Synchronous and Asynchronous Text-Based CMC in Educational Contexts: A Review of Recent Research

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Interaction between teacher and students and among students is fundamental to higher education (Berge, 1999). Teacher-student and student-student interactions are prerequisite to course satisfaction (Allen, Bourhis, Burrell, & Mabry, 2002) and are associated with decreased attrition (Muilenburg & Berge, 2001). Thus, in all instructional contexts, including hybrid and distance education, there is an expectation that learning involves human interaction. Current instructional applications of technology provide two distinct formats for such interaction — asynchronous and synchronous (Hines & Pearl, 2004).

Instructional applications of asynchronous technology

Asynchronous instruction occurs in delayed time and does not require the simultaneous participation of students and teacher (Rovy & Essex, 2001; Sabau, 2005). Learning events are independently experienced by students and learning is not synchronized in time or space. Asynchronous instruction has its roots in early forms of distance education such as correspondence schools (Keegan, 1996); "communication was truly asynchronous because of postal delays" (Bernard et al., 2004, p. 387). Although asynchronous voice conferencing has proven useful in some instructional contexts (McIntosh, Braul, & Chao, 2003), text-based conferencing is widely implemented in post-secondary education (Berge, 1999; Romiszowski & Mason, 2004; Tu & Corry, 2003) and is synonymous with asynchronous online discussion (Fjermestad, Hiltz, & Zhang, 2005).

In a survey of educators, asynchronous online discussion was reportedly useful for "encouraging in-depth, more thoughtful discussion; communicating with temporally diverse students; holding ongoing discussions where archiving is required; and allowing all students to respond to a topic" (Branon & Essex, 2001, p. 36). Identified limitations associated with asynchronous discussion included; "lack of immediate feedback, students not checking in often enough, length of time necessary for discussion to mature, and students feeling a sense of isolation" (p. 36). Based on a survey of student preferences, Dede and Kremer (1999) concluded that asynchronous discussion provided "richer, more inclusive types of interchange" (p. 4), but required more time and provided less social interaction than synchronous chat.

Instructional applications of synchronous technology

Synchronous instruction occurs in real time and requires the simultaneous participation of students and teacher (Romiszowski & Mason, 2004). Synchronous applications of instructional technology can be traced to the use of closed-circuit television on university campuses in the 1940s. By the 1980s, video-conferencing and interactive television connected remote classrooms, allowing students to ask questions and discuss concepts (Bernard et al., 2004). "Synchronous communication and collaboration tools, such as synchronous text chat, audio-conferencing, video-conferencing, and white boards, are increasingly important components

of online learning" (National Center for Accessible Media, 2005). Synchronous communication tools allow multiple users to communicate using text messages and are a common instructional application of technology, although most typically an optional course feature (Burnett, 2003).

In a survey of educators, synchronous chat was reportedly useful for "holding virtual office hours, team decision-making, brainstorming, community building, and dealing with technical issues" (Branon & Essex, 2001, p. 36). Identified limitations associated with synchronous discussion included; "getting students online at the same time, difficulty in moderating larger-scale conversations, lack of reflection time for students, and intimidation of poor typists" (p. 36). While synchronous discussions are more difficult to implement than asynchronous discussions, "they have the advantages of providing a greater sense of presence and generating spontaneity" (Hines & Pearl, 2004, p. 34).

Synchronous versus asynchronous online discussion

An element of controversy surrounds the instructional implementation of synchronous text-based CMC. Chat rooms are often viewed as recreational, as opposed to educational, forums for human interaction (Burnett, 2003). There is, however, a growing movement toward systematic implementation of synchronous chat as a mechanism, not only of social exchange, but also of enhancing student learning outcomes (Dickey, 2003; Shotsberger, 2000). In some instructional contexts, student learning outcomes are reportedly superior in asynchronous online discussion rather than face-to-face discussion (Johnson, Howell, & Code, 2005; Koory, 2003; Wang, 2004). In this regard, synchronous chat, which attempts to emulate face-to-face discussion, is often viewed as inferior to asynchronous online communicative exchange (Berge, 1999; McDonald, 2002).

