Towards a Global Virtual Learning Environment

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Abstract

The World Wide Web (WWW) provides the basis for a virtual learning environment which extends around the globe. This paper will first discuss the principles involved in creating an effective virtual learning environment and then will illustrate this with a description of the web-based Virtual-U system developed with support from the Canadian TeleLearning Network of Centres of Excellence at Simon Fraser University.

General

The World Wide Web (WWW) provides the basis for a virtual learning environment which extends around the globe. This paper will first discuss the principles involved in designing and implementing an effective virtual learning environment. This includes a brief review of the theories of learning on which a design will be based and presentation of a framework which can be used to guide the design and evaluation of web-based learning environments. We will then illustrate this with a description of the web-based Virtual-U system developed at Simon Fraser University with support from the Canadian TeleLearning Network of Centres of Excellence (http://www.telelearn.ca).

Learning Theories in the Design of Virtual Learning Environments

The design of a learning environment must take account of the theories of learning which the course authors and instructors will apply. While learning theories can have many variations, they can be very roughly considered in two classes: the classical behavioural and information processing theories and the contemporary constructivist and socio-cultural theories (Harasim and Stockley, 1997).

Behavioral and Information Processing Theories: These theories underlie the instructional models used in most of the schools, colleges and universities around the world. In simple terms, it is assumed that learning takes place when information is transferred to the student from the instructor and from instructional materials (Mayer, 1996). This can be accomplished when a student receives information in a lecture, for example. The role of the teacher consists of setting learning goals, planning learning outcomes, preparing and sequencing learning materials,

delivering instruction to learners, assigning activities, evaluating the student's products and giving feedback. The behavioral theory, based on a stimulus-response model, assumes that learning takes place when associations are strengthened between a stimulus and a correct response (Mayer, 1992). While almost any learning environment will make some use of methods which can be explained in terms of these theories, there is strong evidence that virtual learning environments can be more effective if they do not try to recreate the classical information transmission - lecture model.

Constructivist and Socio-cultural theories: These theories are an alternative to the classical learning theories and have developed following the work of Piaget (1954) and others in the 1950's and 60's and have gained popularity in the 80's and 90's. Constructivist theorists do not believe that knowledge is a constant for each object or event but rather that it is constructed by individuals as they interact with an object or an event, in relation to their past experiences, their beliefs and their current mental structures (Black and McClintock, 1995; Honebein, Duffy and Fishman, 1997). For constructivists, learning is the process by which information is transformed into personal knowledge (Jonassen et al, 1997). Socio-cultural theories extend these basic principles to the development of the collective knowledge of a community as opposed to the development of individuals' knowledge within the community.
In a learning environment based on constructivism teachers serve as coaches and guides and learners are given significant cognitive responsibilities - analysis, synthesis, problem solving and creativity. It is believed that learner activities should be authentic - i.e. they should be realistic, meaningful, relevant to a community of practice, complex and information rich (Jonassen et al, 1997). Particular features of a learning environment which can support learning include facilitating with scaffolding and fading, cognitive apprenticeship and collaboration.

A Framework for the Design and Evaluation of Web-Based Learning Environments

The learning theories discussed briefly above are complex and difficult to translate into system design features. In addition, there are many other factors such as user interaction, network characteristics, and cost which influence a system design. In an attempt to provide a consistent basis for the design and evaluation of such systems, a comparison framework comprising 17 design dimensions has been developed. The full framework is available as a Technical Report (Pantel, 1997) and only a summary is provided here.
The comparison dimensions are set out in turn - each is intended to capture an important feature of the pedagogical design, the user interface design, the technical characteristics or the economic or business aspects. It is recognized that the dimensions are not orthogonal - i.e. the different features overlap and in some cases are contradictory. However, by considering a design against these features a consistent evaluation profile can be obtained.

