The Internet as a Tool for the Reform of Teacher Education

Kenneth Tobin
University of Pennsylvania, Philadelphia, PA.

INTRODUCTION

The purpose of this paper is to provide an overview of the use of interactive computing to provide practicing teachers with access to graduate level courses and degrees in science and mathematics education. Over a period of four years I have been involved in the development of a number of protocols to allow students to interact with one another and instructors and to complete the requirements of graduate courses through interactions on an interactive web site. Now that I am at the University of Pennsylvania it is my intention to continue to develop a web based application for potential uses in augmenting traditional on campus courses, to allow distance learning to occur for students who may be resident throughout the world, and to provide professional development opportunities for teachers dispersed throughout the United States.

This paper provides an historical overview of the development of the present website, thereby providing a background to the demonstration you will observe. The focus of my colleagues in developing the application has been on building functionality that fitted with our beliefs about optimal learning environments.

What we have accomplished so far is just a beginning and there is much more to do. However, I do think the shell is promising and, can be adapted for more generic uses than those we have envisioned in teacher education. I am hopeful that we can get an interdisciplinary team to work on further enhancement of this web based application .. now for some history.

IN THE BEGINNING

My initial use of technology in science education courses was to use electronic mail in all of my courses at both the undergraduate and graduate levels. At that time, in 1993, the biggest challenges for students related to the availability of computers and accounts. The interface between the student and the computer systems was not optimal and they did not enjoy the accessibility of mail packages that could easily edit and send formatted documents. The asymmetry between the tools I had available to me and what was available to students was striking and it took me several visits to the computer laboratory in the nearby science library to convince me that it actually was very difficult for students to log on and respond to the enticing issues I presented for them to discuss. The click and drag environment of the Macintosh that made it so convenient for me to edit, copy and paste into a message area or attach and send formatted documents was not even a remote possibility for many of my students who were faced with the use of old technology and obsolete software.

Despite the seemingly insurmountable challenges faced by students in getting access to suitable tools the potential of the use of email to transform the way students engaged in science education courses was immediately evident. Two desirable trends emerged. First, students provided thoughtful and extended responses on a wide variety of issues that were pertinent to science education. The points of view expressed in the email messages were not necessarily those that ordinarily came up in class and, as a consequence, the discourse that evolved was

qualitatively different than what usually evolved in science education courses. Because we created a class account all messages were sent to all classmembers and, as a consequence, the discourse was able to mediate the learning of all readers. Second, the availability of email as a tool for expressing a point of view appeared to be empowering to students who might not regularly communicate in class time. The written discourse of many students was surprising when considered alongside of the oral discourse of the classroom. Thus, email provided students with opportunities to engage in different ways and enabled those with a preference to express their thoughts as written dialogue to do so. The extent of the empowerment also was seen in the way that students began to direct their written comments to additional faculty on campus and then to scholars in the research community. Thus, the tools provided opportunities for students to create bigger and more diverse communities of co-learners.

The potential of the initial forays into the use of technology began to suggest different ways to organize science education classes. An early realization was that email conversations needed to be structured in order for them to realize their potential. Accordingly, I created the roles of initiator and synthesizer. For each topic, or electronic conference, an initiator would be identified with the role of getting the discussion going and then staying tuned throughout so that further input could be provided to keep the discussion alive. Typically an initiator would have the role of making a written contribution at the beginning of the week (e.g., Sunday night) and then making another toward the middle of the week. The synthesizer also would follow the discussion throughout the week and would provide a synthesis for all to read and respond to by the end of the week. Others in the class, participants would be expected to contribute to each conference at least once between Sunday and Thursday. All contributions were to be bite sized so that reading from the screen would be feasible.

DISTANCE LEARNING ON THE INTERNET

Over a series of courses procedures such as those listed above evolved and glimpses of the potential of using the internet became more visible among the myriad challenges and problems that presented themselves. These glimpses were of sufficient promise that I received a modest grant to offer a course on research methods in science education on the internet. The course was an immediate success at the conceptual level with groups from all over the world requesting permission to participate formally or informally as “lurkers”. For example, groups from Ohio, Florida, and Queensland (Australia) joined individuals from several countries in the world as participants in the course. The popularity and associated large numbers revealed some problems that might otherwise not have emerged and led to the development of a different mode of delivering courses to students in off campus locations. Before discussing the problems that emerged and the benefits from engaging in this way, I briefly discuss three very different groups of participants from Florida.

