

Computer Learning Networks: Educational Applications of Computer Conferencing

Linda Harasim

Abstract

Such notions as "on-line education" and the "electronic schoolhouse" are gaining public attention and interest. Nevertheless a great deal remains to be learned before the promise, as welcome as it may be, can become a reality. Although the technology for establishing electronic linkages between the home, the workplace, and the educational institution is available, knowledge of how to successfully design and operationalize such a learning environment is only beginning to be accumulated. Before devoting the enormous amounts of human and material resources necessary to implement such a system on any significant scale, pilot studies which generate data to inform the practice are critical. This paper, by reporting the results of an innovative pilot project to establish computer learning networks, aims to contribute toward developing a base of knowledge which can inform future activities in electronic learning.

Résumé

Une nouvelle conception de l'enseignement, "l'enseignement électronique," suscite de plus en plus d'attention et d'intérêt. Il reste néanmoins beaucoup à apprendre avant que ses promesses, aussi séduisantes soient-elles, ne deviennent des réalités. Bien qu'il soit dès maintenant technologiquement possible d'établir des liens électroniques entre le foyer, le lieu de travail et les institutions d'enseignement, la connaissance des moyens pour mettre en place et exploiter avec succès un tel environnement d'apprentissage en est encore à ses débuts. Avant d'investir les sommes considérables de ressources humaines et matérielles nécessaires à l'élaboration de projets d'envergure suffisamment grande pour être significatifs, il serait souhaitable de mener quelques études pilotes pouvant fournir des renseignements pratiques et pertinents. Cet exposé, donnant un compte-rendu des résultats obtenus par un projet innovateur d'établissement de réseaux d'enseignement par ordinateur, a pour but de contribuer au développement d'une base de connaissances susceptibles de servir aux progrès de l'enseignement électronique.

Introduction and Background

John Naisbitt, well-known American trend-analyst, recently wrote that the age of "electronic education" is upon us. He predicted that:

Personal computers will turn living rooms into classrooms. Hundreds of adults will return to school via electronic university programs designed for home computers, cable television, or work-site educational extension programs. (1984b, p. 23)

"Electronic education" is today very much a reality, as universities around North America and Europe offer credit and non-credit courses using the computer as a communication device.¹ While the use of computers in education has traditionally signified activities along the lines of "teaching machines" and/or individualized, CAI-type applications (in which the immediate interaction is between the learner and the computer), the use of computer conferencing systems introduces a new dimension of group (learner-learner-instructor) interaction into computer-mediated learning. Computer conferencing systems² can facilitate a group learning environment which can in large part simulate the educational community that occurs on-campus, without such access restrictions as geographic location, scheduling and availability of classes, travel time, and cost. Moreover, the electronic medium not only can simulate existing activities, but offers the potential to reinvent educational strategies and activities, opening new possibilities for group-centered learning interactions. Experience demonstrates that computer conferencing holds tremendous potential for both on-site and off-site (distance) education. It can greatly enhance educational opportunities for learners anywhere in the world, expanding their access to learning resources, to information sources and expertise, and to collegial information-sharing.

This article reports one exploration of the potential of the conferencing system to create "computer learning networks,"³ an innovative design which took advantage of computer conferencing to strengthen more direct learner participation in the production and use of new knowledge. It focuses specifically on one course mounted recently at the Ontario Institute for Studies in Education (OISE)⁴, combining a graduate-level credit course and a professional development non-credit course. There were 41 participants in all: 20 graduate-level credit students and 21 teachers who were taking the course for professional development rather than for graduate credit. All participants were experienced educators (teachers and adult educators). Of the 41 participants, 5 had never used computers before, 10 had used computers for one to two years; and 26 had two or more years' experience. Thirty-two of the participants had never before used modems, and none had ever used computer conferencing before. Of the 41, 35 participants reported regular and convenient access to a microcomputer and modem, although for many the computer was in their school rather than in their home. Thirty-eight of the participants were female; 3 were male. The majority were in their mid-30s.

There were two instructors who shared the tasks, although one assumed primary responsibility for the content of the conferences, while the second assumed primary responsibility for process activities such as training, user support, and coordination tasks.