Comparison dimensions

- Facilitating learning - Does the system provide direct tools to facilitate learning, tools which support for facilitating, and tools for scaffolding and fading?
- Cognitive apprenticeship - Can learners participate in a community of practice, engage in authentic activities, and engage in legitimate peripheral participation?
- Collaboration - Are there facilities that enable learners and teachers at a distance to communicate and work together?
    1. Asynchronously - different kinds of discussion - email, listserve, and conferencing systems;
    2. Synchronously - chat, Internet phone, video conference, shared whiteboards, shared applications.
- User Interface - Is the design based on established UI principles? Do the metaphors used support the learner? Does the workspace support awareness and help to create a virtual learning environment?
- Personal workspace - Are tools provided to support the learner in concept mapping, annotations, semantic associations, document upload, etc.?
- Course authoring - Are facilities available to assist the author in planning and structuring a course, in assembling materials, etc.?
- Assessment - Are there tools to assist in assessing knowledge acquisition and retention (exams, tests and quizzes), and to evaluate the students' learning processes?
- Tracking - Can student participation be tracked from log files?
- Ethical and social issues - Does the design contribute to the depersonalization of learning? Are issues of privacy, monitoring, fair accessibility handled ethically? Are there methods to protect intellectual property?
- System requirements - What are the client, server and network requirements? What is the quality of service?
- Robustness and security - Does the design use proven technology?
- Integration - Is there sound internal integration? Does the system integrate into existing environment?
- Customizability - Can the system be easily customized for the needs of a particular client?
- Support - Does the vendor provide support and upgrades?
- Training - how to use, how to teach and learn
- Business - What is the target market? What are the total costs including those of hosting the learning environment?
- Future direction - What are the vendor's development plans for the product?

Summary of Design Features

Based on the principles of constructivist learning, the goal in designing a web-based virtual learning environment is to create virtual-classrooms, seminars, discussion groups, laboratories and problem sessions which support student centred approaches to collaborative learning, and knowledge building (Harasim, Hiltz, Teles and Turoff, 1995). A primary prerequisite for the environment is that it must allow rich discourse between students and instructors and between individual students. This can be achieved with both synchronous and asynchronous conferencing systems. Experience suggests that for most purposes asynchronous conferencing supports the most effective discussions (Hiltz and Wellman, 1997). Another highly desirable feature for the environment is that it should support hypermedia. In this way students can build rich links between their own notes, other students' notes, instructors' comments, course resources, etc. The resulting learning takes place as the students build their ideas and knowledge (Harasim, Calvert and Groeneboer, 1996).