One group from Florida consisted of community college instructors from around the entire State. These science and mathematics educators were learning to do research that was focused on their own practices and on the practice of science and mathematics education in their own institutions. For the most part they were geographically remote from one another, but our grant provided funds for three meetings during which we were able to discuss how to send and receive email and to clarify conceptually difficult material. The second group was a cohort of doctoral students each of whom was a practicing teacher. These teachers were from geographically dispersed regions and met twice during the semester to discuss aspects of the

course and to plan for their progression through the degree program. The final group was an on-campus group consisting of candidates for the doctoral and masters degrees and one colleague from the department of chemistry. This latter group participated fully in the email part of the course and also met once a week for a period of three hours. Thus, the on-campus group had experiences with the course content that were different from those of the off-campus groups. Those different experiences were frequently the foci for rich conversations and enabled all participants to elaborate the content of the course. Conversely, the off-campus participants connected the issues of the course to their professional experiences and also were able to focus discussions on a variety of professional practices associated with teaching and learning science in elementary, middle, high and college grade levels. The diversity of the group within the domains of science and mathematics education provided a breadth of relevance that enriched the learning opportunities of all. However, the volume of email soon became a limiting factor that began to affect the motivation of some to participate.

"Do you have any idea how it feels to have 50 messages download very time you log on to the computer?" A telephone call from a fellow researcher broke the news that was already becoming a stark reality. The students perceived themselves to be in a deluge of mail and the relentlessness of it was becoming a problem. A solution was obvious, break up the participants into the constituent groups. Unfortunately, this causal way of thinking about the issue resulted in some of the advantages previously described disappearing from the course. For example, the community college and the Australian groups were separated from one another and the Tallahassee communities which remained in one group. The Ohio group also functioned independently. The problem that we were addressing was solved almost immediately but an unintended and undesirable outcome was that all groups except for the Tallahassee group became silent and many students who previously had been active participants in the computer oriented conversations became less engaged.

Had the problem been characterized differently, a different solution might have been possible. For example, on reflection, the biggest problem of the email deluge was associated with the lack of autonomy of the user. The user had no choice about what and when to access email. For the most part, as an individual accessed the email it began to download and that was slow and for many of the participants expensive. It was not possible to quickly scan the pages and then decide whether or not to download or print. In most instances the downloading process was automatic and did not take into account the relevance of particular files for specific participants. Any long term solution to this problem needed to take account of the desirability of the participants having autonomy with respect to their own learning. As we thought about the direction in which we should proceed the issue of providing students with autonomy with respect to their own learning became increasingly important.

The main difficulties experienced by the participants in these initial courses are described below. The extent to which participants could learn how to use the technology while at the same time learning the substantive content of the course was a problem. Indeed many of the students listed the learning of how to use the technology as one of their most important goals for the course. This problem took many forms. Some of the participants were virtually illiterate when it came to computers and did not know even how to switch one on and get it to do anything useful. Their challenge then became one of learning how to use a variety of applications and then how to interface these applications with communications software. In addition to that many students had not typed before and were very slow. Accordingly, it was a major effort for them to reliably type several sentences whereas others were able to type several pages in the same

period of time. Lack of facility with computer and related interactive technology became for some an obstacle to their involvement. A second problem, related to the first, was the rapid change in the software and hardware tools available to support interactive learning. During this period there were rapid transitions in terms of the development of better email resources and a growing awareness of the importance of the internet. Freenet and private servers became available and Point to Point Protocols also were seen as necessary for all users of the internet rather than the few who already were regular surfers on the net. By the time we had reached the mid point in the research methods course it was apparent that the future growth of the computer oriented courses would focus on the use of web sites as organizers for interaction and access to resources.

USE OF WEB SITES FOR DISTANCE LEARNING

In the following semester the two Tallahassee based groups enrolled for credit in a doctoral course on Teaching and Learning Science. A goal for the development of interactive computer support for this course was to begin with the email system developed in the previous semester and to gradually phase in the use of a web site. Our developmental energies then focused on the development of a website that would meet the following goals:

- Provide students with autonomy to access education when they have the time.
- Provide options that permit highly interactive learning environments and environments that are less interactive. Time constant varying from live to 5 days.
- Allow public and private interactions between faculty and students.
- Convenient access to resources.
- Limit the inconvenience of account clutter.

