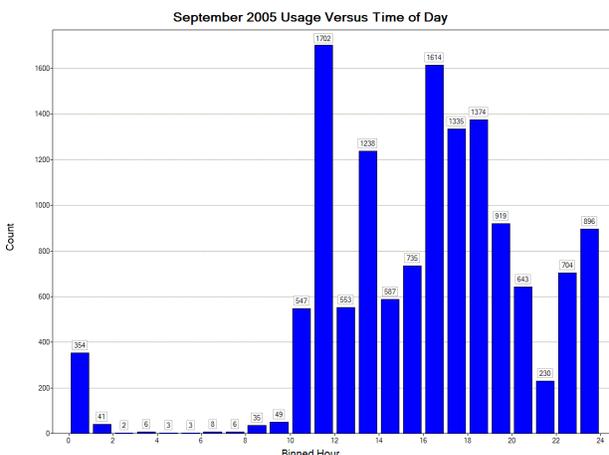


Figure 38: Usage by Time of Day

The sense of community also exists outside of the classroom environment. Participants like to share their evening activities, even those as mundane as eating and sleeping. In particular, single (ie without a spouse or partner) iSchool students would choose to share their common daily activities with the virtual chatroom. This behavior is usually seen in the evenings and outside of class settings when there is a smaller group of core users logged into the chatroom. Because the core users are often the same participants every evening, there is a subculture within the iSchool chatroom that encourages this sharing of personal lifestyle activities.

Identity, Reputation, and Trust

Establishing identity and reputation in a virtual community has long been understood to be one of the most important characteristics to increasing participation and engagement within that community (Lave & Wenger, 1991; Papargyris & Poulymenakou, 2005; Turkle, 1997; Wellman & Gulia, 1999; Wellman et al., 1996; Wenger, 1998). Social recognition is one of the biggest motivators for participants in the iSchool chatroom. Participants acquire instant gratification, approval, and acceptance upon entering the chatroom. Regardless of whether this motivation is ego-driven or altruistic, participants often go to extreme lengths to enhance their social capital with the community, which serves to then build their reputation in the community, inserting them into a cycle of increased participation and acceptance. People tend to categorize themselves as part of the group if the salience of perceived differences among these individuals is minor, relative to the perceived differences to other individuals. Thus, perceived similarities between different iSchool community members concerning attitudes, beliefs, norms, and values, a common task or a shared history are significant contributors to social identification and group cohesion (Pape, Reinecke, Rohde, & Strauss, 2003).

The most common form of identity recognition is a participant's username. Core community members rarely change usernames and if they do it is because of server or connection problems with their preferred nickname and they will choose a similar alternative name. As has been suggested above, chat's real-time synchronous affordances make it difficult for people to mask their identity within the community. Because of the synchronous nature of the iSchool channel and its very strong sense of community, trust is a crucial dynamic of the backchannel environment. For both regular community members and new participants, a sense of trust within the channel is mandated at all times. This is primarily maintained by requesting all users to reveal their true identity, as suggested above. Other key contributors to increasing trust include rules, personal disposition, history, shared category membership, and roles (Pyysiainen, 2003). In particular, establishing shared context between users is essential to maintaining trust online.

For the iSchool community, the sense of shared context is easily increased through the daily personal interactions that users experience in their face-to-face environment. By chatting informally in the classroom hallways, during lunch, or in outside social settings, users establish a sense of trust that is quickly transferred to their interactions in the online environment. The sense of shared context facilitates discussions and conversations online. The more shared context participants have, the easier it is for them to negotiate their sense of interpersonal trust and reputation. In one sample chat log, two members of the MIMS class of 2005 entered the channel to check it out. The MIMS 2006 class members knew the identity of the MIMS 2005 participants, but the MIMS 2007 class did not. They immediately questioned the identity of the new participants, but were ultimately willing to trust that they were welcome members of the channel as long as the 2006 class members could vouch for their identity.

Rules and Moderating

The iSchool chatroom is unique from many other IRC channels in that it is highly un-moderated. The original channel creator purposely set it up with few rules or regulations, empowering the chatroom participants to develop their own ecological community. The underlying purpose of rules is often about establishing control. Who governs the roles that participants play, how they interact with others, and any sense of ownership within the community? The rules of

participation are defined by a number of characteristics, ranging from the technology itself - rules that are built into the software that runs the community - to rules defined by the host. Although the iSchool community has no established moderators or community members who are appointed to moderate the discussion flow, a set of rules has evolved, of which participants maintain a general knowledge and awareness.

Central and Peripheral Participation

Core channel participants have the highest salience within the backchannel community. However, there are a number of examples of iSchool students who are well-known physical community members who have entered the backchannel only recently, despite having been able to join it at anytime over the past year. For example an iSchool 2006 student joined a year after the creation of the chatroom, eliciting surprise from her classmate. Later, a MIMS 2007 student joined and was asked to identify herself immediately. A student's participation is clearly closely tied in with his or her physical presence and social network. As the graphs above indicated the virtual communities in the backchannel seem to follow common usage patterns, where a few users are highly active, then participation drops off among the lurkers and peripheral users.

What Doesn't

Multi-Tasking and Cognitive Overload

Many opponents to the backchannel highlight its potential for distraction (Schwartz, 2003). Although students have always been subject to distractions during class, in a modern wireless-enabled physical space, the possibilities for distractions increase (Phalen, 2003). Some have suggested the term "continuous partial attention" to describe a student's cognitive ability to pay attention to the teacher's presentation when simultaneously engaged in the backchannel. Others, somewhat cynically, suggest that "continuous partial inattention" is a more appropriate description (McCarthy & boyd, 2005). Regardless of how well intentioned a student may be, a backchannel is going to elicit reactions and engagement from the students that will be asynchronous and off-topic to the teacher's lecture. The following example took place in an iSchool class:

18:42:31 Student1	Wait, what did she say? Something about ADD. I wasn't paying attention. Oooh, a birdy is flying out the window...
-------------------	---

Students may be distracted in the classroom and find themselves processing information at increasingly superficial levels while they attempt to juggle tasks and transfer attention across multiple domains simultaneously (Hembrooke & Gay, 2003; Hembrooke & Gay, 2002). Multi-tasking has emerged at the forefront of discussions related to both childrens' and adults' uses of technology (Ransford, 2005; Rideout & Foegr, 2005; Hafter, 2001). Educators need to determine if and how the tendency towards multi-tasking can be taken advantage of through the use of technology in the classroom rather than being given up on as an entirely negative outcome of wireless technologies. Some studies have indicated that learners can effectively multi-task in the classroom (Kennedy et al., 2005; Kaplan-Leiserson, 2003). At the iSchool, multi-tasking sometimes provided more insightful backchannel discussions through the posting of links and reflective comments. For example:

11:25:29 Student1	did he conclude the difference between copyright->employer and patent->employee?
11:25:33 Student1	or did I just miss it?

11:30:17 Student2 <http://www.uscourts.gov/courtlinks/>

Other times, it simply provided distractions that were off-topic to the professor's lecture. For example:

17:31:28 Student1 yeah. I had a roommate who went running with friends and ran like 10 miles. He came home and was eating jam directly out of the jar. It was funny.
17:32:01 Student1 I never saw anyone adult eat jam directly before.
17:32:17 Student2 i eat peanut butter straight from the jar sometimes

Can synchronous classroom activities be designed around conceptually related tasks to encourage deeper processing and greater learning of classroom content? Can the connectivity and real-time discussion facilitated by chat and the multi-tasking capabilities of students contribute to new learning opportunities in the classroom?