Designing and Implementing Virtual-U

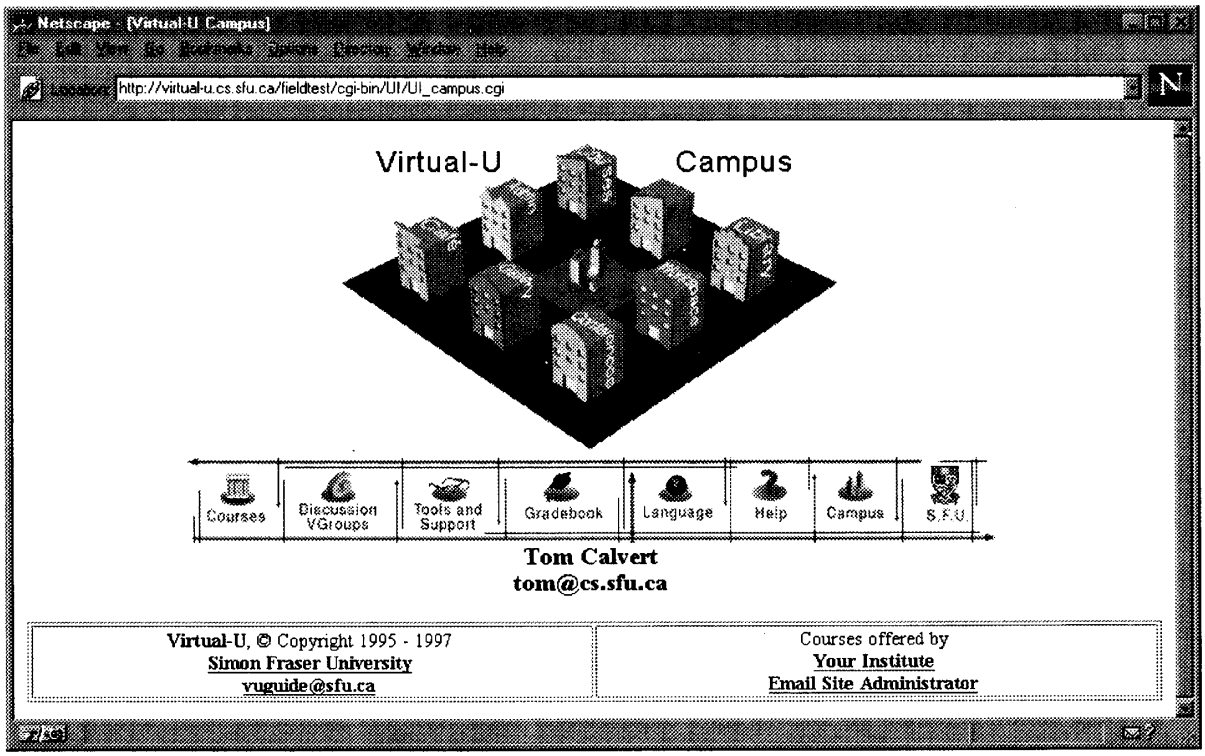


Figure 1. A spatial metaphor is used for the virtual campus.

Background.

The Virtual-U system has been developed to achieve the objectives set out above. Virtual-U, one of the Beacon Technologies of the Canadian TeleLearning Network of Centres of Excellence (http://www.telelearn.ca), is a World Wide Web-based networked learning environment customized for the design, delivery, and enhancement of post-secondary education. Virtual-U is

designed to provide a flexible framework to support advanced pedagogies based on principles of active learning, collaboration, multiplicity, and knowledge building. This paper provides a brief description of Virtual-U and presents preliminary evaluation results (http://virtual-u.cs.sfu.ca).

Based on a decade of field research in online course delivery, the design and development of the system now known as Virtual-U was initiated in 1994. The goal was to provide a flexible framework to support advanced pedagogies in varied content areas including sciences and the arts, and in varied instructional formats including seminars, tutorials, group projects, and labs. The framework consists of tools to support core activities including course design, individual and group learning activities, knowledge structuring, class management, and evaluation. The attention to pedagogy is what distinguishes Virtual-U from many other virtual universities. The Web has typically been used as a publishing environment characterized by a correspondence course model or a broadcast model of learning in which faculty post lecture notes or students post assignments online.