This paper presents a review of recent research that examines the relative instructional utility of text-based synchronous and asynchronous CMC. As a mechanism for limiting the number of studies reviewed as well as controlling for emergent technologies, only research published since 2000 was reviewed. The goal was to synthesize empirical evidence regarding the instructional effectiveness of synchronous and asynchronous online discussion. Comprehensive search of academic databases (e.g., ERIC, Expanded Academic Index, Academic Search premier) and online journals identified research that compared: 1) students using asynchronous-postings with students in face-to-face discussion; 2) students using synchronous-chat with students in face-to-face discussion; and 3) students using both asynchronous-postings and synchronous-chat. Within each of these three comparison groups, a variety of criterion are used including objective and subjective measures of student achievement, student satisfaction and perceived value of learning experiences, evidence of higher-level thinking skills, and amount, type and substance of communicative exchange.

Asynchronous text-based CMC: Student achievement and satisfaction

Four studies were located that used objective measures of student achievement to determine the effectiveness of asynchronous discussion. Koory (2003) conducted a study that compared two versions of a course, *Introduction to Shakespeare*. One form was taught in a traditional face-to-face university class; the other was delivered online and required extensive message board postings. "The same course in both an online and on-campus environment makes for an extended experimental comparison of learning outcomes, while controlling for two important variables: the instructor and the course content" (p. 1). Compared to students in the on-campus course, online students reported higher levels of course satisfaction, achieved higher grades, produced more written work (5,250 words as opposed to 3,875 words) and completed the course in less time. Korry concluded that "text-based communication in the online class reinforces the skills pertinent to a literature class" (p. 1). Similarly, Johnson and her colleagues (2005) report a study in which undergraduate educational psychology students analyzed and submitted case studies under one of two instructional conditions: WebCT small group discussion postings or in-class discussion with individual written submissions. Five case studies that applied and reinforced course content were distributed and analyzed throughout the academic term. Students who made online case study postings had a mean final examination mark of 78.0%; students who made written case study submissions had a mean of 74.9% , $t(121) = 1.95$, $p = .05$. The researchers speculate that "the online discussion group outperformed the written submissions group, at least in part, due to peer evaluation and peer interaction which functioned to enhance individual motivation to make postings of the highest quality" (pp. 69-70).

Wang (2004) investigated the relationship between graduate student online visibility (measured as number of Blackboard discussion postings) and final course grades. A strong correlation ($r = 0.7$, $p = .01$) was reported suggesting that students who were highly visible (i.e., made many discussion board postings) academically outperformed students who were less asynchronously active. In contrast, Johnson (2005) reported a curvilinear relationship between articles posted in WebCT discussions and college student final grades. The fewest number of discussion postings predicted the lowest student achievement; the greatest number of postings did not predict the highest student achievement. Johnson speculated that limited asynchronous postings may have adversely affected student achievement by minimizing active involvement in e-learning. At the same time, excessive postings may have reduced time available for other forms of learning (e.g., online practice quizzes). Some students may have inaccurately concluded that increased postings compensate for lack of alternative learning behaviors.

"Individuals who used both synchronous and asynchronous forms of online discussion were the most likely to complete required course activities"

Research has attempted to determine the effectiveness of asynchronous discussion by analyzing the content of postings. Based on critical thinking and problem solving criteria, Meyer (2003) coded the content of graduate students' threaded Blackboard discussion postings. Reportedly, 18% of the postings formulated a problem, 51% were directed toward obtaining information, 22% reflected construction of possible solutions and 7% provided critical feedback. Meyer interpreted these results as evidence of the capacity of asynchronous postings to generate higher-order thinking skills and concluded that "integration and resolution especially require 'time for reflection' which may be more likely to occur in the extended time period of the threaded discussion" (p. 9). Additionally, Järvelä and Häkkinen (2002) examined the quality of asynchronous interaction in a web-based conferencing system for pre-service teachers. Twenty-four percent of the discussions were categorized as *high-level* because the content of postings included theoretical analysis with mutual negotiation. Forty percent were categorized as *progressive* because, although reciprocity was apparent, the content was largely based on personal experience. Thirty-six percent were categorized as *lower-level* because the content reflected disconnected comments and opinions. Further, in analyzing the content of asynchronous postings under structured and non-structured discussion conditions, Aviv, Erlich, Ravid and Geva (2003) concluded that structured discussions "revealed high phases of critical thinking" (p. 15) and were "associated with a high degree of cohesion" (p.16).