Netscape and Eudora were perceived by us as the main tools for the learning resource we would develop and we began with the expectation that interactive tools would be developed at a rate that would challenge the flexibility of our thinking.

Our initial conceptualization was that the primary resources for a course would be accessible from a central homepage from which students would link to other clusters of pages. At the planning stage we thought about the above listed criteria and the development of a learning tool in terms of several referents that were consistent with our beliefs about the learning of highly committed teachers who would continue in their employment while building graduate level understandings about teaching and learning of science.

For more than two years we have developed the website and incorporated functions to allow participants to interact in a variety of communities. The following sub-sections provide an overview of some of the most significant parts of the website and an explanation of how participants interact asynchronously and synchronously.

Notice Boards

One component of web-based dialogue is the notice board, where individuals may broach any topic in any way they choose. There is no identification necessary, no censorship, and no permission required to post. Entries may range from informal, unedited and unfocused to formal, edited and topic specific. Like a graffiti wall, postings are removed periodically to make room for other announcements. Occasionally gems spring up that

are transferred to the library and catalogued to benefit learners in contemporary and future courses.

The purpose of the notice board is to foster communication among a group of students. We have found it desirable to provide notice boards for sections of 20-30 students, and although we do not restrict postings to members of that group only, the identification of a notice board with a group of individuals tends to constrain the extent to which others refer to it and hence the tendency to use it to communicate with persons belonging to the identified group.

Conference Centers

Students may also engage in on-line conferences in the conference centers. Each class section can access one or more conference rooms that focus on designated topics. We have tended to use the conference centers to disseminate what was learned from the classroom based research undertaken by participants. For example, when students were undertaking research on language and the learning of science each of the five class sections engaged in a conference on that topic. The proceedings of each conference were available to all participants in the course and it was possible for a reader of the proceedings to append comments and interact with those who had contributed a posting to the conference. Like a professional meeting, conferences are scheduled for given rooms to commence at a given time and continue for two weeks. After that period, the proceedings from each conference are saved to an archive in the library where they can be retrieved and accessed by users who can append notes which are subsequently available for other participants to read.

Four different roles were envisioned for the conference center: convener, presenter, participant, and synthesizer. The convener is required to make an introductory presentation on a given topic. The introduction is thematic and addresses some of the major trends in the research relating to the topic and identifies some of the key scholars in the area. So that the text can be conveniently read on screen, its length is restricted to 300 words. It is anticipated that the text is carefully edited, is not a first draft effort, and is pasted into the conference center from a word processor. The convener has the added role of focusing the discourse in order to adequately deal with the major issues.

Presenters contribute to the conference after it has been introduced by the convener. Each presenter selects a topic that relates to the conference theme and contributes a polished presentation of 300-500 words. Formal presenters are expected to prepare a scholarly presentation that is grounded in research and theory. The presenters are there to enhance the learning of all students who are enrolled in the course, and the instructors too. Accordingly, the topics of each presentation will be coordinated in such a way as to minimize redundancy and to cover the scope of the topic of the conference.

The participants are class members who read over the presentations and ask questions, comment on what transpires, seek clarification on certain points or request elaboration and justification. Entries are limited to 150 words so that a particular individual cannot dominate the discourse in a particular conference room. Interactive dialogue also can occur between participants when they occupy the conference room at the same time. For any given conference, a coordinator is designated for each room with the role of initiating dialogue among the participants. When the conversation lulls, the coordinator

is responsible for initiating dialogue. To ensure full participation it is required that each student in a class section participates in each conference at least three times a week. Formal participation is required in the room assigned to their class, however, participation also is permitted in the other rooms as well.

The synthesizer has the task of pulling the different presentations together in a 500 word synthesis that concludes the conference. The synthesis may include texts from the convener, presenters, and participants as well as selected material from the published literature. The syntheses are pasted into the conference room, to be archived later in the library with all other contributions.

The style of discourse that characterizes the conference center is formal. The convener, presenters and synthesizer are expected to plan their conference in the week preceding the scheduled conference and must be ready to participate fully throughout the entire week.

Dialogue Journals

Based on our experiences with science education graduate students and research on teacher learning and change, we knew that critical reflection on action was an important goal. To facilitate critical reflection we set up what we refer to as a dialogue journal. In the dialogue journals, students select one or two partners with whom they engage in a critical discourse on issues that are germane both to science education and to their interests. The partners collectively edit a common file and take turns initiating discussion and responding as critical friends. The purpose of this part of the website is to enable participants to relate their professional practices to their personal beliefs, associated literature, and research outcomes. It provides an opportunity to reflect on practice and to link those reflections to what is taught in the courses. These reflective remarks are then shared with others in the small group.