This group worked together over the winter session of 1986 for a period of 3 months. The focus of the computer network/course was sex equity and gender issues in relation to computers in education. As all participants were experienced educators, the network employed a participatory research method which linked participants' experiences as educators with sociological analysis. This strategy validated the participants' experiential knowledge and encouraged them to function as experts in the network. The instructional design was based upon a learner-centered rather than the classic instructor-centered approach, encouraging the learners to assume increasing responsibility for their own learning. Group learning was emphasized, whereby participants were encouraged to engage in non-competitive and sharing relationships with one another through small group discussions, conducting group research projects, preparing a class presentation, and providing critical feedback to one another's presentations. The instructors assumed a facilitative rather than a judgmental role. The design of the course took advantage of the features of the conferencing system to accomplish the networking objectives.

The participants were located in cities, towns, and remote areas around the province of Ontario (Canada) and were linked with one another through their microcomputer, modem, and a telephone line, whereby they accessed the PARTICIPATE⁵ conferencing system housed at OISE. Through this link, they participated in electronic conferences in a wide variety of activities (e.g., plenary sessions, small discussion groups, working groups, etc.), used electronic mail, and conducted electronic polls.

Description of the Activities

The activities for the course can be conceptualized as comprising three distinct but interrelated phases:

Phase 1. Four sessions mounted as "electronic seminars": each session had a particular focus and lasted one week. Participants read the materials and articles for that session provided in their Learning Kit, and engaged in discussions on-line in seminar style.

Phase 2. Participants formed "working groups" of 5-8 members each to conduct research and develop a "class presentation"—all on-line. The working groups had 4 weeks in which to prepare their presentations. Once their presentations were mounted on-line, the class had 2 weeks in which to read and critique/respond to each presentation.

Phase 3. A process of analysis and evaluation by the plenary on the use of computer conferencing in education.

Participants could log-on whenever convenient, but they were expected to log-on at least twice per week for a total of 2-3 hours on-line per week.

As mentioned earlier, the character of the instructional design was to shift the educational activity from being primarily the responsibility of the instructors to becoming the responsibility of the learners. The design of the network was based upon active learner participation and networking. We aimed, moreover,

both to stimulate discussion and to ensure a "productive organization" of that discussion. The course began with a "great debate," a plenary discussion involving all 41 participants in one conference. This format stimulated a high level of active participation (although initially the interaction was quite polite). The objective of this session was to introduce the topic and to actively involve each participant and begin to create a sense of group cohesion. After 1 week of active exchange of views and ideas, the conferencing activities were shifted to small groups. While the initial plenary format had been valuable for introducing participants to one another, following the communication strands in a conference with 41 active participants became quite cumbersome. The small groups enabled participants to engage in more focused discussions and become more familiar with the other group members. After 3 weeks in various small discussion groups, during which they were introduced to a range of topics, participants moved into their on-line working groups. Here they assumed an even greater role in the learning activities, taking on the responsibility of conducting research and analyzing data. Each group prepared an "on-line class presentation" for the entire group. The class then read each presentation and provided informational feedback and critique to each working group. Following 4 weeks in working groups and 2 weeks for feedback and critiques, participants returned to the plenary for a process of analysis and assessment of the use of computer conferencing in education.

Results of the On-line Activity

The computer network was successful in several ways. Users reported comfort with the basic mechanics of the conferencing system and with computer-mediated communication within the first 3 hours of use. Even for those participants who had never before used the computer, learning to use the conferencing system did not represent a major problem.

The network achieved very high participation rates from the beginning, which apparently is not the case for most computer networks. Whereas participants typically spend a relatively long period of time as "Read Only Members," in the OISE network right from the outset participants engaged in actively writing as well as reading conference items. In the first 1 1/2 weeks they wrote 400 conference items and 900 personal notes. In total, over the 12 weeks of conferencing, there were 3,132 conference items and approximately 4,475 personal notes written by the participants (i.e., an average of about 85 conference items and approximately 120 personal notes per person). They also logged on regularly for an average of 3.5 hours per week for the professional development participants, and 4.22 hours/person/week for OISE students. Whereas other networks report that "the most commonly discussed problem in on-line courses is how to keep students active on-line" (Humphrey, 1985), we experienced the opposite problem: At times it was like Pandora's box, and our most commonly discussed problem was "information overload." The fear of an "overflowing" in box, on the other hand, served as a good motivation to maintain regular log-ons.