Too Distracting

The issues around distraction are similar to the preceding section on Multitasking and Cognitive Overload. The conversations within the chatroom can divert the students attention from frontchannel, causing confusion and disruption for the participants as well as the speaker.

10:51:22 Student21 Yeah, I missed that, reading the [removed] thread
10:51:28 Student21 what's that about usability?

The iSchool backchannel suggests that in an un-moderated classroom environment, the majority of multi-tasking online will be unrelated to the professor's lecture, although on occasion it will remain on topic. Kinzie et al contrasted these results in their study, in which students felt they were capable of engaging in on-task discussions and of expressing opinions and exploring instructionally relevant topics. However, even though students routinely multi-task in classrooms as they attend to lectures, process the contents, and record notes for later study, both students and the instructors expressed some discomfort with discussion occurring synchronously with classroom lectures (Kinzie, Whitaker, & Hofer, 2005). In particular, they found that students in the open laptop condition suffered decrements on traditional measures of memory for lecture content. However, "while students were obviously distracted by having access to the Internet, e-mail, IM, and browsing as evidenced by their performance on traditional tests of memory, their performance in the class overall does not reflect this same disruption" (Hembrooke & Gay, 2003) "While it may be that future cohorts of students will be more comfortable engaging in this form of instructional multi-tasking, the students and instructors participating in this research recommended multi-tasking involving focused sequential attention to different related activities, rather than simultaneous attention. Use of brief alternating time periods for lecture and on-line discussion, for instance, would help us consider a sequential definition of multi-tasking. In addition, it may be that skills in instructional multi-tasking can be developed for individuals over time; related inquiries could productively explore patterns of student discussion activity over time and across types of content and student personality" (Kinzie, Whitaker, & Hofer, 2005). "If students can become "better browsers", or at the very least become more facile at self-monitoring their browsing behavior, the typical decrement found under multi-tasking conditions might be negated" (Hembrooke & Gay, 2003). A student's ability to use the technology also factors into how distracted they may be by it. For example, in the first ClassChat experiment, when the software was highly buggy, one student admitted, with good reason, that:

14:24:37 Student 21 i'm so distracted by this chat room that i can't pay attention to [professor], we may consider this a noise factor

However, the first student had posted four minutes earlier that he was having trouble using the tool:

14:20:35 Student 21 i'm having a hard time with this chat

Subsequently, a second student responded that he was also having difficulties:

14:25:42 Student11 i'm distracted by the lack of refresh, requires me to concentrate on refreshing

Both comments about being distracted were therefore in direct correlation with the usability of the tool, rather than the dynamics of the conversation itself. This example reinforces the importance of the role that the software itself plays in the success of the backchannel.

Second Order On-Topic Discussions

We have already described our coding methods in the section above. Here, we describe in more detail some examples of discussions that are Second Order On-Topic. These discussions are started based on a subject related to the professor's lecture, but then divert into social discussions that may or may not be occasionally tied back into the lecture topic. We present three vignettes below as examples of second order on-topics discussions. These types of threads are particularly interesting because they often involve a number of students and take place over a significant time period (on the order of 2-15 minutes, which is significant in context of a class discussion). We correlate the lecture slide, the professor's actual lecture based on video transcriptions, and the backchannel discussion in order to reveal how the backchannel discussions are generated and in what ways they may or may not be related to the professor's discussion.

Vignette 1: The Essence of Tablehood¹⁷

Analyzing Tables [4]

- And in addition to the problem that most tables aren't represented in ways that capture their "tablehood" essence, it has been estimated that 95% of the information marked up as <TABLE> on the web is not really a table
- What characteristics distinguish genuine tables from non-genuine ones?
- And some small percentage of things that are tables according to our definition defy content encoding because they combine content, structure, and presentation in ways that are often impossible to untangle or that are highly idiosyncratic but conventional

Figure 39: April 12, 2006 Lecture Slide

Professor Glushko began his discussion of analyzing tables at 2:15:20 pm.

2:17:08 pm: "How do you know it's a table?"

2:17:50 pm: "What is tablehood? What is the essence of tables?"

2:18:24 pm: "The essence of tables is systematic relationships between content, structure, and presentation."

2:33:55 pm - 2:34:30 pm: "They lose their tablehood essence..."

¹⁷ <http://www.sims.berkeley.edu:8000/academics/courses/is243/s06/lectures/20060412/243-20060412.htm>

They use this kind of invent by cold fusion kind of HTML where everything is made to sit on a screen for layout, for that purpose... which makes it more difficult to figure out what content really is”

14:30:21 Student4	"the essence of tablehood"
14:30:39 Student23	La Mesa
14:30:41 Student4	Any InfoVizzers here? Reminds me of the Steve Few Designing for Tables book!
14:30:54 Student 13	i am guilty of using tables for structure...
14:31:05 Student23	My consulting business will be mesa-hood
14:31:33 Student66	Are you starting a consulting business?
14:31:39 Student23	no
14:31:44 Student23	I'm jus tkididng
14:33:38 Student31	I remember when html didn't have tables... when they came out it was amazing how many broken pages happened...
14:38:09 Student31	the Bible sez Jesus turned over the tables... Even Jesus didn't like tables!!!!
14:39:26 Student4	except the fat table at the Last Supper
14:40:10 Student23	Well, some tables are good. The Last Supper table had real content and structure.

Vignette 2: "A Ride on the Infinity Train"

2:19:34 pm – 2:20:00 pm:

Professor Glushko:

“So that contrasts with database design where you try to apply normalization”

Student in class:

“It’s like database design where you try to normalize data”

Professor Glushko:

“Some database analysts are completely compulsive. Right. They have these very complicated tables. they’ll normalize to the 18th degree.”

15:16:22 Student41	Remember normalization from 202!
15:16:25 Student77	18th?
15:16:35 Student52	OCD = normalizing to the nth degree
15:16:52 Student77	infiniti
15:16:53 Student52	I'm a 7th level Vegan, I don't eat anything that leaves a shadow
15:17:03 Student77	where n goes to infiniti
15:17:41 Student52	I'd like to catch a ride with n as it goes to infinity, never been there
15:18:37 Student22	hitch a ride on the infiniti train?
15:18:51 Student23	staple myself to an n
15:19:20 Student52	I've never been to N, only N-1. Everytime I iterate, just as I'm about to get to n, the loop ends

Vignette 3: “Is a Tortilla a Standard Unit of Measurement?”¹⁸

3:03:03 pm – 3:10:29 pm:

Professor Glushko:

“Everyone knows what a recipe is, but they are incredibly different, 20,000 recipes that all look different.

What is the content model for an ingredient? Is it just a piece of data? That’s a weak requirement for an ingredient, a string of text... If it’s an ingredient, that’s the component type... Is that enough? You want to have measures. It could be quantity followed by unit....

Student in class:

“I mean, is a tortilla a standard unit of measurement? I mean, I think so. But it depends on how many burritos you eat.”

15:05:31	Student52	recipes... I always get hungry when we talk food...
15:06:34	Student61	[student42]: yeah, seems like a cool thing to model, that is, modeling the cost model of constraints
15:09:46	Student3	This just makes me want to go get food.
15:09:51	Student61	wondering about 'academic nutritional' value of a given class... 25% of RDA of concepts related to topic on task list...
15:10:24	Student22	[student61]...perpetually off topic
15:10:36	Student52	[student61] - very interesting way to approach a course - don't you think though that's the grading breakdown or the syllabus?
15:11:09	Student19	this is making me hungry
15:11:25	Student22	"Is a tortilla a standard unit of measurement?"