Writing in the dialogue journals is restricted to group members and those with access to a password to the file, including the course instructors. The file is password protected and can only be edited by members of the group. This degree of autonomy carries some potential risks because simultaneous editing offers the opportunity for multiple versions of the same file to coexist. However, over a period of time we have adapted the dialogue journal so that the problems have been minimized. At the present time the students can add commentary, view it before posting, and then post it to the journal. The faculty also can read and comment on any part of the dialogue journal. We have taken away the option of deleting text that previously has been posted. This change was necessary because students and/or faculty were inadvertently deleting segments of the dialogue journal that had been previously posted. Entries from the dialogue journal are simultaneously posted to the portfolio and also can be read from there.

Library

The library is another important component of our website that provides four main functions. Primarily, it provides student access to a variety of papers. In the initial stages, these papers were written by faculty and were prepublication versions (to avoid copyright problems). As time passed, we began to obtain permission from our colleagues to include some of their papers in the library, thereby expanding its utility as a learning

resource. The library continues to develop in much the way large libraries develop within an institution. Initially, it included a small number of resources to support each course. However, as the number of articles has increased, the need has arisen to classify the materials so that they can be accessed by students participating in a diverse array of courses. Therefore we have consolidated materials into collections for the science education library and mathematics education library.

A second function of the library is to provide direct links to the existing electronic resources at the main libraries on campus and within the state.

Critical Reviews

One of the many conversations we believe ought to occur involves textbook and other scholarly reading. To facilitate discussions about common readings we have established a site that enables students to post thoughtful and well edited comments regarding chapters of the texts and other resources used to promote learning. All students from a given section of a course prepare a critical review of a given resource and post it on a bulletin board that is assigned for that purpose.

A file is allocated to each chapter and participants in the course can write once on each chapter. Unlike other sites, it is not intended that the discourse here be spontaneous or interactive. On the contrary, each contribution to this section is carefully prepared and edited before posting and each participant is able to post on only one occasion for each chapter. The contributions are bite-sized and focus on an issue associated with the resource that is being critically reviewed. As it is posted, the text is date and time stamped and identifying information of the author is provided. The critical reviews for each chapter of a text, therefore, are contained in one file. The file is open for anyone to read and learn from, but only identified participants are able to contribute to the file. Initially we did not provide participants with editing privileges however after we had used the website for a semester we decided to place more responsibility on the student and permit editing to occur after the initial post.

It is our intention that the reviews are public and can be foci for critical dialogues between students. However, we decided to restrict the number of postings on a given topic to one per student and also to restrict the length to 300-500 words. The restrictions are intended to promote critical thinking and the identification of the most salient issues about which to write. Interactions among students about the posted material also can occur and are stored on notice boards that are linked to the critical reviews. The interactions differ in form from the original contributions in that they are likely to be unedited, spontaneous and shorter (approximately 150 words).

The critical reviews are automatically posted to the student's portfolio where each contribution can be self assessed and also be graded by peers and the instructor. The critical reviews section is a public, and hence tangible sign, of the emergence of a critical discourse within a learning community.

Portfolio

An electronic portfolio is automatically created for each student and consists of contributions the student makes in the conference center sorted by topic, dialogue

journals, and assignments. Each of the pieces to be included in the portfolio is assessed by the student, peers from the student's group, and the instructor.
The portfolio is accessible to students for reading and to the professors for commenting. At this time the portfolio contains sections corresponding to the conferences, critical reviews, and the dialogue journal. Each component of the portfolio can be assessed by an instructor, a peer and by the individual student who has contributed the work to the portfolio (i.e., self assessment). A five point rating scale of superb, very good, good, satisfactory and unsatisfactory is used to assess the performance of each artifact in the portfolio and provision is provided for private comments to justify the assigned rating.

Grade Book

Students can access all assessments of their work through an electronic grade book, which is personalized and password protected. The grade book includes distributions of scores from peer review on each assessed task as well as self and instructor assigned assessments. Only the instructor can edit the grade book. However, other students may also generate assessments to be included in a peer evaluation section.

