Abstract: Synchronous conferencing systems are under utilized in most distance learning environments. Appropriate use of the synchronous CMC systems contributes to student satisfaction and active participation in an online environment. This study employed the formative evaluation method to assess students' perceptions toward different CMC systems. The systems are divided into three categories: text-based chat, audio-video conferencing, and virtual reality applications. The results of the study indicated that, among all synchronous CMC systems, text-based and virtual reality conferencing systems are more efficient for synchronous online learning.

1. Introduction
Online learning refers to any type of learning activities that take place over a computer network. Synchronous online learning refers to online learning that takes place in real time. As an increasing number of courses in various disciplines go online, various types of computer-mediated communication (CMC) systems are also utilized to facilitate online learning. CMC systems, as defined by Kerr and Hiltz, "use computers to structure, store, and process communications" (Kerr & Hiltz, 1982, p. 2). Many research studies have shown that the features of CMC systems can not only reduce physical and social constraints but also increase online interaction and knowledge acquisition (Kay, 1992; Verdejo & Cerri, 1994). Many studies have focused on the final impact of technology on student learning. This research proposes to use formative evaluation to study the process of student learning about new technology. The findings will further the understanding of the applications of the CMC systems for online learning as well as student perceptions toward new technology. As Bloom et al (1971) have noted that evaluation is a systematic way of collecting evidence to determine if learning has taken place in individual students. This research used observation, reflection journals and social presence ratings to survey student perceptions toward CMC systems.

2. Background
2.1. CMC Systems for Synchronous Online Learning
The CMC systems used in the course for this research were a combination of text-based, audio-video, and virtual reality systems. The main communication system was WebCT, which was a web-based learning courseware. WebCT provided a set of tools for instructor and students to engage in online instruction and learning. These tools included: homepage, presentation area, annotation tool, self-test, course content, course reference material, email, chat room, bulletin board, calendar, searchable image and file archive, syllabus, course content manager, grade tools, timed online quizzes, file manager, indexed searching, student progress tracking, etc. (Goldberg, 1997). In additional to WebCT, this course also utilized the following systems for synchronous learning.

2.1.1 Text-based Conferencing Systems
2.1.1.1 ICQ: ICQ ("I seek you") is an Internet paging and chat utility. Users can page a partner via Internet for a live chat. A contact window will indicate if another conversation partner has come online. This tool is ideal for small group interaction. Teachers can use it for virtual office hours. (http://www.icq.com)
2.1.1.2 WebCT Chat: a Java-based chat program and a component in WebCT. Group discussions can take place in four separate chat rooms. Conversations in the chat rooms are recorded. (http://www.webct.com)

2.1.2 Audio-video Conference Systems
2.1.2.1 Netscape CoolTalk: an audio conferencing system that allows people to talk to each other over the Internet. (http://www.netscape.com)
2.1.2.2 CU-Seeme: a video conferencing system. Users can see and hear each other via a video camera over the Internet. (http://www.cuseeme.com)

2.1.3 Virtual Reality Systems
2.1.3.1 ActiveWorlds: a graphically enhanced 3D-conferencing system. Users are represented by avatars which walk, dance, and jump around in a world. A world is a metaphor for the ideal world that a user would like to build in the cyberspace. Programming knowledge is required to build a world in the ActiveWorlds. Conversations are typed into the chat window and logged automatically. (http://www.activeworlds.com/)

2.1.3.2 The Palace: another graphically enhanced affective conferencing system that also uses avatars to represent conversationalists. The main difference from the ActiveWorlds is that users can change the emotional expressions such as sadness, happiness, and excitement on the avatars. Users can dress the avatars using props in the suitcase or from the Internet. (http://www.thepalace.com)

The selections of these CMC systems were intended for the students to develop the skills to manage various types of CMC systems. The main criteria of the selections are based on economic considerations. Programs that could be freely downloaded or affordable were first considered. The next section will discuss about the online learning activities for synchronous online learning via these CMC systems.

2.2 Synchronous Online Learning Activities
Most of the online learning environments are based on the model of asynchronous learning in which students engage in online activities at a time of their choosing. For courses that emphasize memorization of factual knowledge, asynchronous communication may be sufficient. For a course, such as in the case of this study, that was designed to improve online communication skills, synchronous communication is no less important than asynchronous communication. Students can learn the techniques for online discussions and develop the skills to operate these CMC technologies through synchronous learning. Synchronous communication and asynchronous communication are of equal importance in the curriculum.