There is recent evidence that student characteristics affect asynchronous online behavior and perceptions. Hwang and Wang (2004) demonstrated a relationship between time of postings and undergraduate student examination performance; distributed and early postings were associated with increased student achievement. Yang and Tang (2003) reported a study in which graduate students made online asynchronous postings subsequent to in-class discussion. On the basis of feedback regarding perception of classmates, students were categorized as functioning in; 1) friendship networks, 2) advice networks and 3) adversarial networks. As membership in friendship and advice networks increased, both the quality and quantity of asynchronous discussion postings tended to increase. Rovai (2002) found that sense of community in asynchronous online discussion related to student perception of learning. Approximately 43% of the variance in perceived learning was accounted for by differences in perception of classroom community.

Several recent studies have used student perception as the criterion by which to determine the instructional utility of asynchronous discussion. Walker and Arnold (2004) measured student evaluation of asynchronous postings in a hybrid economics course. More than two-thirds of the students reported that the asynchronous online experience enriched their learning. Picciano (2001) measured a range of graduate student perceptions related to asynchronous postings and reported "a strong relationship between students' perceptions of the quality and quantity of their interaction and their perceived performance in an online course" (p. 12). Meyer (2003) assessed student satisfaction with face-to-face versus online asynchronous discussion formats. "Almost every student mentioned how much time it took to read others' postings, think about a response, prepare a response, and check back later to others' contributions to the discussion" (p. 7). Students commented that face-to-face discussion was energetic and enthusiastic while asynchronous postings were slow and emotionless. Wu and Hiltz (2004) reported a study in which university students engaged in extensive asynchronous online discussion using

WebBoard and WebCT. Post-course questionnaire data indicated that over half of the students reported learning a great deal from their peers through online discussion.

Two studies were located that compared required versus optional asynchronous discussion postings. Kear (2004) noted that approximately two-thirds of a sample of university students reported using and benefiting from optional asynchronous discussions; 79% reported that they were very satisfied or fairly satisfied with their required asynchronous online discussion. Johnson and Howell (2005) compared students who made WebCT discussion postings as required course assignments with students whose use of WebCT was optional. "Students whose use of instructional technology was required developed increasingly favorable attitudes toward such technology as compared to those students whose use of WebCT was entirely optional." Apparently, students do not resent mandated asynchronous discussion but, on the contrary, respond positively to required postings.

In summary, unless postings are excessive and interfere with other forms of learning (Johnson, 2005), recent research establishes that student achievement is facilitated by asynchronous online discussion (Johnson et al., 2005; Koory, 2003; Wang, 2004). Asynchronous discussion reflects high-level cognitive processing (Järvelä & Häkkinen, 2002; Meyer, 2003). When compared with unstructured discussion, structured discussion has been associated with the highest levels of complex and critical thinking (Aviv et al., 2003). Required postings are more effective than optional postings (Johnson & Howell, 2005; Kear, 2004). While asynchronous discussion has limitations (Meyer, 2003), the majority of students are satisfied with the learning experience (Picciano, 2001; Walker & Arnold, 2004; Wu & Hiltz, 2004). Student characteristics mediate the nature and extent of online asynchronous discussion (Hwang & Wang, 2004; Ravai, 2002; Yang & Tang, 2003).

Synchronous text-based CMC: Instructional viability and student satisfaction

The instructional effectiveness of synchronous text-based communication has not been well-researched. Comprehensive search of the literature did not result in the identification of a single true experiment (e.g., random assignment of students to one of two conditions in which one of the conditions is synchronous chat and the other condition is asynchronous discussion; Johnson & Howell, 2006). Similarly, studies that utilized objective measures of student achievement were not found. Current research on the instructional use of synchronous chat primarily reflects case study evaluation. For example, Locatis and his colleagues (2003) reported that a multipoint video-conference was webcast live to an audience that communicated with conference panelists and with each other via synchronous chat messaging. The authors concluded that "it is technically feasible to simultaneously stream videoconferences to large audiences and expand participation by chat" (p. 152). Dickey (2003) presented an evaluative case study of a university course that made extensive use of teacher and student synchronous chat. Although specific data were not provided, the author claimed that the online instructor "successfully presented new concepts for discussion, fostered interaction and explanations, and received confirmation of understanding through the chat tool" and that "learners often came to each other's aid with explanations and clarification" (p. 112).