AN APPLICATION OF THE WEBSITE IN DADE COUNTY, FLORIDA

The initial course that we studied on the computer was intended to provide participants with some insights into action research. The resources around which interaction could occur were identified as a textbook, written comments by students, written comments by the instructors and others from the university community and articles available in an electronic library accessible through the internet. I selected a textbook that I thought would be provocative, but manageable for teachers, one that would challenge their extant notions of research and lead them toward engaging in interpretive inquiry in their classrooms. The text, a 1989 volume written by Guba and Lincoln, adopted a constructivist approach to the conduct of *fourth generation evaluation*. In making the case for an approach that incorporated the use of a hermeneutic dialectical circle Guba and Lincoln attacked traditional views of science and evaluation. I thought their provocative stance would set a context for rich arguments and an opportunity for diverse perspectives to be revealed thereby creating ideal circumstances for reflection about positions that previously were implicit. Because all teachers were teaching throughout this course it also seemed probable that they would link what they were reading and their perspectives on its viability, to their practices in the classroom. Since I required them to undertake a series of classroom based action research studies they all would be linking what they were reading and discussing to their classroom practices.
Guba and Lincoln proved to be an extremely difficult text to use. The ideas about constructivism were not easy for the students to grasp and the complex terminology employed throughout the book made some of the ideas that were very visible to me quite difficult for the teachers to grasp. Whereas I wanted the participants to learn about interpretive research by studying the text and interacting about its content, for the most part the students did not make a clear connection between research and evaluation. Furthermore, rather than linking what they were reading to a new role for them as a teacher-researcher they endeavored to connect fourth generation evaluation to their

practices as teachers and the manner in which they assessed the learning of their students. Although there is nothing wrong with them making such connections I found it somewhat frustrating that they did not relate the chapters to an emerging new role that I had decided a priori was appropriate for them. In the circumstances it would have been preferable to have focused the interactions about a different set of stimuli.

The participants were expected to read a chapter from the text and write a critical review using the appropriate tool that was created for this purpose. Prior to making their submission they should read all of the critical reviews for this chapter that already had been written and placed on the web. Ideally, each critical review would be accompanied by comments from the instructor and it would be possible for writers to take into account the interactions that already had occurred. If students read the contributions of others and the critical analyses of the instructors then the later contributions to the critical reviews section would be clearly linked to those that were presented earlier. Because of the volume of material that was available for each chapter, approximately 130 reviews and associated comments, it was soon apparent that limits would have to be imposed on the amount of reading that was required. Similarly, it was apparent that my goals of having students comment on what others had written and the comments of instructors were overly ambitious. The reading of the chapter and the construction of a 300-500 word review proved to be beyond the capacity of most teachers on a week by week basis. The task was exacerbated by the difficulties many students had in accessing the internet, due mainly to the difficulties we were experiencing in providing a stable environment that could be reliably accessed by many different internet providers at a time when rapid changes were occurring in terms of browser technologies and internet providers and universities were constantly upgrading equipment so as to keep pace with exponentially increasing demands on access.

As issues arose several points needed to be considered. First, there needed to be a place for public interactions via text where small groups could communicate. With this in mind we created noticeboards for each group of approximately 25 students. The intention was that these noticeboards would be places for substantive interactions on issues that arose in the posts from other places in the web. This did not occur. Instead, the students tended to use the noticeboards for announcements on a myriad of topics, most of which had little to do with the substance of the course. For example, if they could not access a particular place on the web they often complained about this on the noticeboard, and they also celebrated events by placing announcements on the noticeboard. Thus, just as a noticeboard in a village supermart serves a function of communicating about many events and issues so too did the noticeboard serve a similar function in our learning community. Indeed, when I endeavored to change the functions of the noticeboards to report research findings there was an outcry against this possible change. The noticeboards were serving a useful role in facilitating communication within the community of Dade County teachers. Accordingly, I created a Hot Topics Noticeboard to enable discussions to occur about critical issues that arose during the conduct of the course. An example of a lively discussion that did occur on the Hot Topics noticeboard concerned language and the learning of science, particularly the Ebonics issue that erupted in the press during the semester in which this course was conducted.

During the fall semester the students also were required to participate in several conferences. My initial goals of having them assume assigned roles on several conferences during the semester were moderated because of the extent to which teachers lagged behind on the critical reviews assignments and their failure to post their contributions to the conference in a timely way. The goal of having them read and comment on one another's posts did not work out because of the amount of work involved. The tool that was created to allow public viewing of participants' contributions and reactions to the contributions of others along side of the comments of the instructor was used by only a small number of participants.