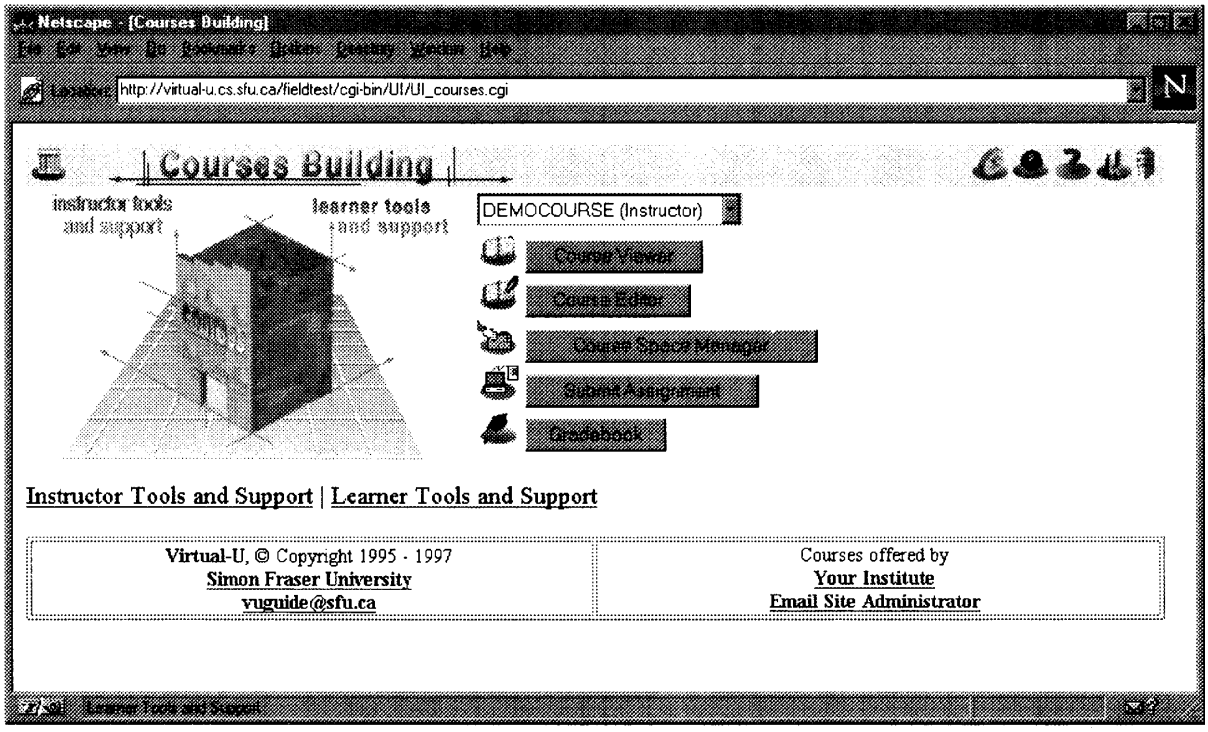


Figure 2. An instructor view of the Courses Building.

Overall Design.

As shown in Figure 1, spatial metaphor is used to enhance the sense of presence on a virtual campus. In the Courses Building (Figure 2), students access the courses in which they are enrolled as well as learner support tools. A hyperlinked Course Syllabus sets out the course content and provides hyperlinked access to course resources and materials (local and remote) as well as course activities (e.g. virtual labs) and assignments (Figure 3). Virtual seminars and other class discussions take place with the support of the VGroups conferencing system (Figure 4).

Other tools allow students to upload multimedia materials to a shared workspace and to upload assignments to the instructor's workspace. gradebook records student grades and makes these selectively available (Figure 5).

The initial design of Virtual-U is based on networked multimedia workstations (PC's or Macs) and a UNIX server. The decision was made to build on widely available World Wide Web (WWW) tools since there is active interest in developing these tools for multiple platforms. Thus the students and instructors using Virtual-U need only a Java capable browser on their workstation because all of the Virtual-U software resides on a central server.