"Systematic and objective research on the ways in which synchronous and asynchronous online discussion can be combined to maximize student learning is required."

Shotsberger (2000) described a professional development program aimed at helping mathematics teachers implement professional standards. The program included WebBoard weekly synchronous chats that required participants to read material, brainstorm ideas for teaching and reflect on implementation of standards. "All participants rated the opportunity to interact with other teachers on a routine basis and to share news about implementation efforts as either very effective or effective" (p. 54). Lobel, Neubauer, and Swedburg (2002) presented an evaluative description of an undergraduate course in which text and image-based lecture material were posted in real-time and students had real-time opportunities to branch into discussion groups. Approximately 70% of students participated in synchronous discussions with 331 interactions per hour, averaging 22 words per message. "There was no indication that students found it difficult to receive, assess, and respond to the information generated by the observed 'parallel communication' interactions" (p. 12). The authors speculated that high rates of synchronous discussion were the result of a learning environment that circumvents face-to-face social cues, thereby providing learners with less risk in self-disclosure.

Duemer and his colleagues (2002) described the effectiveness of synchronous online chat in developing a sense of community among engineering students. In satisfying their English literature requirement, first-year students discussed specific books outside of class time in a Multiuser Object-Oriented environment. Students were required to participate in three of six real-time discussions led by graduate student mentors. All chat sessions were transcribed and analyzed to gain understanding of community formation in synchronous online discussion groups. Reportedly, when pressured to adhere to deadlines, groups failed to advance to sophisticated levels of interaction. "Mentors who acted as authority figures were found to be detrimental to interactive behaviors such as exchanging and debating ideas, or sharing interpersonal information" (p. 6).

"Student chat sessions reflected more substantive messages (i.e., directly related to the prescribed topic) than did the asynchronous discussions."

Noting that "synchronous online chat has been largely ignored as a medium for productive group discussion between distance learning students and their tutors" (p. 247), Burnett (2003) archived and analyzed online chats in a distance education teacher training program. Chats occurred monthly and were intended to encourage student reflection on the relationship between theory and practice. "The study demonstrated that it is possible for tutors to address social, organizational, and intellectual aspects of discussion through online chat" (p. 258). However, some tutor communication (i.e., directing and summarizing) was interpreted as an attempt to reassert the uneven teacher-student power relationship — a relationship that the medium appears to challenge.

Based on the literature reviewed, synchronous text-based communication is viable in learning contexts (Lobel et al., 2002; Locatis et al., 2003). However, the only research paradigm that established *effect*, the true experiment (Johnson & Howell, 2006), does not appear in the literature reviewed. While largely anecdotal, case studies suggest that asynchronous text-based communication contributes to student motivation and specific learning outcomes. There is some evidence that students enjoy synchronous chat as a supplement to other learning events (Dickey, 2003; Shotsberger, 2000). Analysis of transcribed messages supports the contention that students develop skills via synchronous chat and that tutor online behavior affects the quality of synchronous interaction (Burnett, 2003; Duemer et al., 2002).

Combining asynchronous and synchronous text-based CMC: The best of both worlds?

Synchronous and asynchronous online discussions have been combined and contrasted. Ohlund, Yu, Jannssch-Pennell and Digangi (2000) presented teachers with online learning that including both email and chat sessions. Participants included 161 kindergarten through twelfth grade educators engaged in the development of collaborative teaching and Internet skills. Group leaders facilitated bimonthly chats and biweekly email exchanges. Use of the two communication tools was logged and coded into four binary variables: 1) use of email; 2) use of chat; 3) use of both email and chat and 4) use of neither email nor chat. Individuals who used both synchronous and asynchronous forms of online discussion were the most likely to complete required course activities. Apparently, combined synchronous and asynchronous online discussion maximized personal engagement in learning.