The first of the action research assignments required participants to describe the learning environment in their classroom. There were relevant articles available for students to read in the electronic library and some of these included methods of undertaking interpretive research and ways to undertake research on learning environments. All students in all groups were expected to post descriptions that reflected their own perspectives and to follow up on this with those of a selected student. A third task was to provide the perspectives of a second student selected because of his/her differences with the first student. Thus the students were experiencing the use of a hermeneutic dialectical circle and also were practicing ethnography. At this stage it was apparent that my original schedule was far too ambitious for these students in a context of them being busy professionals, the problems of accessing a technology that was not dependable and was constantly changing, and making sense of what they were learning in terms of their goals and the requirements of the school district. Accordingly, I decided to restrict the required participation in conferences to just one more. The final conferences were to set the stage for interpretive research to be undertaken in the spring semester. The topics included language and learning of science, the home as a support for the learning of science, co-participation in science activities, and equity in science classrooms.

The participation in conferences was disappointing for most students, although there were notable exceptions who appeared to thrive in conducting research in their classrooms. However, there was scant interaction about the posts in the conference centers and for most students the posts were a place to visit during the breaks between courses and in subsequent semesters. Thus, they were an important resource for learning but the interactions envisioned initially did not eventuate for most students and the opportunities for learning, although rich, were not what I expected in the beginning.

The dialogue journals, that allowed small groups of students to interact in a semi-private way were invaluable for those students who used them. However, not all students were able to interact via the dialogue journals. Those who did interact developed a rapport that supported their learning in the course and the dialogue journals were critical opportunities for the discursive capital of others to mediate learning within the community. The semi-private nature of the dialogue journal enabled some students to deal with issues that were somewhat personal and related to their own perceived needs to change.

The portfolios were places for the instructor to interact directly and privately with students in a one on one manner. In essence the instructor could place private comments into the portfolio in an endeavor to take the student to a higher level in the way they thought about issues. For my own part I became very focused in my comments in the portfolio and tried to communicate my expectations of the student. This was a place for

interaction about learning goals for each individual. However, in the initial parts of the course the direction of the communication was one directional. Students did not respond with equal candor and there was an obvious power imbalance favoring the voice of the instructor.

The spring course was set up to allow the participants to undertake research in their own classes. Based on the experience of the fall course I decided to focus on a research project and utilize a text that would feature critical analyses of research undertaken by teachers like themselves. The selected text was an edited volume that contained reports of 12 studies undertaken by middle school teachers in their science classes. Although the idea appealed as a good one the major problem was that most of the studies were not interpretive and contained numerous problems associated with both the methods employed, the interpretations, and the conclusions. Although it was not possible at the time it would have been preferable for them to be critiquing research that was not only undertaken by teachers but that fell within the genre of interpretive ethnography. Now that more than 100 such studies exist it will not be a problem in the future.

The studies undertaken by the teachers were drafted in the spring and polished in the summer. Students not only planned and implemented the studies but participated in peer review of others' manuscripts using dialogue journals during the spring and in small group interactions during the summer. Successive drafts of the paper were undertaken prior to submission for inclusion in a portfolio or to be published in a variety of sources.

When we commenced the project we had an internet protocol that was working sufficiently well to give us the confidence that we could offer a viable degree program. However, because of the distance between the students in Dade County and the university it was necessary for students to elect their own internet providers so as to avoid extensive long distance telephone charges. What we did not anticipate was that different providers would use different web browsers that would provide somewhat different interfaces with our website. Throughout the initial summer in which we commenced the project we feverishly worked to develop a website with appropriate tools that could be accessed in viable ways by all of our students. On a weekly basis the programming languages for the internet were changing, browser technology was improving in leaps and bounds, and the requirements of home computers to access the website were increasing at a rapid rate. Many problems were associated with these developments.

From the perspective of the students most were able to access the website throughout the program. Although the majority was accessing the internet for the first time when they commenced the program, they purchased an adequate computer, contracted with a suitable internet provider, and experienced minimal inconvenience. In contrast, a minority of students experienced significant problems that detracted from the learning environment. Some did not make a commitment to purchase either a computer that could access the internet or did not purchase a contract with an internet provider. Some of these students withdrew during the first year and others were re-assigned to a group that would meet face to face once a week from the beginning of the second fall semester.