Chicken Quesadillas

These Tex-Mex favorites are a Southwestern version of a grilled cheese sandwich.

- 2 tsp vegetable oil
- 1 lb boneless, skinless chicken breasts
- 1/2 tsp freshly ground black pepper
- 1/4 cup chopped fresh cilantro
- 1/4 cup ground cumin
- 8 flour tortillas
- 2 Tbsp vegetable oil
- 1/2 cup shredded Monterey Jack cheese
- 1/2 cup shredded Cheddar cheese
- 4 oz canned chopped green chiles, drained

Heat 2 tsp oil over high heat in a medium skillet. Cook chicken, cilantro, pepper and cumin in oil, stirring occasionally until chicken juices are clear. Shred chicken into small pieces, mixing with cooked cilantro.

Brush one side of a tortilla with some of the 2 Tbsp oil. Place oil side down on a platter. Arrange 1/4 chicken mixture and 1/4 of each cheese over the tortilla. Top with 1 oz. chiles. Place another tortilla on top. Brush it with more oil. Repeat until you have 4 quesadillas.

Carefully slide the quesadillas onto a hot grill over medium coals. Grill uncovered 4 minutes, turn, and grill 3 more minutes. Cut quesadillas into four wedges each.

Serves 4.

STANDARD	AMOUNT	UNIT	PERCENT
Calories	566	Calories from fat	24%
Total Fat	110g	Vitamin A	12%
Iron	10g	Vitamin C	14%
Cholesterol	90mg	Calcium	32%
Sodium	900mg	Iron	72%
Carbohydrate	42g		
Dietary Fiber	3g		
Protein	35g		

Dietary Exchanges: 2 starch/breads, 3 medium fat meat, 1 vegetable, 1 grain milk, 2 fat

Figure 40: April 12, 2006 Lecture Slide

What can we learn from these three vignettes? First, second order on-topic discussions are often the most likely to generate threaded discussions with the highest participation among total users. This may be because these discussions are both academic and social and all students can therefore relate to the discussion. Furthermore, these discussions often relate the professor’s lecture material to subjects of interest in the student’s own personal lives. They therefore may find themselves engaged in the backchannel discussion on many levels. We are unsure as to the academic value of these type of discussions. Obviously, they are distracting on one level. However, they also help students to build a sense of community and trust, which may then lead them to participate more frequently purely academic first order on-topic discussions. There appears to be a tradeoff in costs and benefits within these discussion that require a complex inquiry into how students learn and in what ways they can best collaborate in an engaged and proactive learning environment with minimal drawbacks.

¹⁸ <http://www.sims.berkeley.edu:8000/academics/courses/is243/s06/lectures/20060412/243-20060412.htm>

Disrespectful to Teacher

There are a number of ways in which the backchannel could be rude or disrespectful to the professor. First, if the professor is not aware of the existence of the backchannel, he is arguably placed in a compromisingly uninformed position about the dynamics of the audience to whom he is presenting. Second, the context of the backchannel discussion could very likely contain negative or disrespectful comments about either the presentation content or personal characteristics of the presenter. Third, as has been described already, participants' presence in the backchannel suggests a partial or complete lack of attention to the professor. "The term "backchannel" is a political term, implying not only the existence of a primary "front-channel", but also carrying implications of an unofficial, unwanted, illicit quality. In the lecture-oriented classroom, backchannels have always had a rich life, enabled by the technology of the day—from whispering, hand signals, and note passing, to today's e-mail, instant messaging, and mobile phone-based SMS" (McCarthy et al., 2004).

Professors have lamented the use of wireless technologies in the classroom, resorting to banning classroom usage or attempting to turn off access. "Some have banned the technology from classes, some turn off the Internet during instruction, while others struggle through lectures knowing that students are instant messaging, looking at photos, writing papers, and playing games instead of focusing on teacher-relayed information" (Phalen, 2003). At the University of Virginia's Darden School of Law a faculty member decided to turn off wireless access during class times. At the University of Texas, a law professor climbed a ladder and disconnected the wireless transmitter due to student inattention. "'Laptops are a real problem," says Charles M. Grisham, a professor of chemistry and chief technology officer of the University of Virginia College of Arts & Sciences. "You can stand at the door and see students surfing the web, e-mailing to each other....We wanted to bring this knowledge [technology] into the classroom, but it may be crippling in other ways" (Phalen, 2003).

Professors at the iSchool expressed varied opinions about the iSchool backchannel and its use during their lectures. One professor felt that he now had to teach in shorter bursts in the hopes of holding the student's attention better. He was not happy about this since he felt that his subject material required a lot of concentration on complexity. Another professor who had not been previously aware of the chatroom expressed discontent at having no awareness of it. This professor asked, somewhat cynically, if she could also be given access to this chatroom. She did not appreciate that students might be talking about her behind her back without her knowledge. This latter reaction was expressed by a number of professors, lecturers, and teachers. In Golub's study, the lecturer's initial reaction was one of anger and apprehension that students were talking about her behind her back. However, when she realized that the participants in the chatroom had been talking about topics related to her presentation, she was more enthusiastic about the idea (Golub, 2005).

Another iSchool professor confided that the iSchool backchannel was disconcerting for him because he did not know what was being said. "When a whole bunch of people start smiling broadly or snickering, you sometimes go, wait, did I say something weird or what?" He emphasized that he felt a disconnect when he did not know what was going on and what people were doing on it. They could be double checking references on google or chatting with other students for information purposes. He hadn't been on the iSchool backchannel before but

presumed it was relatively informal. However, he felt that it could play an interesting role if it were incorporated into the classroom through professor endorsement or a frontchannel display. It would provide an interesting dynamic for teachers and students to combine lecture and debate at the same time. If it were incorporated into the classroom, would it change the entire content of the discussion? “Would it poison the well?”

A better understanding of the social dynamics around the technology is essential to improving its use in the classroom. “We must learn from social trends, capture the power of student-technology interactions, and consider how such relationships engender students’ motivation for learning. The stipulation is that we as educators must be willing to reshape our traditional norms of communication as well as be open to draw upon skills students bring to the classroom” (DeGennaro, 2005). Another professor in the iSchool program expressed a contrasting perspective on the backchannel. He knew that students were chatting online during class because he could easily perceive their engagement with the computers as such. However, he stated that it did not bother him as it did many of the other professors. Somehow, this particular professor did not feel that the possibility that students were chatting about him behind his back was a challenge to his authority or self-esteem.

In the ClassChat experiment, Professor Glushko made a reference to the backchannel during lecture. What is interesting is that he had a particular assumption about how the backchannel was being used at that instance which was not accurate. In this case, he realized mid-lecture that he had mixed up two topics in the slide below¹⁹:

Generalizing and Specializing Components

- You can add a context qualifier to specialize a component rather than defining a completely new one (this reuses the "base" component type)
 - In the *Engineering Compendium* both Figures and Tables have Captions, and the Caption is similar enough in both to allow it to be re-used by both.
 - This suggests components for FigureCaption, TableCaption
- You can also remove or "factor out" context to define a more general or abstract component that can be used more broadly
 - "Delivery Date" and "Ship Date" suggest a "Date" component

Figure 11: April 12, 2006 Lecture Slide

We compared the video recording of his lecture at this point with the backchannel chat which revealed a very intriguing story about the disconnect between the professor’s perception of backchannel activity and actual activity.