Three recent empirical studies examined the relative effectiveness of synchronous and asynchronous online discussion in foreign language learning. Abrams (2003) compared the performance of students in a German language course under three instructional conditions: 1) synchronous WebCT chat; 2) asynchronous WebCT discussion postings and 3) face-to-face small group collaborative assignments. Students in the synchronous chat rooms demonstrated the greatest increase in quantity of oral language production. However, "analyses of the quality of language indicted no significant difference among the 3 groups either lexically or syntactically" (p 157). To facilitate Spanish language learning, Pérez (2003) required first-year university students to engage in both synchronous online chat and asynchronous email dialog journals. While a higher number of words were produced in the chat rooms, there was no significant difference in new vocabulary across the two groups. Schwienhorst (2003) described a tandem learning network in which learners provided and received foreign language support using asynchronous email and synchronous chat. Reportedly, students in asynchronous tandem networks were more likely to complete required tasks than were students in synchronous networks. The researcher speculated that this was because student "attention is more focused on the task" and asynchronous email is more clearly "an act of learner autonomy" (p. 437).

Several current studies have attempted to determine student preferences and patterns of behavior in synchronous and asynchronous discussion. In a survey of directors of distance education dental hygiene programs, Grimes (2002) reported that while asynchronous discussion forums were more common than synchronous online chat, no difference in student satisfaction was apparent. Davidson-Shivers, Muilenburg and Tanner (2001) assigned graduate students to either small group chat or threaded discussions to debate a designated topic. After one week, the groups switched discussion modes and another topic was assigned. During both weekly sessions, student chat sessions reflected more substantive messages (i.e., directly related to the prescribed topic) than did the asynchronous discussions. With regard to student evaluation, however, "results of the study indicate that both types of discussion are liked and should be considered viable options in on-line learning communities" (p. 351). In contrast, Shapira and Youtie (2001) reported an evaluative case study in which students ranked asynchronous discussion higher than synchronous chat. Volet and Wosnitza (2004) analyzed transcriptions of synchronous and asynchronous cross-national student online discussion and found that both interactive mediums "showed a substantial amount of social interchange and meaningful learning" (p. 5).

Ligorio (2001) described a qualitative analysis of activities undertaken in a virtual world called *Euroland*. Communication formats available in Euroland included synchronous chat, asynchronous discussion and visuals (e.g., virtual objects and photos). Euroland was designed, implemented and evaluated by students, teachers and researchers performing educational, cross-cultural and interdisciplinary activities. Analysis of visual/iconic versus text-based communication and synchronous versus asynchronous communication suggested that an integration of modes provided for mutual enhancement of tool use. The interdependent nature of virtual tasks triggered both synchronous and asynchronous discussion which re-directed creative processes. Discussion boards (where ideas were stored for subsequent reflection) compensated for the immediacy of synchronous chat. "Once this complex reciprocal influence is activated, the community is able to undertake new activities combining and integrating the various communication tools available and thereby utilize all input available during each interaction" (p. 122).

Based on the reviewed literature, students in synchronous discussion produce a greater volume of communication than students in asynchronous discussion but asynchronous discussion is equal to or better than synchronous discussion in terms of student satisfaction of course requirements (Abrams, 2003; Pérez, 2003; Schwienhorst, 2003). Students do not report a clear preference for synchronous or asynchronous online discussion (Davidson-Shivers et al., 2001; Grimes, 2002; Shapira & Youtie, 2001; Volet & Wosnitza, 2004). It has been suggested that combining synchronous and asynchronous online discussion results in higher levels of student satisfaction and mastery of course requirements than implementation of either mode in isolation (Ligorio, 2001; Ohlund et al., 2000).

Implications for future research: The need for systematic and objective inquiry

Both synchronous and asynchronous forms of online discussion have advantages and there is evidence that both contribute to student cognitive and affective outcomes, albeit in distinct fashion. Asynchronous discussion facilitates student learning and higher-level thinking skills, perhaps due to the cognitive processing required in writing, time to reflect upon posted messages and consider written responses, and the public and permanent nature of online postings. Structured and mandated asynchronous discussion is associated with better cognitive outcomes than non-structured and optional discussion. Student characteristics influence the nature of asynchronous online interaction. Implementation and evaluation of structured asynchronous discussion in a range of learning contexts, for various subject-matter and for diverse learners is warranted.