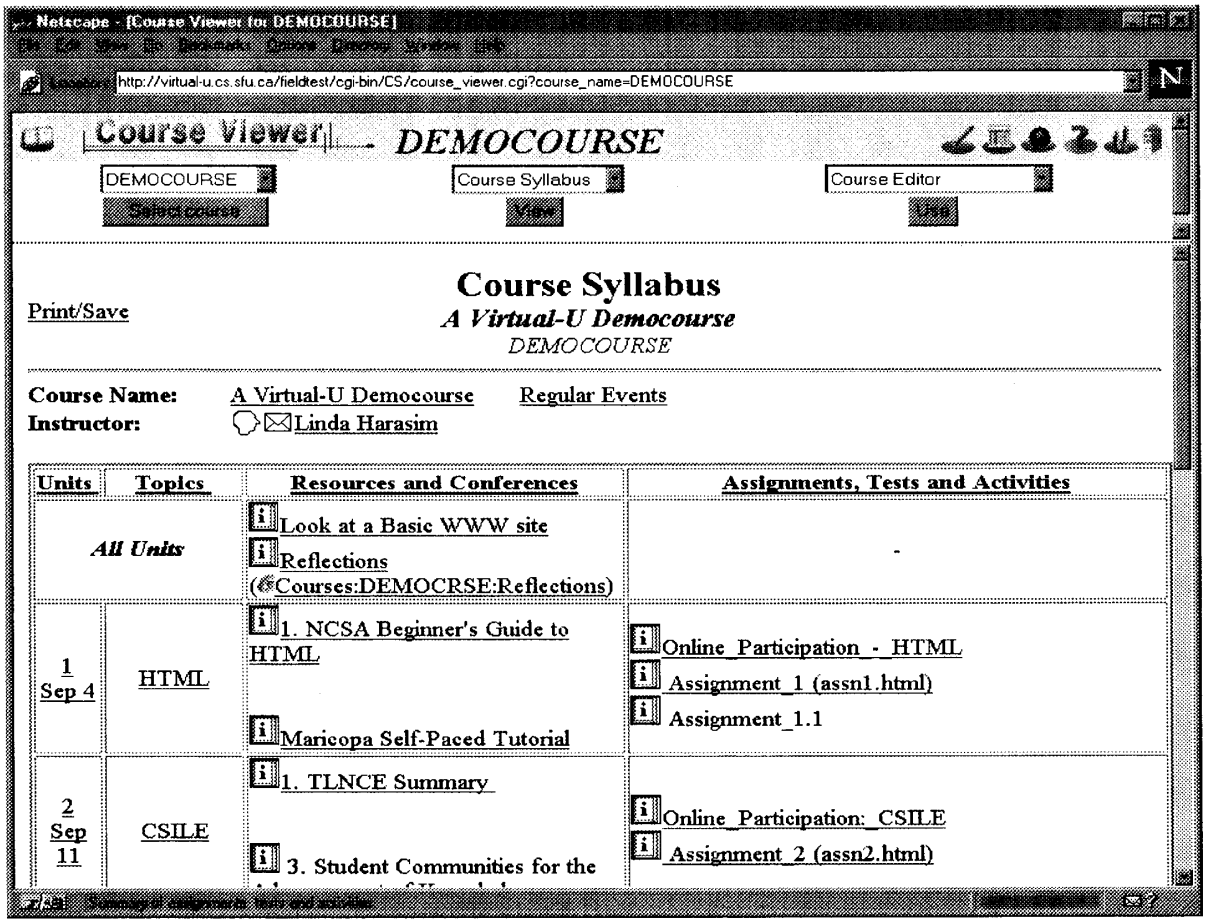


Figure 3. The interactive Course Syllabus

User Interaction Issues.

Until recently online learning environments were completely text based; thus, the participants form their own imagery of the virtual environments, much like the situation when one reads prose. With multimedia which provide 2-dimensional images of 3-d scenes, and even video or animation, it is possible to provide the students with explicit cues which help them orient themselves, both in terms of navigating around the virtual environment as well as in setting social norms as to the appropriate behaviour expected in each virtual space (Turoff, 1997). While the

key spaces are instructional, such as virtual classrooms for seminars and discussion groups and spaces for team projects, labs, etc., the Virtual-U environment also includes spaces for academic advice, for administrative activities such as registration and fee payment, for access to library and other information resources (including an art gallery) and for social interchange (the virtual café). Another major component of Virtual-U is the set of tools to support core activities including course esign, individual and group learning activities, knowledge structuring, class management, and evaluation.