From 3:04:58 pm to 3:05:25 pm, Professor Glushko says:

“I have my examples backwards in the slides!
I recognize that I have a caption, I go to this caption and then I realize the fact that there are two different types of caption, maybe I’ll specialize the caption...
think about what you see and decide what makes the most sense...”

Then, from 3:05:33 pm -3:05:55 pm he says:

¹⁹ <http://www.sims.berkeley.edu:8000/academics/courses/is243/s06/lectures/20060412/243-20060412.htm>

“See why this is great, I argue against my own slide here. But I think you get the idea that you can see both kinds of arguments. I have captions but maybe there is a different kind of caption and it depends on what kind of caption... **And they're going wild in the chatroom.**”

However, when we looked at the logs, we found that during this time was when the backchannel experienced the least activity of all throughout the whole class. In fact, from 3:02:51 pm - 3:12:16 pm, there was not a single posting in the backchannel!

Professor Glushko was concerned that a slight error in his lecture slide would be a source for backchannel critique or mockery, when in fact, students had no such intentions. This suggests that professors need to either be able to monitor the channel with minimal interruption to their standard lecture process, or to develop a common sense of familiarity and behavior around the backchannel through which they feel comfortable and confident lecturing without constantly wondering what is being said behind their backs. As we consider the role the IRC channel can play in the classroom, it will be essential to incorporate the professor or teacher's perspective into how it is used.

Usability

Because ClassChat usage is dependent upon synchronous interaction with other users, traditional single-participant usability tests would not be an effective method of analysis. In addition, the system is not designed to support a particular process, but a type of interaction, so scripted tests would not be particularly useful. Instead, students were given the opportunity to use the prototype during two regular class sessions. Logs from these sessions were analyzed for usability concerns, and follow up interviews were designed to probe for further issues. Lastly, a team of researchers unrelated to the project performed a Heuristic Evaluation.

Log Analysis

During the first phase of testing, significant technical problems were encountered with the interface. Due to a JavaScript error, the application was not refreshing automatically, forcing users to manually refresh the page. Frequent references to this problem appear in the chat log:

Student 43

```
14:12:09 hmmm. i don't know if this is refreshing
14:12:36 oops, refresh resubmit
```

This issue was fixed for the second testing phase. Participants expressed satisfaction with the fix:

April 12

```
student 43 14:08:55 wow. cool. refresh.
Teaching Assistant 14:10:28 is refresh working?
student 43 14:10:32 hi [Teaching Assistant]
Teaching Assistant 14:10:37 yes!
student 43 14:10:37 yep, yep
<Student4> 14:10:44 should be. can you see this? :)
```

Other problems uncovered from log analysis include:

Color: Some users found the text difficult to read due to the color scheme.

Scrolling: Each refresh forces the user to scroll or tab back down the page. This proved a significant efficiency problem for many of the users.

Name changes: Users had a difficult time discovering how to change user name. No direction is given, but the username appears in an editable text field. This is insufficient.

In addition, transfer effects from IRC usage were observed. Users expressed confusion over the similarities and differences between this web application and traditional IRC functionality. Students asked whether other users were “bots” (IRC robots), attempted to use IRC commands to control features, and requested features used specifically in the iSchool IRC channel. In this instance, a user refers to a function programmed into the bot used on the IRC channel:

```
14:55:33 We need a grouphug function
```

Interviews

During the interview phase following the tests, participants were asked specifically about usability problems they encountered while using the prototype. Subjects echoed the issues found during log analysis, specifically mentioning the refresh issue and the scrolling issue. One participant commented that few people changed their names from the anonymous default, due to the fact that this feature was not apparent. One subject also mentioned that the type was large, resulting in information scrolling off the page quickly.

Heuristic Evaluation

The heuristic evaluation was performed by a second group of graduate student researchers, unaffiliated with ClassChat, who had not used the application before. The full content of the heuristic evaluation is in appendix E. The evaluation found additional usability issues, many of which were more related to more subtle interface details. It illuminated many possible sources of confusion, particularly in wording and graphic representation. At this point, it would be useful to brainstorm design solutions with the evaluators, adjust the prototype, and perform additional user testing.

Summary of Major Usability Issues

Issue	Log Analysis	Interviews	Heuristic Evaluation
Page did not refresh automatically	X	X	
Color scheme interfered with legibility	X		
Refreshing places the user at the top of the page, and she must scroll down.	X	X	
Name change functionality was not transparent	X	X	X
Users expected additional IRC functionality.	X		
Text was too large		X	
Information scrolled off the page too quickly.		X	
Parts of activity graphs unclear			X
Button labels unclear (“B,” “I,” “add”)			X

Recommendations

As technology becomes an increasingly ubiquitous component of everyday life, educators will be left with little choice but to find a way to incorporate technology into the classroom. Computer and technology use and behavior is dynamic and evolving with the changing demands of the users and disciplines in which they occur. Ethnicity, gender, experience, and personality are all variables that factor into technology use. This paper is not an attempt to prescribe blanket statements or predictions about how technology can be used in the classroom. Rather, it is an effort to offer a set of hypotheses which educators, academics, industry leaders, and researchers can use to guide their own future research. A thorough understanding of the characteristics and implications of how this chatroom fits into the classroom structure will enable educators to design a better framework for learning.

The backchannel will vary across different contexts and domains

This analysis of the backchannel is unique to the iSchool graduate community. However, implementations of the backchannel could exist across a number of domains, including K-12, undergraduate classes, graduate programs, law schools, business meetings, conferences, and online learning or eLearning environments. Schools, in particular, need to incorporate the notion of communities of practice in combination with contemporary learning theories to become more intentional and systematic for improving learning and education.

Teaching styles should take advantage of the social and educational affordances

Technology by itself cannot improve instruction (Hestenes, Wells, & Swackhamer, 1992). However, technology can enhance the effectiveness of a good instructional design (Hoadley & Enyedy, 1999). Many teachers will be more likely to adopt chatroom technology in their classrooms if they are first provided support and instruction on how to use the technology (Cuban, 1993). Teachers may need to teach in shorter cycles to hold students’ attention. They

should adjust their curriculum and teaching styles to provide different and improved environments for scaffolding than the standard lecture format. A tighter integration of the backchannel may require their lectures to be more permeable and the right level of focus and formality will need to be determined. Students should be enabled to continually build upon their own knowledge and use the backchannel to share and enhance their learning process (Bruner, 1966). For example:

16:17:30 <Student1>	I studied stats back in undergrad and used a free package that is way better than SPSS, if anyone wants a link to it. I'm going to learn it in more depth if you want to collaborate.
16:18:27 <Student2>	I'd like to, Student1
16:18:31 <Student3>	it looks cool, Student1, and [professor] seems to support it. How hard is it to learn and is there a community support group behind it?

In the ClassChat experiment, we found that the Document Engineering class was not an ideal lecture style in which to use a backchannel. First, Professor Glushko uses a consistent lecture format in each class, posting his slides online consistently. Students therefore are provided with a thorough and extensive resource in which to understand the material, which is enhanced by a textbook that was written by Professor Glushko about the course topics. The backchannel is of little use therefore, because students rarely have questions or feel lost in the lecture. In class questions are often more like seminar-style discussions, which are not well-suited to a backchannel medium.