The courseware developers had a difficult job. They were trying to maintain a working system while students used it and to be responsive to our requests for added functionality. As students asked to do certain things and we wanted to expand our ideas of creating a community of learners tensions began to emerge because developments were introduced

before they were fully tested with all of the differing internet providers. Thus, functions that would work for most students would not work for a minority and these students would be frustrated and disadvantaged. After the second semester we decided that, to the extent possible, we would develop added functionality without changing the website for the users. At the same time, violence was experienced when a computer hacker broke into our website and brought it down. This experience heightened our sensitivity to security issues and this focus inadvertently led to our programmers limiting access to the work of students. That is security of the website and programmer perspectives on what was most appropriate led to an evolving website that was no longer as viable in terms of our models for what was best for the teacher-learners. This trend was exacerbated by a problem that at first sight might not seem relevant to the paper. In this rapidly advancing field our programmers developed expertise that was commercially marketable and several first class programmers were enticed to leave our project to assume highly paid positions in industry. Their experience in developing our website became an excellent component of a portfolio and we did not have the fiscal resources to retain their services. Because of the sophistication of the programming we were too frequently spending significant amounts of time allowing bright computer scientists to teach themselves the language of PERL and CGI script to enable them to maintain and continue to develop the website.

After two years of web development we are now in a position to recognize that the asynchronous features are those that should be highlighted and enhanced in a tool that is built for the two main browsers being used internationally (Explorer and Netscape). From the beginning we knew that teachers needed the autonomy to decide what to study, when to study and how to study. However, in the development of the website we developed a variety of synchronous and asynchronous tools but found soon that the asynchronous tools were of most value. The least successful activities were those where we placed limitations on the autonomy of teachers. Having said this, there is a tension in the desirability of providing maximum autonomy to teachers in regards to what they do and when they do it and the need to build a community in which each person can learn from the efforts of others. This issue is perhaps one of the most significant that needs to be addressed at the present time.

A final constraint that we experienced in developing our website was the high cost of developing a site were high and other stakeholders were disinclined to collaborate with us to develop an internet tool. Because we developed tools based on the theoretical foundations of social constructivism, communities of practice and neural network theory (Churchland, 1989), we believed that some features, such as asynchronous interaction between participants and allowing for degrees of private and public interactions, were of paramount importance. In contrast to our own efforts there were two trends. First, there was an inclination to employ the glitz and glamour of color, animation, hot links, and video and audio clips. Second, there was a tendency to try to replicate live classrooms by developing synchronous tools to enable groups of participants to interact in real time. Neither of these trends was a high priority for our group and, accordingly, we worked alone to develop the internet tool with assistance from DCPS and a modest university grant. The problem of multiple groups developing internet tools on the university campus continues ar the present time, as we proceed with the development of our own

tool, adapting it for generic use in staff development contexts and making it possible for teachers to set up classes to access the tools that have been developed and tested.

HAVE WE MET OUR GOALS?

> *The advantages of using the internet as an educational format far out weighs the disadvantages. As a wife, mother, teacher, girls scout leader, church participant, etc. I enjoy being a member of a learning community that is avalable 24 hours a day, 7 days a week. I can participate and improve my practice of teaching without inconveniencing my family. As typical of many of the participants in the program, I am responsible for many of the family responsibilities such as shuffling children to various sports practices and other activites, providing the basic household support and keeping the family together. I truly appreciate being able to explore new ideas and still be able to "be there" for my family. If you checked the times of many of my postings, you would notice that many were done in the early morning hours. It is difficult to attend typical university courses at 5:00 am.!* (Middle school teacher)

The development of a website while learning how to meet the needs of students who are studying at a distance is a work in progress. We have to remain oopen as learners and listen to our students. I have regularly undertaken evaluations of the courses and the website to enable me to be responsive to the changing needs of students while fully exploiting the features of the rapidly changing technological tools. In the process of making sense of student feedback I have identified 20 categories that are salient to any ongoing work that is undertaken. I present these briefly below with an example of the feedback from students.