Of the 20 OISE participants, there were 3 drop-outs. All 3 of these were auditors (2 of them dropped out for family reasons). Among the non-credit participants there were no drop-outs, although there was an ebb in activity after the group presentations. The preparation of the presentations was found to be quite demanding and was followed by a period during which participation lulled. This period also corresponded to spring break, which was then followed by Easter holidays and a very busy period for the teachers when they prepare report cards. Most then resumed active participation.

A third major outcome was in the high level of connectivity or networking among the participants. There seemed to be a blurring of distinctions among the two groups, given a common professional commitment and experience. Friendships, special interest groups, and professional collaborations and support networks emerged on-line. The networking was also consciously facilitated by the design of the conferences.

The major problem reported by participants was learning to establish modem connection. In our experience, the use of the modem/telephone connection/Datapac represented the "Achilles Heel" of the network. This was particularly the case given the great variety of combinations of computers, modems, and software, which creates a difficult situation for providing user support. Nevertheless, most problems and difficulties relating to the basic mechanics of conferencing and using the modem were resolved relatively early on.

Evolution of User Behaviour On-line

The on-line activity was designed to avoid overloading and intimidating the new user by introducing only the basic mechanics of computer conferencing at the initial training session. This initial face-to-face training session was found to significantly reduce learning time for getting on-line and to increase user confidence and self-reliance in using the system. Moreover, participants reported that the initial face-to-face meeting also significantly contributed to the success of the network by creating a sense of group among individuals who had not before met and who would thereafter be communicating through the electronic medium. With time, users began to demand more sophisticated skills to expand their knowledge of and control over the system. Users also came to be more proactive with the system. They began to request information on more specialized features of the conferencing system and to explore the power of the system. A second face-to-face session (after 4 weeks) proved useful to introduce users to features of the system which could facilitate their research activities (i.e., use of the polling feature, introduction to the text editors, use of the search commands, etc.).

Users reported that in the first several weeks they wrote more personal messages than conference items. After the first 2-3 weeks, this reversed as conferencing became the major on-line activity. The use of personal messages, however, seems to have helped the new user become comfortable with electronic communication: Several participants reported some initial apprehension about writing to a group. Fear of "publishing" is heightened by the fact that

computer conferencing is an unfamiliar communication medium. Participants reported that writing personal messages and using learning partners⁶ helped to alleviate the fear of publishing and the unknown territory, developed their conferencing skills, and provided support and confidence. Writing personal messages remained a vital aspect of the on-line activities for the participants, serving to personalize the system by promoting or enhancing on-line friendships, professional contacts, and support groups.

While participants found the basic mechanics of the PARTICIPATE system quite easy to learn, they reported that 5-10 hours of conferencing was required in order to learn how to navigate around the system and to become oriented to the electronic space, given the lack of physical cues (such as facial expressions, body language, voice tone) which characterize face-to-face or telephone communication.

Key Factors in Designing and Facilitating Computer Learning Environments

The ingredients for a successful conferencing experience are an important but elusive subject to determine. The following factors were found to have an important bearing on the successful design and implementation of the computer learning environment:

1. *Users must be highly motivated to use the system...* it must provide some real benefits/interests for each of them. Users should have a strong interest in the subject matter of the conference and in the other conferees in order to log-on regularly, and also to surmount any technical problems and/or frustrations. Self-screening is an important activity in this context. Potential participants should receive information about the nature of the activity, the skills required, and what will be expected of them in terms of time on-line, nature of participation, course requirements, and so forth, prior to registering for the course. They can then decide whether to participate based upon this information.
2. *Introductory face-to-face training was very important...* an initial training session was a very important ingredient to decrease learning time and increase user confidence. This factor may have significantly contributed to the very active participation of users from the outset, a usage pattern distinct from that reported by other computer network trials. It also contributed to creating a group dynamic and sense of connectivity on-line. Participants rated the face-to-face training as a critical factor in the success of the network.
3. *Begin with basics...* both in terms of skills and concepts. Participants should be introduced only to basic information initially. Do not overload the new user. As the user gains confidence and experience, she/he will discover new needs and will request additional information about more sophisticated procedures to meet these needs.
4. *Planning and design of the sessions...* a significant amount of time was devoted to planning the sessions. This investment was subsequently very

rewarding: The design of the activities and the materials prepared ensured that the focus, procedures, and tasks for each weekly session were clearly outlined. Ambiguity is difficult to overcome on-line. Moreover, clear procedures helped participants to participate with more confidence and independence.