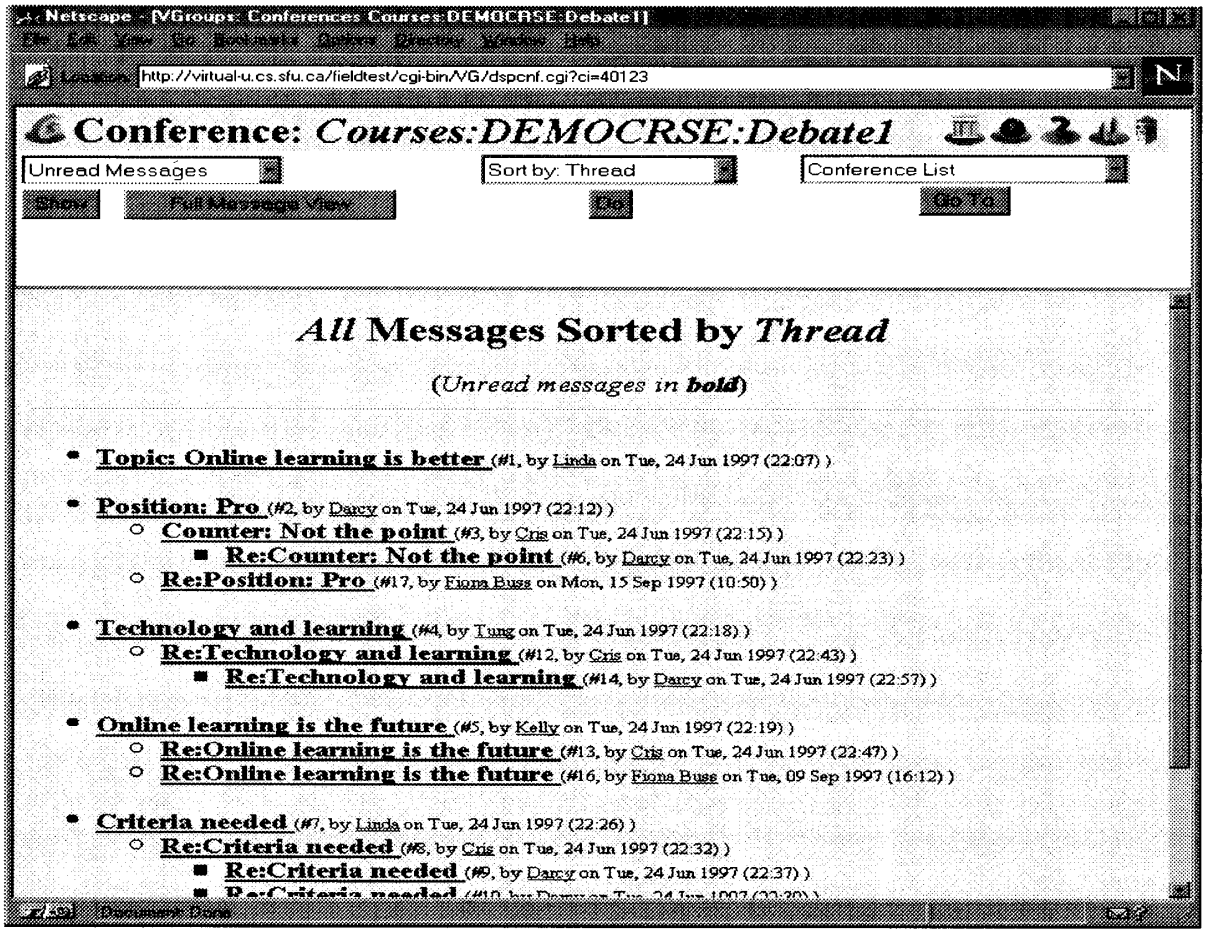
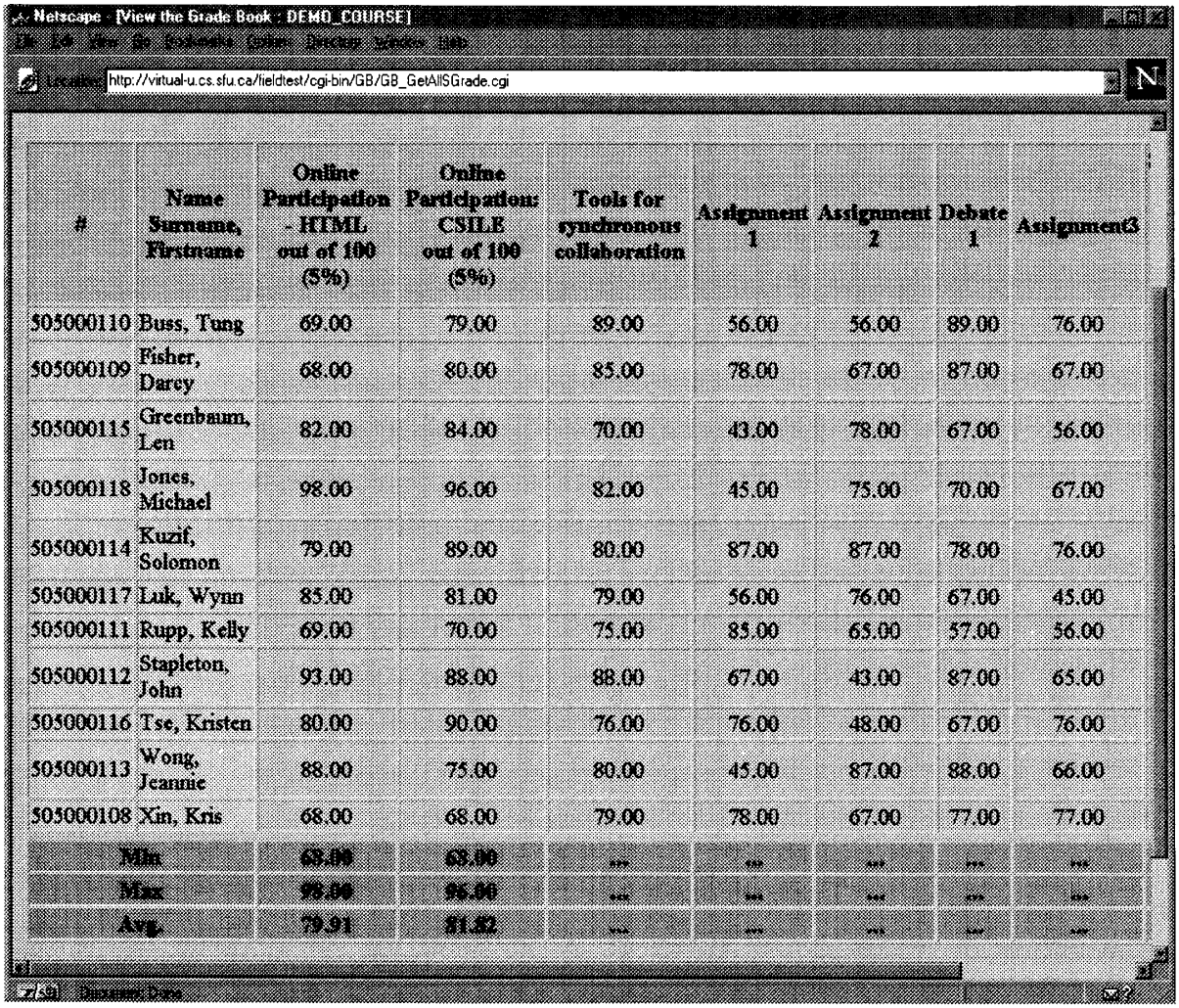