A better understanding of the socially constructed dynamics around the technology is essential to improving its use in the classroom (DeGennaro, 2005). One option is to use two publicly-projected chatrooms: one for comments, one for questions. In the latter chatroom, students could post questions for the teacher. A second option is to use a chatroom robot to monitor a channel and provide basic information as well as perform a heuristic analysis of events for post-analysis. For example, entering the command “@define constructionism” would automatically return a definition from nerdbox. Nerdbox, the iSchool robot, can be programmed to take a variety of different types of commands. A third option is to display the backchannel on the screen in front of the classroom so that students would be less inclined to contribute off-topic postings and would instead focus on the academic discussion. Similarly, a teaching assistant could participate in the backchannel and help facilitate interactions by guiding the discussion and providing scaffolding for the learners.

Chatrooms should enable teacher self-assessment

Presenters want to be able to obtain feedback (Anderson et al., 2003; DiMicco, Lakshmipathy, & Fiore, 2002). For example, Classroom Presenter supports the ability for a student to send a question or comment to the professor as well as the location on the PowerPoint slide to which it relates (Anderson et al., 2003). Teachers should be able to analyze the chat logs of a particular lecture and self-assess their own effectiveness. Did students understand their lecture? Were students engaged in the material? Did they feel comfortable asking questions either in the classroom or in the backchannel? Were all students participating equally in the backchannel? For example:

10:51:08 <Student1>	Did [lecturer] show us where he got his dataset?
10:51:30 <Student2>	I don't think he did
10:52:17 <Student3>	but you can find it in [source]
10:52:47 <Student2>	Actually, I think this is the link
10:52:48 <Student2>	[URL]

Researchers at MIT's Media Lab have designed a number of tools to visualize chat conversations with the goal of evoking intuitive understandings of the nature of the discussion (Mutton, 2004; Donath, 2002). These visualization tools could be used to reveal the structure of the students' discussions, and understanding of the material.

A backchannel should encourage social interactions and community building

In the same way that the physical classroom environment, as well as corporate environments, business meetings, and conferences, all encourage moderate levels of informal chat and humor, the backchannel should also permit the same dynamics. Students' desire to participate in the backchannel is increased if they have a sense of community within the channel, which is most easily built through social interactions and shared experiences. Within the iSchool community, the sense of shared context is easily increased through the daily personal interactions that users experience in their face-to-face environment. By chatting informally in the classroom hallways, during lunch, or in outside social settings, users establish a sense of trust that is transferred to their interactions in the online environment. The more shared context participants have, the easier it is for them to negotiate their sense of interpersonal trust and reputation and therefore facilitate discussion and conversation online. A fostered community of learners will result in greater levels of metacognition, reflection, discourse, deep content knowledge, distributed expertise, instruction, and assessment (Brown & Campione, 1996). For example:

```
13:28:35 <Student1>    how is constructionism different from constructivism?
13:28:48 <Student1>    is it?
13:29:26 <Student2>    seems more hands-on than not... where you actually build something
```

There needs to be a backchannel etiquette

Is a socially acceptable intellectual dialogue better than no engagement at all? How about if the dialogue includes an occasional off-topic or rude comment? For example:

```
13:27:32 <Student1>    i think we should have a goal this semester
13:27:53 <Student2>    to get [student3] a girlfriend?
```

Wireless technologies change how people interact with one another and etiquettes will need to evolve around these technologies. However, it will be difficult to construct a one size fits all set of rules. Rather, etiquette will be contextual and evolving, based on environment, users, and needs (White, 2005; Cox, 2005).

The eroding distinction between the cultures surrounding education, work, play, and technology poses new methodological challenges within the learning environment. What are learners' rights with regards to wireless use in the classroom? Designing for new educational environments using these technologies requires the use of iterative and reflective design methods to explore what works, what is important, and how it enhances learning. This nascent subject offers a rich opportunity for growth and exploration.

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Appendices

Appendix A: Interview Protocol Interview Questions

General questions about backchannel participation

Do you bring your laptop to class on a daily basis?

Tell me how you use your laptop during class.

Does your laptop use (taking notes, email, chatting, surfing) differ depending on the class? How does it differ?

Generally, describe your class participation (discussion, asking questions). How does this differ?

Have you used the sims IRC channel? Tell me about how you heard about the channel.

What were some of your first impressions of the channel? Do you remember the first time you used it?

How often do you go on the channel?

Do you use it during class time?

What do people generally talk about on the channel? Does it differ if everyone is in class together?

Do the people you know well / better at sims participate?

What do you find appealing/unappealing about the channel?

Do you think the professors are aware of the activity? Do they mention it?

More specific Classchat-related questions (for Doc Eng people)

Last week, we tested the Classchat prototype in Doc Eng. Did you try it out?

What made you decide to use it / not use it?

How does using a web app like Classchat compare to IRC?

What problems did you encounter with it (aside from the not refreshing problem on the first day)?

Appendix B: Source code for Log Analysis tool – parsenametypes.pl

```
# Script designed to parse a tab delimited chat log that has been
# coded for relevance, and output a matrix of pairwise proximity
# scores between all users seen in the chatlog. The output is tab
# delimited and can be read into Excel. The final section of output
# is formatted as an RSF (Rigi Standard Format) file which can be
# cut and pasted into tools such as CC-Visu, that visualization graphs
#
# Written for UC Berkeley School of Information Masters Final Project
#       ClassChat
# copyright Stephen Chan April 2006
# sychan@lbl.gov sychan@sims.berkeley.edu

# discard the header line
$line = <>;

while ($line = <>) {
    ($date,$type,$user,$msg) = split /\t/, $line;
    $user =~ s/^\s<///;
    $user =~ s/\>$//;
    $user = lc( $user);
    $msg = lc( $msg);

#   print "$user: $msg\n";
#   calculate the # of seconds for the timestamp
    @date = $date =~ m/(\d+):(\d+):(\d+)/;
    $secs = $date[2]+(60*$date[1])+(3600*$date[0]);

    $count{$user}{$type}++;
    $count{$user}{'total'}++;

#   If this is the IRC server, check for new user entry and update last seen for them
#   but do not update the proximity table
    if ($user =~ /server/) {
        ($user) = $msg =~ m/(\S+) \(/;
        $lastseen{ $user } = $secs;
#       print "User $user enters room at $secs\n";
        next;
    }

#   update the last seen timestamp for this user
    $lastseen{ $user } = $secs;

#   go through the list of people in the room and update the
#   the "proximity table between this user and their peers
    foreach $peer (keys %lastseen) {
        # if the user is self, skip
        if ($user eq $peer) {
            next;
        }
        # if the message is addressed to a particular user, then
        # bump up the score between them by 3 points
        if ($msg =~ /$peer/) {
            $score = 3;
        } else {
            # otherwise bump up the score based on an exponential decay
            # formula - count the number of 30 second increments since
            # the last sighting of that user, call this T, and use
            # 10^(-T) as the increase to the score. That way anyone
            # seen within the last 30 seconds gets a bump of 1 point,
            # from 30sec - 1minute gets .1 point, etc...
            $dt = int(($secs - $lastseen{ $peer})/30) * -1;
            $score = 2**$dt;
        }
        $proximity{$user}{$peer} += $score;
#       print "$user -> $peer + $score\n";
    }
}
```

```

}
}

# Output the scoring matrix, calculating row and column totals along
# the way
print "User\tType1\tType2\tType3\tType4\tType5\tTotal\tAverage\n";
foreach $user (keys %count) {
    print $user,":\t";
    $score = 0;
    foreach $type (1..5) {
        print $count{$user}{$type},"\t";
        $score += $count{$user}{$type} * $type;
    }
    print $count{$user}{'total'},"\t",$score/$count{$user}{'total'};
    $relevance{$user} = $score/$count{$user}{'total'};
    print "\n";
}

print "\nproximity table - one direction\n";
foreach $peer (sort keys %proximity) {
    print "\t$peer";
}
print "\tTotal\n";

foreach $user (sort keys %proximity) {
    print $user;
    $rowsum = 0;
    foreach $peer (sort keys %proximity) {
        print "\t",$proximity{$user}{$peer};
        $rowsum += $proximity{$user}{$peer};
        $colsum{$peer} += $proximity{$user}{$peer};
    }
    print "\t$rowsum\n";
}
print "Total";
foreach $peer (sort keys %proximity) {
    print "\t",$colsum{$peer};
}
print "\n";

# Output another table that sums up all proximity(user1, user2) and
# proximity(user2,user1) pairs.
print "\nproximity table - summed bidirectional\n";

foreach $peer (sort keys %proximity) {
    print "\t$peer";
}
print "\n";

foreach $user (sort keys %proximity) {
    print $user;
    $seen{$user} = 1;
    foreach $peer (sort keys %proximity) {
        unless ($seen{$peer}) {
            print "\t",$proximity{$user}{$peer} + $proximity{$peer}{$user};
        } else {
            print "\t ";
        }
    }
    print "\n";
}

# Output an RSF format file for the table we just printed above
# that can be read into CC-Visu

print "\nRSF format graph: (summed edge weight)/3\n";
%seen = {};
foreach $user (sort keys %proximity) {
    $seen{$user} = 1;
    foreach $peer (sort keys %proximity) {
        unless ($seen{$peer}) {