5. *Availability of a support person...* who is knowledgeable about the system but also familiar with adult learning principles. This was very important to bridge the gap between the familiar and the unfamiliar technological and social terrain.
6. *Regular and convenient access to a micro-computer and modem...* is almost a prerequisite for effective use. Reliable and easy-to-operate modem and software potentially can make or break a computer network. A flexible modem/communications software package was rated by participants as very important for conducting the operations they required, such as up/downloading files, saving to disk, and printing.

The following three factors are seen as important to establishing the *network* aspect of the computer learning environment:

1. *The facilitative role of the conference moderator/instructor:* The instructors acted as conference moderators, providing a sense of direction to the discussions without intervening significantly. Instructors also served as consultants, offering information or advice when requested by participants.
2. *A cooperative, group learning approach:* The instructors assumed a non-judgmental, facilitative role and encouraged the participants to assume increasing responsibility in the learning activities. Activities were designed around a group learning approach, including both plenary and small groups, for discussions and for conducting group projects. A variety of informal conferences (in addition to the "core" conferences) provided space for participants to request and provide assistance among one another and to share information and ideas. Group learning was introduced from the outset (participants worked in groups in the training session; the course also employed such educational approaches as learning partners, plenary debates, small group discussions, working groups) in order to enhance a sense of on-line community.
3. *Availability of some conferences designated as informal "chat" spaces:* This encouraged on-line socializing activities which contributed to improving the social cohesion of the on-line community and made the system fun to use.

Reactions to the System

Learners' Reactions

The following advantages were cited by learners:

1. A major advantage was the removal of time and distance constraints. This was very important for quality participation in the seminars, small group discussions, and working groups. Participants appreciated the ability to

log-on and participate whenever and from wherever was convenient to them.

2. The 24-hour access to the class was very useful: This format allowed learners to devote more focused attention to the discussions because they could choose times to participate when they would not be interrupted or distracted (their best learning-readiness times).
3. On-line educational activities (accessed through a computer at home or in the workplace) significantly facilitated the linking of work and learning. Participants found this feature very valuable for professional development activities, for conducting research, and for studying, since, as one noted, "the electronic medium facilitates bringing the course material and the participants into the learner's own environment (home/school)."
4. The system was described as a "great equalizing force": Everyone could participate as much as they wished without having to compete for air time (a feature which may be particularly important for ESL students, shy people, and/or women). As one participant observed: "The nature of conferencing allows an individual to finish her thoughts without fear of being interrupted by a keen, more outgoing colleague. I feel that this is a great equalizing force in a group."
5. With on-line communication, participants reported a tendency to respond to the content of a message rather than to the presenter. This feature was viewed as contributing to greater on-line democracy.
6. The system allowed participants to react spontaneously if they wished or to take a more reflective approach. As another user remarked, "Conferencing gives us the opportunity to catch thoughts as they fly by on the screen; moreover, since these are frozen in a database, it is possible to review those ideas deemed particularly important."
7. Group learning gave access to a vast pool of relevant and timely experience and information. The network also functioned as a very effective information management tool: It was possible not only to retrieve information, but to be selective about which information to retrieve, since various members of the group would review/assess/critique learning resources.
8. The network was found to be a tremendous source of group support and morale-boosting. Increased contact with professional colleagues was reported as very beneficial for both exchanging information and for providing professional peer support.
9. The information exchange was found to be more diverse in that input came from everyone rather than from only the instructor(s).
10. Having on-going as well as stored transcripts of the proceedings, with the ability to search for past items was a wonderful research and learning tool, functioning as both a database and a filing cabinet.

The following disadvantages were cited by learners:

1. Some sensed a loss of visual cues (facial expressions, tone, body language) which might lead to misinterpretation of message/intent.

2. Most group communication activities have as their strengths the variety and vitality of group input, but decision-making within a group context is often a time-consuming affair. Group decision-making (particularly using a consensus model) within the electronic context was found to be no less problematic. The on-line working groups who assigned an individual or team to coordinate their activities were found to function more effectively. Face-to-face meetings reduced amount of time for organizing and group planning. The system was found useful for facilitating discussion, planning, debating, information sharing, and brainstorming. But it nevertheless is time consuming to achieve a consensus or decision on-line.
3. Some concern was expressed about potential health problems (eye strain; back strain; radiation) related to computer use.
4. Cost could be prohibitive for small operations such as small school districts.
5. Technical problems were frustrating...most users had not used modems prior, and this interfered with their interaction and control over the system. In particular, some form of prior (separate) instruction would be useful for aspects such as up/downloading, printing from the screen, and editing.