Accomplishments: *I think a highlight for me was simply to master using the computer and the website, and have it all work for me. I really enjoy it.*

Quality: *Many of my peers posted documents that suggested ideas and concerns that were brought up in my readings by the best of published minds. Where else can you read other participants' papers and savor their ideas? This is great. Your ideas can be consistently challenged from a variety of perspectives. There's always something new to learn. Some of the postings were book reports; others were anguished mental debate on the value of qualitative research.*

Reflection: *The growth of my practice has been incredible and I truly look forward to being engaged in more action research. Action research and self-reflections about the classroom practice are the keys to improving the educational experience of all students. The empowerment of teachers exist within themselves: reflecting and improving on their individual classroom practices.*

Enjoyment: *Surfing the web it's amazing what you can find, becoming more computer literate and less afraid*

Flexibility: *The success of a program like this one involves having flexible people to work with who are willing to dedicate the time and effort to make it work.*

Confidence: *My knowledge of computers and technology has increased tremendously and I am not AFRAID to experiment in the classroom. (I always had a DESIRE to implement technology in my classroom, but I would place other home and school priorities BEFORE this one. Therefore, my students would suffer because I would not allow them to do much with the computers.)*

Tedium: *The critical review concept gets very monotonous when applied from text to text to text to text. Need a creative "change-up" once in awhile.*

Frustration: *The disadvantages of the website are the constant alterations and supposed improvements in the system. Less tinkering with the system would be beneficial as each tinkering seems to leave the website inoperable for a long period of time.*

Difficulty: *I acquired the knowledge to perform the computer tasks needed for the course. Again I taught myself to learn the mystery of the computer, and the world of "Web Surfing." because of this program, I am no longer apprehensive about teaching science. I have obtained a wealth of information that will help me introduce the world of science to children. I am very happy that I remained positive, and stepped forward with confidence that I will learn along with my students. In the beginning, learning science was uncomfortable for me. As a result of my experiences of learning, I have acquired a new attitude towards exploring the many wonders of science.*

Professionalism: *The posting of the reviews need to be done by all of us on a timely basis in order to benefit from each other.*

Autonomy: *My DJ partner and I would discuss the practical aspects of the material we were reviewing. As our critical reviews would be "scholarly" and formal, the DJ allowed us the opportunity to discuss the implications of our critical reviews in our Dade County classroom. The DJ gave us the opportunity to express doubt and confusion about the material while our critical reviews portrayed our formal and analytical interpretation. As the critical reviews were serious and polished, the DJ showed our true perspective of the material. We were allowed to be honest about conceptual difficulties as these comments were not posted on the public website. We had the freedom to question ourselves and each other when using the DJ. This would not be appropriate in the critical review format.*

Convenience: *I think probably the greatest advantage of the website is its convenience. It's wonderful to be able to participate whenever you want or are able to.*

Efficiency: *The advantages of long distance learning are many; the time element is basically an important issue for someone like me because I am a full time teacher, carrying many other responsibilities in my school besides teaching and I am also involved in community activities. This mode of learning allows me the flexibility to study and collaborate with fellow learners on my own time schedule as well as gives me enough structure to feel I am organized and*

disciplined. There is no doubt in my mind that one must be self-disciplined in order to learn and function under the
guidelines of this unique learning environment.

Interaction: *It is beneficial to interact with a partner, but I think the d.j. could be expanded to a larger group of participants with better results i.e., more interaction.*

Feedback: *I can get immediate, or almost immediate feedback from fellow classmates, if I get stuck or just want to discuss a problem or idea. That is probably one of the best advantages. I have never had this in any other of my classes. After all, you usually see your classmates once or twice a week and usually everything including discussion is professor directed. Here we can work in an open forum and everyone has contact with everyone else whenever they need it. It is also less threatening. I am usually one of those students that sits in the back of the class afraid that if she opens her mouth she will automatically be embarrassed. Writing is a little less threatening.*

Collaboration: *A positive aspect of the critical reviews and other assignments on the web, is the access to the work of others. You can learn from what others are writing and engage in a discourse community.*

Personalization: *The instructors "know" you better, therefore learning is more personal.* (Student 1)
When one is a new student, it is difficult to "fit in" because one has not had personal contact with one's classmates. (The summer term works well to alleviate this problem. I feel much more a part of a group now that I have attended face-to-face classes and performed cooperative-group activities with my colleagues.) (Student 2)

Friendship: *the new friends and networking has been amazing.*

Resources: *I have begun to read the noticeboards on a more frequent basis. They are a good source of information on problems, concerns, and even personal news that we should be aware of.*

Tasks: *A lot of work assigned.* (Student A)

The critical reviews provide a routine for me. I know when they are due and they help me to pace myself. (Student B)