"Case study evaluations suggest potential learning benefits associated with synchronous online discussion."

Case study evaluations suggest potential learning benefits associated with synchronous online discussion. Systematic and objective research on the instructional applications of synchronous online discussion is required, particularly in terms of student cognitive and achievement outcomes. For example, in recent data collection I implemented an ABAB research design with 120 students in hybrid learning contexts. The A-Condition was WebCT asynchronous discussion of material tested on in-class examinations; the B-Condition was WebCT synchronous chat of material tested on in-class examinations. Figure 1 provides a visual-graphic summary of the
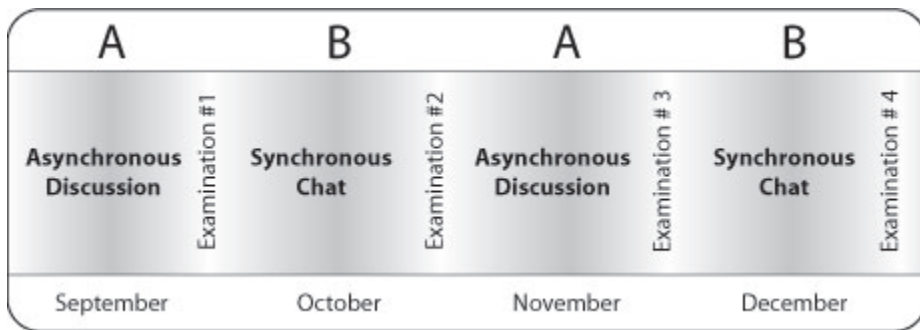
Figure 1. An ABAB research design for determining the effect of discussion forum on student academic achievement.

research design. In ecologically valid preexisting course sections, random assignment of students to one of two conditions (i.e., synchronous chat or asynchronous discussion) is not viable. The ABAB research design is promoted as an alterative to the true experiment in determining instructional effectiveness (Johnson & Howell, 2006).

Preliminary analyses suggest interplay between synchronous and asynchronous online discussion formats. Systematic and objective research on the ways in which synchronous and asynchronous online discussion can be combined to maximize student learning is required. For example, in the recent ABAB data collection, student learning style and personality (i.e., introversion-extraversion and stability-neuroticism) was measured at the end of the academic term in order to determine if communication tool effectiveness (i.e., student self-report preference and actual effect on achievement) were mediated by individual difference variables. If such is found to be the case, the combined use of computer mediated communication tools may be required in order to meet the needs of all learners regardless of individual differences in cognition and personality.

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References

Abrams, Z. I. (2003). The effects of synchronous and asynchronous CMC on oral performance in German. *The Modern Language Journal, 87*, 157-167.

Allen, M., Bourhis, J., Burrell, N., & Mabry, E. (2002). Comparing student satisfaction with distance education to traditional classroom in higher education: A meta-analysis. *American Journal of Distance Education, 16*, 83-97.

Aviv, R., Erlich, Z., Ravid, G., & Geva, A. (2003). Network analysis of knowledge construction in asynchronous learning networks. *Journal of Asynchronous Learning Networks, 7*. Retrieved March 5, 2005, from http://www.sloan-c.org/publications/jaln/v7n3/index.asp

Berge, Z. L. (1999, January/February). Interaction in post-secondary web-based learning. *Educational Technology*. Retrieved February 25, 2005, from http://www.saskschools.ca/~parkland/interaction.htm

Bernard, R. M., Abram, P. C., Lou, Y., Borokhovski, E., Wade, A., Wozney, L., et al. (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research, 74*, 379-439.

Branon, R. F., & Essex, C. (2001). Synchronous and asynchronous communication tools in distance education: A survey of instructors. *TechTrends, 45*, 36-42.

Burnett, C. (2003). Learning to chat: Tutor participation in synchronous online chat. *Teaching in Higher Education, 8*, 247-261.