Instructors' Reactions

1. The most significant factor reported by instructors was their discovery that teaching in the electronic medium is quite different from that of the traditional classroom situation, where the instructor has a significant amount of control over the nature and timing of the class interaction. The traditional "presence" of the instructor in the classroom (supported by such factors as the physical/spacial organization of the classroom with the instructor at the head of the class, etc.) undergoes a transformation in the on-line environment. The instructor is less able to direct or control interaction on-line; the electronic environment is a more democratic space.
2. The provision of user support is crucial: It is important to spend a lot of time behind the scenes providing encouragement, assistance, and so forth.
3. Instructors found it easier to recognize and to respond to individual needs in the on-line environment.
4. On-line instruction requires a significant time commitment, particularly in the planning stages. The importance of good planning and design cannot be overstated, in our opinion, and adequate time should be allowed for that purpose. Once the session is mounted, the time commitment decreases, although regular log-ons by the instructors remain critical to the quality of the activities on-line. (With increased experience and knowledge in the design of electronic educational activities, it is expected that the time and effort required to mount on-line courses will be significantly reduced. Part of the problem at the moment is that there are no models nor a body of knowledge to guide our efforts.)
5. Instructors also greatly appreciated the ability to log-on and participate at a convenient time and place.
6. Moreover, the instructors found conferencing to be almost addictive and that it was easily possible to spend hours at a time on-line. Conferencing

proved to be enjoyable, fascinating, and a great way to engage in group discussion and debate.

7. The technical issues around hardware and software can create problems, given the permutations of hardware/software used by students.

Implications for Education

The electronic medium holds significant advantages for offering quality education and access to learning resources and expertise to students, regardless of where they are located. Therefore, it is a great medium for educational delivery to non-traditional learners, such as people with family obligations, people who work during the day, single-parents, learners who are geographically remote, and so forth. But beyond the ability to improve access, computer conferencing can open up entirely new roles for the instructor and the learner. The instructor assumes the role of facilitator and consultant, rather than the person who directs the learning process; students can be more proactive and have access to a vast pool of information and experience from peers. The approach is excellent for graduate studies, which emphasizes group learning methods (e.g., seminars) and the development of independent, critical thinking. Adult learning theory indicates, moreover, that adults learn a great deal from respected peers; they don't learn from authority figures, but prefer a facilitative instructional design. Adults also tend to have a general resistance to being in a classroom, which can interfere with traditional instruction.

Electronic education also has tremendous potential for primary and secondary school. I personally see it as holding great promise for expanding the world vision of our youth and creating stronger linkages for global awareness and understanding. We can promote international sharing through such activities as electronic pen pals and electronic newsletters. I have seen an international computer conference in use linking primary and secondary students in Canada, Great Britain, the U.S.A., Italy, and France, and was very impressed by its value for developing writing and reading skills, and also as a tool for social and historical research, as the children in different countries shared information about themselves, their lives, their countries, and their hopes for the future.

Some questions must be addressed, however, despite many educators' enthusiasm for the medium. One is access. Costs of Datapac and using a conferencing system remain prohibitively high for some. Hardware costs are also still high. While the rewards are arguably tremendous, it remains a fact that in an age of economic restraint, there are few schools or students who can afford to subsidize such activities. Even in the case where a university assumes the computer charges, the question of "who pays the Datapac?" must be resolved: Should the distance learner be penalized? Should there be a flat fee for all on-line participants? Should the university or the department assume the Datapac charges for all on-line courses? Another concern is that of the potential of computers to be employed not as a tool for empowerment of the learner, but for control. Factors such as the ability of the software to monitor time on-line and

amount written could be invitations for abuse. Moreover, the issue of confidentiality is one about which we must remain vigilant.

Nevertheless, as this paper shows, the opportunity for opening up exciting new horizons of learning interactions and knowledge sources become increasingly within our grasp with the advent of computer conferencing systems as learning tools.