There are many options for synchronous activities, for example, guest speakers from remote sites, online debate, and role-play. This course utilized all these means to enhance student learning interests. To help the students in getting ready for synchronous discussion, two preparations can be done ahead of time: dividing students into small groups and providing guidelines for discussions. Ill-prepared synchronous communication can be characterized as non-linear, chaotic, unfocused, and unproductive. Small group discussions have the advantages of initiating focused, equal, dynamic, interactive, and quality discussions. Sharan and Sharan (1976) postulated that "small groups are an effective organizational medium for encouraging, clarifying, and guiding student participation in planning classroom activities, both academic and social" (p. 10).

Furthermore, the guidelines directed the students toward a good start for online discussions. All students were given a set of Student-Centered Discussion (SCD) guidelines at the beginning of the semester. The SCD guidelines were adapted from Dr. Linda Shoop’s model of SCD (http://home.kiski.net/~dwright/scd/home.html). The SCD guidelines were introduced for the purpose of facilitating discussions and increasing the quality of student participation. The guidelines included two main parts.

2.2.1 The role of the participants
Discussants of online forum should follow the etiquette that ensures good discussions.
1) Respect for each others: be polite to each others.
2) Idea generating: formulate ideas and try to state them in clear terms.
3) Listening: read other people's messages before jumping into debate.
4) Referencing: always include the names of the past speakers when making references to their messages.
5) Display responsible involvement: avoid chitchat in public forum and try to address to the whole group as much as possible.

2.2.2 The role of the moderators
In order to lead a successful discussion, a moderator should do the following preparations to keep the discussion alive:
1) Greeting: Moderators should greet every participant when they join the chat room.
2) Warm-up activities: Moderators can devise short activities to get everyone ready for the formal discussion. For example, the moderator can solicit a quick poll on current issues.
3) Make an opening statement: The statement should provide information for the understanding of the topic of the day before initiating formal debate.
4) Step-by-step discussion process: Ask one question at a time and try to keep the discussion focused.
5) Asking questions: Have several questions ready before the seminar. When the discussants exhaust one topic, the moderator can either build on what has been discussed or ask a new question to keep the discussion afloat.
6) Script write the discussion: If necessary, the moderator can write down in advance certain set phrases, e.g. greeting, opening statements, introduction to the guest speaker, etc. It is more efficient to cut-paste these phrases into the chat window than keeping everyone waiting until the moderator finishes typing.
7) Concluding remarks: At the final round of the discussion, the moderator should try to consolidate the key points that surfaced during the conference and make concluding remarks.

In the following section, further details on a class

3. Formative Evaluation

3.1 Methods
Bloom et al (1971) defined formative evaluation as "the use of systematic evaluation in the process of curriculum construction, teaching, and learning for the purpose of improving any of these three processes. (p. 117). Bloom et al stated that "the purpose of formative observation is to determine the degree of mastery of a given learning task and to pinpoint the part of the task not mastered" (p. 61). The results of formative evaluation can help instructors to improve curriculum design for better learning outcomes. Furthermore, formative evaluation can contribute to the improvement of computer-based educational technology (Flagg, 1990) The results of the formative evaluation in this study can help educators to make useful decisions in selecting CMC systems.

The methods used in this study included reflection journals, observations, and social presence ratings. Students were asked to reflect on the use of each CMC system in their weekly journals. The researcher also took notes while observing student adaptation to a new CMC system. After each use of the CMC system, students were also asked to complete a social presence ratings survey. Social presence is the degree that the senders and receivers can sense each other during their communication (Short et al, 1976). People interact differently according to the degree of social presence that they can feel. High social presence can convey multiple, nonverbal communication channels and continuous feedback. The social presence ratings used in this research employed semantical differential techniques that included a number of bipolar questions. For example, students were asked to rate a CMC system on a one-to-seven scale based on the following bipolar pairs: Impersonal - Personal; Distant - Close; Dehumanizing - Humanizing; Expressive - Inexpressive; Emotional - Unemotional; Insensitive - Sensitive. The results will be discussed in the Discussions section.

3.2 Research questions
In order to gain a better understanding of student adaptation to technology, I would like to ask the following questions:
1) What are the advantages and disadvantages of the CMC systems for synchronous learning?
2) How do students adapt to each CMC system?
3) How efficient are these CMC systems for communication?

3.3. Settings and Procedures
The data for this research is based on a writing-intensive online course that took place in fall 1998 in the Communication Department at the University of Hawaii. The course was titled "COM459: Theories and Applications for Computer-Mediated Communication Systems." The CMC systems employed in this course included the following three categories: text-based systems, audio-video conferencing, and virtual reality systems. The main objective of this course was to better the understanding of CMC systems through efficient use of various CMC systems. The student population consisted of junior, senior, and graduate students in communication, business, journalism, ESL, and philosophy. The majority of students are majoring in the communication department.