```

```

        print "summed $user(".$relevance{$user}.) $peer(".$relevance{$peer}.) ",(($proximity{$user}{$peer} +
        $proximity{$peer}{$user})/3),"\\n";
    } else {
    }
}
}

```

Appendix C: Script for modifying CCVisu layout files into final visualization format

```

while (<>) {
    @line = split /\t+/, $line;
    $max = $line[3] if ($line[3] > $max);
    push @lines,$_;
}

foreach $line (@lines) {
    @line = split /\t+/, $line;
    ($name,$relevance) = $line[4] =~ /^(.+)\((.+)\)/;
    $line[4] = $name;
    $line[5] = int($line[3]/$max*255)*256; # set brightness of green color
    $line[3] = 1.5**((6 - $relevance)*3);
    print join( "\\t", @line);
}

```

Appendix D: Sample output of IRC log analysis

User	Type1	Type2	Type3	Type4	Type5	Total	Average
nerdbox:						1	1
elmo:	8	13		8		29	2.275662
batgirl:			1	1		2	3.5
I33thaxxor:				8	1	9	4.111111
bugsbunny:	1	2		2		5	2.6
thetick:		1	1	7		9	3.666667
elmerfudd:	3	24	5	60	4	96	3.395833
pinky:	5	32	3	65	1	106	3.235849
cartman:		12	2	18	2	34	3.294118
flintstone:		1		3		4	3.5
irc server:						19	5
sailmoon:		2	2	26		30	3.8
ernie:	4	23		39	3	69	3.202899
stimp:	1	4		4	1	10	3
bert:				3		3	4
zorak:		3	1	5		9	3.222222
hobbes:				8		9	2.222222
spaceghost:		2		13	1	16	3.8125

proximity table - one direction

	thetick	elmerfudd	stimp	elmo	hobbes	sailmoon	flintstone	pinky	bugsbunny	spaceghos	cartman	nerdbox	ernie	batgirl	I33thaxxor	bert	zorak	Total
thetick		8.03125	0.128906	6.187501	0.000885	2.582031	1	4.781616	1.156251	1.375031	0.044451	1.25	5.53125	3	1	2.41E-05	0.195316	36.26451
elmerfudd	19.24617		14.00921	29.93283	6.23491	31.99942	5.655903	66.22974	10.59433	14.75469	28.13009	1.767822	70.62305	12.34748	8.625	10.94569	19.42846	350.5248
stimp	0.046955	5.03125		0.093925	2.17E-19	1.001467	5.17E-26	5.128906	3.06E-05	2.089355	3.750061	4.984375	3.001964			0.0448	0.123536	25.29662
elmo	6.515869	25.25	1.489258		2.500008	13.35938	1.558838	20.50861	7.375012	8.407185	1.887586	0.187531	23.27344	2.691406	2.015625	2.000191	8.259767	127.2797
hobbes		6.25	1.318359	3.618359		1.595703	0.000284	6.765625	4.43E-06	4.25061		1.164063			1.29039	2.28125	24.91594	
sailmoon	3.56275	27	1.481446	8.525841	3.601589	0.605103	18.83594	2.312714	2.064138	9.065063	1.062531	22.28125	0.003906	0.515625	1.500714	5.752414	108.171	
flintstone	2.5	4	0.015625	0.75	2.5E-29	0.875	4	3.007813	0.625	0.00293	0.875	4	5.82E-10		6	2.38E-06	0.03125	26.68262
pinky	12.35352	82.21875	13.21046	25.71547	8.001053	27.99017	5.820807		14.21094	20.78512	27.64344	3.238708	65.09961	16.81772	9.25	7.024523	21.00302	360.3833
bugsbunny	0.765869	3.75	1.00589	1.313477	1.63E-27	0.344727	1.515869	5		0.313751	1.141846	0.314484	2.515625	0.253906	3.015625	0.000123	0.012025	21.26322
spaceghos	1.932861	11.625	5.199219	2.397461	2.81E-19	1.795135	0.000244	12.505	1.062539	0.023508	3.05E-05	7.210938	4.059937	0.015625	1.500165	2.562502	51.89017	
cartman	2.58198	28.90625	6.725771	4.087196	2.5625	10.87303	0.094614	20.19531	5.1875	4.035156		0.009872	23.88281	4.261722	2.054688	0.067535	6.512821	122.0388
nerdbox	0.5	1	0.03125	1	5.05E-29	0.25	6.02E-36	1	0.0625	1	0.003906		1	3		3.81E-06	0.0625	8.91016
ernie	10.74435	49.65625	10.98775	22.37992	4.517579	21.5701	2.689698	44.19275	6.250021	9.827601	23.01098	1.058594		12.0951	7	2.627725	10.03849	238.6464
batgirl	0.5625	2	0.001221	0.75	1.97E-30	1.25	0.625	2	1.25	0.039663	0.000275	0.078125	2		0.75	2.68E-07	0.002441	11.30862
I33thaxxor	3.125	6.5	0.019043	2.75	3.08E-29	2.625	5.6875	5.875	3.523438	0.796875	2.503082	0.958984	8.5	3.5		3.04E-06	0.041992	46.40592
bert	0.001953	2.5	0.250977	0.00391	7.11E-15	0.250061	1.27E-21	3	1	0.5	1		2	0.000244			0.511719	11.01886
zorak	0.009777	6.25	1.8125	4.523926	1.75	3.000214	0.000671	7	1	2.50025	4.126587	5.4375	3.000366			2.750122	43.16191	
Total	64.44955	269.9688	56.36853	111.7298	29.16852	121.3614	25.25453	227.0185	57.99308	69.11268	106.5844	10.80168	249.5039	68.03375	40.24219	29.75166	76.8195	