Reference Notes

¹The American Open University, the New York Institute of Technology, the New Jersey Institute of Technology, and the Electronic University in California offer undergraduate courses and degree programs on-line. The Open University of London (England) is planning to offer on-line courses in 1987. In Canada, several universities own computer conferencing systems and a similar trend to employ them as educational delivery tools is emerging. A number of Canadian colleges and universities have recently expressed interest in mounting on-line courses and a few have experimented with conferencing to complement existing on-campus or distance education activities.

²*Computer conferencing* is a teleconference that uses computers, software, and communications networks to allow groups of people to exchange ideas, opinions, and information, and to share resources. In an educational application, it allows users to meet, break into groups, complete tasks, and discuss issues or readings—all through the computer (Hargreaves & Harasim, 1986). Without having to pay for costly travel, it enables two or more individuals at two or more locations to communicate. The participants in a computer conference may all be located in the same building, or they may be located around the province, the country, or even the globe. Each user participates in the conference (via microcomputer or terminal and modem) at her or his own convenience, that is, asynchronously. There is no need for members of the group to be conferencing simultaneously, although they may do so if they wish. A *conference* is a topic-oriented discussion in which a permanent transcript is built up of the proceedings. Users usually participate in a number of conferences or electronic meetings/discussions, entering comments on the subjects being discussed. The processing power of the central computer and its software can be used to *organize* and *structure* inputs, outputs, and communications patterns in a variety of different ways. Computer conferencing software can permit, for example, forwarding, editing, filing, and copying of messages; searches by sender, date, topic, and text items; specialist roles for different conference participants; branching conferences; voting and polling; and directories of participants, conferences, and bulletin boards.

³Networking is based upon the concept of people talking to one another, sharing ideas, information, and resources. The most important part of networking is the process of creating linkages through communication. "Networks exist to foster self-help, to exchange information, to change society, to improve productivity and work life, and to share resources" (Naisbitt, 1984a, p. 215).

⁴The Ontario Institute for Studies in Education (OISE) is a graduate school of

education affiliated with the University of Toronto, Canada.

⁵Trademark of Participation Systems, Inc., Winchester, Massachusetts, U.S.A.

⁶The notion of "learning partners" was introduced into the course design to provide each participant with a colleague with whom she/he could communicate through the electronic mail facility. All participants reported writing at least one message to their learning partner, and the average number of messages was seven.

References

- Brochet, M. (1985). Computer conferencing: A tool to enhance graduate student learning. In *Computer conferencing and electronic messaging: Conference proceedings*. Guelph: University of Guelph Institute of Computer Science.
- Cross, T.B. (1983). Computer tele-conferencing and education. *Educational Technology*, 23(4), 29-31.
- Gerber, C. (1983). Networks: Personal links in the electronic universe. *Online Today*, 12-17.
- Harasim, L., & Johnson, E.M. (1986). *Educational applications of computer networks for teachers/trainers in Ontario* (Education and Technology Series). Toronto: Ontario Ministry of Education.
- Hargreaves, A., & Harasim, L. (1986). Net results in education: The electronic classroom. *EDU*, Spring (Issue 41), 27-29.
- Hiltz, S.R. (1984). *Online communities: A case study of the office of the future*. Northwood, New Jersey: Ablex.
- Hiltz, S.R., & Turoff, M. (1986). *The network nation: Human communication via computer*. Reading, Massachusetts: Addison-Wesley.
- Humphrey, C. (1985). Getting a turnout: The plight of the organizer. *Iassist Quarterly*, 9(2), 14-27.
- Osgood, D. (1986). The electronic university network. *Byte*, 11(3), 171-176.
- Naisbitt, J. (1984a). *Megatrends: Ten new directions transforming our lives*. New York: Warner Books.
- Naisbitt, J. (1984b). *The year ahead: 1985*. Washington, D.C.: The Naisbitt Group.
- Umpleby, S. (1986). Online educational techniques. *ENA Netweaver*, 2(1), Article 6.

Dr. Linda Harasim is the Computer Conferencing and Networking Coordinator at the Ontario Institute for Studies in Education (OISE), in Toronto, Canada. She also teaches on the subject of Women and Computers in Education. Her research interests include educational applications of computer conferencing, design issues in teaching and learning on-line, and sex equity issues related to computers in education.