This course was conducted through both synchronous and asynchronous CMC systems. This research focused only on the synchronous components. The students joined an online seminar once a week via various CMC systems. Each group took turns moderating the discussions. The host group needed to choose a topic related to CMC theories and post questions for discussion in advance. On the day of the seminar, the host group would moderate and facilitate the discussions.

4. Discussions
The following discussions will address the three research questions. The first research question is answered through the researcher’s observations. The second question is based on the analysis of students’ reflection journals. The findings to the third question are based on the result of the social presence ratings.

4.1 Pros and Cons of CMC systems
Based on the researcher's observations and student experience in using various CMC systems, the pros and cons of each system are summarized as follows (table 1):

<table>
<thead>
<tr>
<th>CMC Systems</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>WebCT</td>
<td>a. All conversations are recorded</td>
<td>a. Mac users typing interrupted</td>
</tr>
<tr>
<td></td>
<td>b. General and private conferencing rooms for small groups</td>
<td>b. Technical glitches: Unexpected server shutdown</td>
</tr>
<tr>
<td></td>
<td>c. A sense of place, i.e. virtual office, student lounge</td>
<td>c. Browser incompatibility (works best in Netscape 4)</td>
</tr>
<tr>
<td></td>
<td>d. Private chat with individuals during a public session</td>
<td></td>
</tr>
<tr>
<td>ICQ</td>
<td>a. Contact list: auto-detect if a friend is online</td>
<td>a. Interruption of work</td>
</tr>
<tr>
<td></td>
<td>b. Instant messaging: low bandwidth, point-to-point</td>
<td>b. One-to-one conversation only</td>
</tr>
<tr>
<td></td>
<td>c. Status indication: showing if one is occupied, away, or available for chat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Student help line: easier to reach the instructor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. IP lookup for modem users on dynamic IP addressing</td>
<td></td>
</tr>
<tr>
<td>CU-Seeme</td>
<td>a. Real interaction: Sound and sight</td>
<td>a. Time-consuming preparations: required frequent testing of connections</td>
</tr>
<tr>
<td></td>
<td>b. Conversation of international guest speakers</td>
<td>b. Time zone differences: difficulty in scheduling with users in different time zones</td>
</tr>
<tr>
<td></td>
<td>c. Low cost &amp; high quality interaction</td>
<td>c. Transmission difficulty caused by network congestion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. High bandwidth</td>
</tr>
<tr>
<td>CoolTalk</td>
<td>a. Efficient voice conversation over the Internet</td>
<td>a. Bandwidth &amp; network congestion</td>
</tr>
<tr>
<td></td>
<td>b. Free and easy to setup</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Saving phone bills</td>
<td></td>
</tr>
<tr>
<td>ActiveWorlds</td>
<td>a. Personalized avatars</td>
<td>a. Initial Disorientation</td>
</tr>
<tr>
<td></td>
<td>b. Constructing your own world</td>
<td>b. Programmer required</td>
</tr>
<tr>
<td></td>
<td>c. Exploring 3D virtual campus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Indicating movements: dancing, waving, jumping, and greeting</td>
<td></td>
</tr>
<tr>
<td>The Palace</td>
<td>a. Mood indicator: happy, sad, angry, exciting, thinking, etc.</td>
<td>a. Navigation &amp; room capacity (8 people/server)</td>
</tr>
<tr>
<td></td>
<td>b. Wearable avatars: Dress the avatars in any customs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Text-to-speech: For the visually challenged</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Graphic-enriched backgrounds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increased interactions and active involvement</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Student Perceptions
Student comments reflect the process of adapting to a new technology and what they like or dislike about these systems. Here are some synopses from the student reflection journals.

4.2.1 WebCT
"One thing that bothered me is the lack of organization. With everyone talking at one time it is difficult to actually "hear" anything that is being said."
"I still find chat rooms to be a very artificial means of communication...seemed to have more of a time lag than the other two computers...by the time I posted another question, her reply would pop up."
"when I was in chat and trying to type a message, every time someone else submitted a line my cursor jumped away from where I was typing."
4.2.2 ICQ
"ICQ has a chat function exactly similar to CMC cafe. Real time chatting is easy to follow and you don’t have to wait for the other party to respond."
"Using chat for that projects was effective and interesting"
"I started using icq. It's a bit strange at first, but when you get started, it's fun."
"The way you can see the other person typing in everything is so immediate, I thought this was very exciting. You can leave notes if the other person isn’t online."