Davidson-Shivers, G. V., Muilenburg, L. Y., & Tanner, E. J. (2001). How do students participate in synchronous and asynchronous online discussions? *Journal of Educational Computing Research, 25*, 351-366.

Dede, C., & Kremer, A. (1999). Increasing students' participation via multiple interactive media. *Inventio, 1*. Retrieved March 1, 2005, from http://www.doit.gmu.edu/Archives/feb98/dede_1.htm

Dickey, M. D. (2003). Teaching in 3D: Pedagogical affordances and constraints of 3D virtual worlds for synchronous distance learning. *Distance Education, 24*, 105-121.

Duemer, *L.*, Fontenot, D., Gumfory, K., Kallus, M., Larsen, J., Schafer, S., et al., (2002). The use of online synchronous discussion groups to enhance community formation and professional identity development. *Journal of Interactive Online Learning, 1*. Retrieved March 1, 2005, from http://www.ncolr.org/jiol/ARCHIVES/2002/2/04/index.html

Fjermestad, J., Hiltz, S. R., & Zhang, Y. (2005). Effectiveness for students: Comparisons of "in-seat" and ALN courses. In S. R. Hiltz & R. Goldman (Eds.), *Learning together online: Research on asynchronous learning networks* (pp. 39-80). Mahwah, NJ: Lawrence Erlbaum.

Grimes, E. B. (2002). Use of distance education in dental hygiene programs. *Journal of Dental Education, 66*, 1136-1145.

Hines, R. A., & Pearl, C. E. (2004). Increasing interaction in web-based instruction: Using synchronous chats and asynchronous discussions. *Rural Special Education Quarterly, 23*, 33-36.

Hwang, W. Y., & Wang, C. Y. (2004). A study of learning time patterns in asynchronous learning environments. *Journal of Computer Assisted Learning, 20*, 292-304.

Järvelä, S., & Häkkinen, P. (2002). Web-based cases in teaching and learning – the quality of discussion and stage of perspective taking in asynchronous communication. *Interactive Learning Environments, 10*, 1-22.

Johnson, G. M. (2005). Student alienation, academic achievement, and WebCT use. *Educational Technology and Society, 8*, 179-189.

Johnson, G. M., & Howell, A. J. (2005). Attitude toward instructional technology following required vs. optional WebCT usage. *Journal of Technology and Teacher Education, 13*, 643-654.

Johnson, G. M., & Howell, A. J. (2006). The impact of Internet learning technology: Experimental methods of determination. In B. L. Mann (Ed.), *Selected styles in web-based educational research* (pp. 282-301). Hershey, PA: Idea Group Publishing.

Johnson, G. M., Howell, A. J., & Code, J. R. (2005). Online discussion and college student learning: Toward a model of influence. *Technology, Pedagogy and Education, 14*, 61-75.

Kear, K. (2004). Peer learning using asynchronous discussion systems in distance education. *Open Learning, 19*, 151-164.

Keegan, D. (1996). *Foundations of distance education* (3rd ed.). London: Routledge.

Koory, M. A. (2003). Differences in learning outcomes for the online and F2F versions of "An Introduction to Shakespeare." *Journal of Asynchronous Learning Networks, 7*. Retrieved March 3, 2005, from http://www.sloan-c.org/publications/jaln/v7n2/v7n2_koory.asp

Ligorio, M. B. (2001). Integrating communication formats: Synchronous versus asynchronous and text-based versus visual. *Computers & Education, 37*, 103-125.

Lobel, M., Neubauer, M., & Swedburg, R. (2002). Elements of group interaction in a real-time synchronous online learning-by-doing classroom without F2F participation. *USDLA Journal. 16.* Retrieved March 5, 2005, from http://www.usdla.org/html/journal/APR02_Issue/article01.html

Locatis, C., Fontelo, P., Sneiderman, C., Ackerman, M., Uijtdehaage, S., Candler, C. et al., (2003). Webcasting videoconferences over IP: A synchronous communication experiment. *Journal of the American Medical Informatics Association, 10*, 150-153.