proximity table - summed bidirectional

	thetick	elmerfudd	stimp	elmo	hobbes	sailmoon	flintstone	pinky	bugsbunny	spaceghos	cartman	nerdbox	ernie	batgirl	I33thaxxor	bert	zorak
thetick		27.27742	0.175861	12.70337	0.000885	6.144782	3.5	17.13514	1.92212	3.307892	2.626431	1.75	16.2756	3.5625	4.125	0.001977	0.205093
elmerfudd	19.24617		19.04046	55.18283	12.48491	58.99942	9.655903	148.4485	14.34433	26.37969	57.03634	2.767822	120.2793	14.34748	15.125	13.44569	25.67846
stimp	0.046955	5.03125		1.583183	2.17E-19	2.482913	0.015625	18.33937	1.005921	7.288575	10.47583	0.03125	15.97213	3.003185	0.019043	0.295776	1.936036
elmo	6.515869	25.25	1.489258		3.818367	21.88522	2.308838	46.22407	8.688469	10.80465	5.974782	1.187531	45.65335	3.441406	4.765625	2.004101	12.78369
hobbes		6.25	1.318359	3.618359		5.197292	0.000284	14.76668	1.63E-27	4.43E-06	6.813111	5.05E-29	5.681642	1.97E-30	3.08E-29	1.29039	4.03125
sailmoon	3.56275	27	1.481446	8.525841	3.601589		1.480103	9.820807	4.523682	0.625244	0.097544	0.875	6.689698	0.625	11.6875	2.38E-06	0.031921
flintstone	2.5	4	0.015625	0.75	2.5E-29	0.875		19.21094	33.29012	47.83875	4.238708	109.2924	18.81772	15.125	10.02452	28.00302	
pinky	12.35352	82.21875	13.21046	25.71547	8.001053	27.99017	5.820807		17.67621	3.376291	0.376984	8.765646	1.503906	6.539063	1.000123	0.012025	
bugsbunny	0.765869	3.75	1.00589	1.313477	1.63E-27	0.344727	1.515869	5		4.058664	1.000031	17.038	4.098999	0.8125	2.000165	5.062752	
spaceghos	1.932861	11.625	5.199219	2.397461	2.81E-19	1.795135	0.000244	12.505	1.062539	0.023508	3.05E-05	7.210938	4.059937	0.015625	1.500165	2.562502	51.89017
cartman	2.58198	28.90625	6.725771	4.087196	2.5625	10.87303	0.094614	20.19531	5.1875	4.035156		0.009872	23.88281	4.261722	2.054688	0.067535	6.512821
nerdbox	0.5	1	0.03125	1	5.05E-29	0.25	6.02E-36	1	0.0625	1	0.003906		1	3		3.81E-06	0.0625
ernie	10.74435	49.65625	10.98775	22.37992	4.517579	21.5701	2.689698	44.19275	6.250021	9.827601	23.01098	1.058594		12.0951	7	2.627725	10.03849
batgirl	0.5625	2	0.001221	0.75	1.97E-30	1.25	0.625	2	1.25	0.039663	0.000275	0.078125	2		0.75	2.68E-07	0.002441
I33thaxxor	3.125	6.5	0.019043	2.75	3.08E-29	2.625	5.6875	5.875	3.523438	0.796875	2.503082	0.958984	8.5	3.5		3.04E-06	0.041992
bert	0.001953	2.5	0.250977	0.00391	7.11E-15	0.250061	1.27E-21	3	1	0.5	1		2	0.000244			0.511719
zorak	0.009777	6.25	1.8125	4.523926	1.75	3.000214	0.000671	7	1	2.50025	4.126587	5.4375	3.000366			2.750122	43.16191

RSF format graph: (summed edge weight)/3

```

summed thetick(3.666666666666667) elmerfudd(3.395833333333333) 9.09247248892001
summed thetick(3.666666666666667) stimp(3) 0.0586202939354431
summed thetick(3.666666666666667) elmo(2.27586206896552) 4.23445674777037
summed thetick(3.666666666666667) hobbes(2.222222222222222) 0.000295162200927734
summed thetick(3.666666666666667) sailmoon(3.8) 2.04826050003521
summed thetick(3.666666666666667) flintstone(3.5) 1.1666666672611
summed thetick(3.666666666666667) pinky(3.23584905660377) 5.71171333796034
summed thetick(3.666666666666667) bugsbunny(2.6) 0.64070677572632
summed thetick(3.666666666666667) spaceghost(3.8125) 1.1026306152353
summed thetick(3.666666666666667) cartman(3.29411764705882) 0.97547704577446
summed thetick(3.666666666666667) nerdbox(5) 0.5833333333333333
summed thetick(3.666666666666667) ernie(3.2028995072464) 5.42519888794067
summed thetick(3.666666666666667) batgirl(3.5) 1.1875000159101
summed thetick(3.666666666666667) I33thaxxor(4.111111111111111) 1.375
summed thetick(3.666666666666667) bert(4) 0.000659080920740962
summed thetick(3.666666666666667) zorak(3.222222222222222) 0.0683644271145264
summed elmerfudd(3.395833333333333) stimp(3) 6.34682101011276
summed elmerfudd(3.395833333333333) elmo(2.27586206896552) 18.3942780353245
summed elmerfudd(3.395833333333333) hobbes(2.222222222222222) 4.16163657761243
summed elmerfudd(3.395833333333333) sailmoon(3.8) 19.6664736413707
summed elmerfudd(3.395833333333333) flintstone(3.5) 3.21863446512122
summed elmerfudd(3.395833333333333) pinky(3.23584905660377) 49.4828287760417
summed elmerfudd(3.395833333333333) bugsbunny(2.6) 4.78144225184011
summed elmerfudd(3.395833333333333) spaceghost(3.8125) 8.79323141056669
summed elmerfudd(3.395833333333333) cartman(3.29411764705882) 19.0121144551473
summed elmerfudd(3.395833333333333) nerdbox(5) 0.922607421875
summed elmerfudd(3.395833333333333) ernie(3.2028995072464) 40.0930989583333
summed elmerfudd(3.395833333333333) batgirl(3.5) 4.78249262180179
summed elmerfudd(3.395833333333333) I33thaxxor(4.111111111111111) 5.041666666666667
summed elmerfudd(3.395833333333333) bert(4) 4.48189762512713
summed elmerfudd(3.395833333333333) zorak(3.222222222222222) 8.55948536878655
summed stimp(3) elmo(2.27586206896552) 0.527727603989964
summed stimp(3) hobbes(2.222222222222222) 7.23961946644809E-20
summed stimp(3) sailmoon(3.8) 0.827637727061907
summed stimp(3) flintstone(3.5) 0.005208333333333333
summed stimp(3) pinky(3.23584905660377) 6.11312206586202