4.2.3 CoolTalk
"The delay was a little frustrating at first, but once we got the hang of it we could work the worksheet well. Nothing is ever fast enough with technology, I guess I expected the communication to have clear, immediate results. I’ve never communicated through audio or visual so it was a great experience to see and hear the conversation with (guest speaker)."
"CoolTalk activity was fun and also enlightening- I especially like'd the hands-on experiential qualities of the small group face-to face and through CoolTalk interaction. Due to poor sound (I believe the speaker in the computer I was using is cracked), CoolTalk transmission was not as successful as it could have been, "

4.2.4 CU-SeeMe
"At times the audio wasn’t all that great on some of the systems but I enjoyed using the system."
"Unless your connection is fast, then the picture quality is very poor. Video allows people to see one another halfway across the world."
"I wasn't very impressed with the synchronous communication systems (CoolTalk and CUSeeMe) we saw last week. The video images were really poor and the quality of the communication was also. I don't think that the current technology is very useful. When improvements in reception are made, then I think people will be inclined to use it."

4.2.5 ActiveWorlds
"The virtual world was an interesting experience. Instead of chatting with another person in text on a screen, you can choose avatars that resemble yourself giving you a feeling of more interactions. The surroundings in the virtual world are also creative and eye catching. The movement is rather slow, but the chats are immediately posted."
"The Virtual University also wasn't impressive. It just seemed like a glorified computer game which just replaced the traditional lecture style classroom with a virtual environment,"

4.2.6 The Palace
"It creates interest in wanting to be there, which is then conducive to learning."
“it has real potential to be used in education. It seemed to me to be the best system out of all the ones we have tried.”
“the ability to wear an avatar can give an added sense of personality”
“We were having some difficulties because not everyone showed up and one of the other students had trouble with lag time. But acting out the legend was pretty fun and it was good to have the audio and visual to work with.”

4.3 Social Presence Ratings
Students completed the social presence ratings right after each use of the system. Some systems were used only once through the entire semester. Some systems were used repeatedly, e.g. WebCT. Pre-test and post-test were conducted for systems used more than once. The results of the ratings are indicated by the mean scores of each system on a one-to-seven scale. The higher the score, the higher social presence ratings each system receives.

<table>
<thead>
<tr>
<th>System</th>
<th>Post-test</th>
<th>Pre-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>WebCT</td>
<td>5.3</td>
<td></td>
</tr>
<tr>
<td>The Palace</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>ActiveWorlds</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>CU-SeeMe</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>CoolTalk</td>
<td>3.4</td>
<td></td>
</tr>
</tbody>
</table>

The ratings for the audio-video conferencing systems such as CU-SeeMe and CoolTalk are much lower than the text-based and virtual reality conferencing systems. This is partially due to the poor audio and video quality during the seminars. The video and sound quality was constraint by the available bandwidth during the seminars. The time lags during conversations made the communication laborious. Students had to repeat questions several times to get the
messages across the wire. Although, in the reflection journals, students seemed to be excited about the possibilities of audio-video conferencing, the results of the social presence ratings indicated that they are not convinced that audio-video conferencing systems were ideal for effective communication at the time that the conference took place. Interestingly, students complained excessively about WebCT in their journals at the first week of practice. WebCT received the highest social presence ratings at the end of the survey. This may explain that time is a critical factor in adapting a new system. The more often the students practice on one system, the more comfortable they are with the system. Furthermore, the ease of use of the text-based conferencing (WebCT) made the conversation much smoother and less distracting in online conferencing. The virtual reality system (The Palace) came in second place. This is an indication that the add-on affective components made the conversation more realistic. Students liked to apply emotional expressions to their avatars to facilitate the communication.

5. Conclusions
The appropriate use of CMC systems can contribute to synchronous online learning in the following ways:

1) Enhanced cognitive and affective learning outcomes: students come to a new understanding of a course-related subject through in-depth online discussion. They are more motivated to keep up with the learning while interacting with each other in real-time.
2) Increased interpersonal connections: Students generally appreciate the instant feedback from the instructor and fellow students during synchronous communication. They also get to know each other better through online social interaction.
3) Active learning: When students were bestowed with the responsibility to plan and lead a seminar, they became active learners in the process of planning and moderating a seminar.
4) Equal participation: Shy students tend to speak up more in online seminars than in face-to-face meetings.

To ensure a successful synchronous seminar, in addition to the activity design, the selection of the CMC systems is critical in the planning process. It can be time-consuming in planning an online seminar and technology failure is sometimes unavoidable. Nevertheless, within the controllable variables, I would recommend the following criteria for selecting a CMC system: ease-of-use interface, cross-platform, conversation logs, indication of the presence of the attendees, function to create new chat rooms, add-on affective components (e.g. emotional expressions), and strong technical support from the system developer.

In short, the keys to successful synchronous online learning rely on the appropriate activity design (e.g. student-centered discussion) and a good selection of the CMC systems. This study focuses on the evaluation of the CMC systems. Future research should also focus on the types of online activities for synchronous learning.

6. Bibliography