McDonald, J. (2002). Is "as good as face-to-face" as good as it gets? *Journal of Asynchronous Learning Networks, 6.* Retrieved March 3, 2005, from http://www.sloan-c.org/publications/jaln/v6n2/v6n2_macdonald.asp

McIntosh, S., Braul, B., & Chao, T. (2003). A case study in asynchronous voice conferencing for language instruction. *Educational Media International, 40*, 63-73.

Meyer, K. A. (2003). Face-to-face versus threaded discussions: The role of time and higher-order thinking. *Journal of Asynchronous Learning Networks, 7.* Retrieved March 3, 2005, from http://www.sloan-c.org/publications/jaln/v7n3/v7n3_meyer.asp

Muilenburg, L. Y., & Berge, Z. L. (2001). Barriers to distance education: A factor-analytic study. *The American Journal of Distance Education, 15*, 7-22.

National Center for Accessible Media (2005). *Guidelines for developing accessible synchronous communication and collaboration tools.* Retrieved March 1, 2005, from http://ncam.wgbh.org/salt/guidelines/sec7.html

Ohlund, B., Yu, C. H., Jannssch-Pennell, A., & Digangi, S. A. (2000). Impact of asynchronous and synchronous internet-based communication on collaboration and performance among K-12 teachers. *Journal of Educational Computing Research, 23*, 405-420.

Pérez, L. C. (2003). Foreign language productivity in synchronous versus asynchronous computer-medicated communication. *CAICO Journal, 21*, 89-104.

Picciano, A. G. (2001). Beyond student perceptions: Issues of interaction, presence, and performance in an online course. *Journal of Asynchronous Learning Networks, 6.* Retrieved March 8, 2005, from http://www.sloan-c.org/publications/jaln/v6n1/v6n1_picciano.asp

Romiszowski, A., & Mason, R. (2004). Computer-mediated communication. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (pp. 397-432). Mahwah, NJ: Lawrence Erlbaum.

Rovai (2002). Sense of community, perceived cognitive learning, and persistence in asynchronous learning networks. *Internet and Higher Education, 5*, 319-332.

Rovy, B., & Essex, C. (2001). Synchronous and asynchronous communication tools in distance education. *TechTrends, 45*, 36-42.

Sabau, I. (2005). *Effective asynchronous communication online.* Retrieved February 11, 2005, from http://breeze.ucalgary.ca/p52308523.

Schwienhorst, K. (2003). Learner autonomy and tandem learning: Putting principles into practice in synchronous and asynchronous telecommunications environ-ments. *Computer Assisted Language Learning, 16*, 427-443.

Shapira, P., & Youtie, J. (2001). Teaching with Internet and multimedia technologies: Insights from an online seminar on industrial modernization. *Journal of Planning Education and Research, 21*, 71-83.

Shotsberger, P. G. (2000, January/February). The human touch: Synchronous communication in web-based learning. *Educational Technology,* 53-55.

Tu, C. H., & Corry, M. (2003). Designs, management tactics, and strategies in asynchronous learning discussions. *The Quarterly Review of Distance Education, 4*, 303-315.

Volet, S., & Wosnitza, M. (2004). Social affordances and students' engagement in cross-national online learning: An exploratory study. *Journal of Research in International Education, 3*, 5-29.

Walker, R., & Arnold, I. (2004). Introducing group-based asynchronous learning to business Education: Reflections on effective course design and delivery. *Educational Media International, 41*, 253-262.

Wang, M. (2004). Correlational analysis of student visibility and performance in online learning. *Journal of Asynchronous Learning Networks, 8.* Retrieved March 3, 2005, from http://www.sloan-c.org/publications/jaln/v8n4/index.asp

Wu, D., & Hiltz, S. R. (2004). Predicting learning from asynchronous online discussions. *Journal of Asynchronous Learning Networks, 8.* Retrieved March 5, 2005, from http://www.sloan-c.org/publications/jaln/v8n4/index.asp

Yang, H. L., & Tang, J. H. (2003). Effects of social network on students' performance: a web-based forum study in Taiwan. *Journal of Asynchronous Learning Networks, 7.* Retrieved March 5, 200,5 from http://www.sloan-c.org/publications/jaln/v7n3/v7n3_yang.asp