```

summed stimp(3) bugsbunny(2.6) 0.335306977256323
summed stimp(3) spaceghost(3.8125) 2.42952489852905
summed stimp(3) cartman(3.29411764705882) 3.49194401007844
summed stimp(3) nerdbox(5) 0.0104166666666667
summed stimp(3) ernie(3.20289855072464) 5.32404327392578
summed stimp(3) batgirl(3.5) 1.00106157859166
summed stimp(3) I33thaxor(4.11111111111111) 0.00634765625
summed stimp(3) bert(4) 0.0985921621322632
summed stimp(3) zorak(3.22222222222222) 0.645345211145468
summed elmo(2.27586206896552) hobbess(2.22222222222222) 1.27278902257482
summed elmo(2.27586206896552) sailormoon(3.8) 7.2950719272969
summed elmo(2.27586206896552) flintstone(3.5) 0.769612630208945
summed elmo(2.27586206896552) pinky(3.23584905660377) 15.4080244749784
summed elmo(2.27586206896552) bugsbunny(2.6) 2.89616314570109
summed elmo(2.27586206896552) spaceghost(3.8125) 3.60154851286401
summed elmo(2.27586206896552) cartman(3.29411764705882) 1.99159415562948
summed elmo(2.27586206896552) nerdbox(5) 0.395843505859375
summed elmo(2.27586206896552) ernie(3.20289855072464) 15.2177844395434
summed elmo(2.27586206896552) batgirl(3.5) 1.14713542881267
summed elmo(2.27586206896552) I33thaxor(4.11111111111111) 1.58854166666667
summed elmo(2.27586206896552) bert(4) 0.66803380105921
summed elmo(2.27586206896552) zorak(3.22222222222222) 4.26123100038482
summed hobbess(2.22222222222222) sailormoon(3.8) 1.73243081569751
summed hobbess(2.22222222222222) flintstone(3.5) 9.47316487630208e-05
summed hobbess(2.22222222222222) pinky(3.23584905660377) 4.9222595463348
summed hobbess(2.22222222222222) bugsbunny(2.6) 5.41701179644613e-28
summed hobbess(2.22222222222222) spaceghost(3.8125) 1.47521495819101e-06
summed hobbess(2.22222222222222) cartman(3.29411764705882) 2.27103686358587
summed hobbess(2.22222222222222) nerdbox(5) 1.68290326447149e-29
summed hobbess(2.22222222222222) ernie(3.20289855072464) 1.89388054637592
summed hobbess(2.22222222222222) batgirl(3.5) 6.57384087684177e-31
summed hobbess(2.22222222222222) I33thaxor(4.11111111111111) 1.02551917678732e-29
summed hobbess(2.22222222222222) bert(4) 0.430013020833336
summed hobbess(2.22222222222222) zorak(3.22222222222222) 1.34375000000152
summed sailormoon(3.8) flintstone(3.5) 0.493367517989408
summed sailormoon(3.8) pinky(3.23584905660377) 15.6037008826435
summed sailormoon(3.8) bugsbunny(2.6) 0.885813397665819
summed sailormoon(3.8) spaceghost(3.8125) 1.2864246369136
summed sailormoon(3.8) cartman(3.29411764705882) 6.64603193600972
summed sailormoon(3.8) nerdbox(5) 0.437510172526042
summed sailormoon(3.8) ernie(3.20289855072464) 14.6171169606969
summed sailormoon(3.8) batgirl(3.5) 0.417968751571607
summed sailormoon(3.8) I33thaxor(4.11111111111111) 1.046875
summed sailormoon(3.8) bert(4) 0.583591546921526
summed sailormoon(3.8) zorak(3.22222222222222) 2.9175426576597
summed flintstone(3.5) pinky(3.23584905660377) 3.27360248573859
summed flintstone(3.5) bugsbunny(2.6) 1.50789388020833
summed flintstone(3.5) spaceghost(3.8125) 0.208414713541667
summed flintstone(3.5) cartman(3.29411764705882) 0.0325145845611986
summed flintstone(3.5) nerdbox(5) 0.291666666666667
summed flintstone(3.5) ernie(3.20289855072464) 2.22989916875187
summed flintstone(3.5) batgirl(3.5) 0.208333333527359
summed flintstone(3.5) I33thaxor(4.11111111111111) 3.89583333333333
summed flintstone(3.5) bert(4) 7.94728597005209e-07
summed flintstone(3.5) zorak(3.22222222222222) 0.0106404622395833
summed pinky(3.23584905660377) bugsbunny(2.6) 6.40364664155527
summed pinky(3.23584905660377) spaceghost(3.8125) 11.0967076929914
summed pinky(3.23584905660377) cartman(3.29411764705882) 15.9462494796511
summed pinky(3.23584905660377) nerdbox(5) 1.41290283203125
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Appendix E: Results of Heuristic Evaluation

ClassChat Heuristic Evaluation

Methodology:

The evaluation was performed by interacting with the interface and exploring the available options. No specific tasks were provided to better emulate user flexibility. A set of heuristics published by Jakob Nielsen was used, along with a severity scale of one to four, detailed below.

Severity Ratings:

Severity 1: Cosmetic problem: fix if there is extra time available

Severity 2: Minor usability problem: low priority

Severity 3: Major usability problem: high priority

Severity 4: Usability catastrophe: imperative to fix before product release

Heuristics:

H1. Visibility of system status

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

H2. Match between system and the real world

The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

H3. User control and freedom

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

H4. Consistency and standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

H5. Error prevention

Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

H6. Recognition rather than recall

Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

H7. Flexibility and efficiency of use

Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

H8. Aesthetic and minimalist design

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

H9. Help users recognize, diagnose, and recover from errors

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

H10. Help and documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

Evaluation:

Problem: No Help link

Heuristic Violated: H10

Severity: 3

Problem: Not clear what the mini bar graph represents

Clicking on it did not make its function more obvious since. All that was visible were three bars but no labels or descriptions.

Heuristic Violated: H6, H10

Severity: 4

Problem: Not immediately clear what Add refers to. Post might be better and more standard.

Heuristic Violated: H4

Severity: 1

Problem: Changing name and pressing enter or Add without entering text, returns one message: “<Name> joined the conversation”, but changing the name and entering text before pressing Add returns “<Name1> changed name to <Name2>.”

Heuristic Violated: H4

Severity: 3

Problem: When name is changed without entering text in the text field, the old name still appears in the list of students in the chat-room. This does not happen when the name is changed in conjunction with posting.

Heuristic Violated: H1

Severity: 4

Problem: Not clear what B and I mean until you click on them

Heuristic Violated: H6

Severity: 2

Problem: “Enter the text you would like to create your link with” is convoluted and not very descriptive. I was not sure if the text would be clickable or would just appear next to the link.

Heuristic Violated: H2, H5

Severity: 3

Problem: Not clear what “Lace is Active” means. The functionality didn't seem to be active.

Heuristic Violated: H1, H2

Severity: 3

Problem: Not clear what the graph buttons mean by just looking at the page. I needed to mouse over them to get that information from the tool tip.

Heuristic Violated: H6

Severity: 3

Problem: Clicking a posted link navigates user away from the application instead of opening a new window.

Heuristic Violated: H3, H5, H7

Severity: 4

Problem: Not clear what the scale for the sliders in the activity bar is.

Heuristic Violated: H2

Severity: 3

Problem: Not sure what 30 log entries means

Heuristic Violated: H2

Severity: 3

Problem: Not sure what the y- axis in the activity graph represents – I thought it might mean entries but the tooltip says 0 entries for a point that is a 5 on the y axis.

Heuristic Violated: H2

Severity: 4

Problem: The name field is not labeled, although it's not difficult to deduce what it is.

Heuristic Violated: H6

Severity: 1