Figure 4. A view of a threaded discussion in the VGroups conferencing system.

Field test Evaluations.

The first field trials began at Simon Fraser University in September 1995. In the Spring Semester of 1997 12 courses were offered on Virtual-U at Simon Fraser University and there were numerous other offerings at 12 field sites across Canada. The data collected from the field sites consists of basic statistics for the courses concerned, pre- and post-questionnaires and computer logs of all student interactions. The questionnaire data and the basic statistics are relatively straightforward to analyse. The transcripts of the student interactions in the virtual seminars, etc. are currently analysed by hand to track the discourse and arguments and deduce the learning

strategies. There is an urgent need for natural language understanding tools to assist this analysis. Preliminary results confirm earlier research and show that in online collaborative learning student participation is much more even than in face to face.



#	Name Surname, Firstname	Online Participation - HTML out of 100 (5%)	Online Participation: CSILE out of 100 (5%)	Tools for synchronous collaboration	Assignment 1	Assignment 2	Debate 1	Assignment3
505000110	Buss, Tung	69.00	79.00	89.00	56.00	56.00	89.00	76.00
505000109	Fisher, Darcy	68.00	80.00	85.00	78.00	67.00	87.00	67.00
505000115	Greenbaum, Len	82.00	84.00	70.00	43.00	78.00	67.00	56.00
505000118	Jones, Michael	98.00	96.00	82.00	45.00	75.00	70.00	67.00
505000114	Kuzif, Solomon	79.00	89.00	80.00	87.00	87.00	78.00	76.00
505000117	Luk, Wynn	85.00	81.00	79.00	56.00	76.00	67.00	45.00
505000111	Rupp, Kelly	69.00	70.00	75.00	85.00	65.00	57.00	56.00
505000112	Stapleton, John	93.00	88.00	88.00	67.00	43.00	87.00	65.00
505000116	Tse, Kristen	80.00	90.00	76.00	76.00	48.00	67.00	76.00
505000113	Wong, Jeannie	88.00	75.00	80.00	45.00	87.00	88.00	66.00
505000108	Xin, Kris	68.00	68.00	79.00	78.00	67.00	77.00	77.00
	Min	68.00	68.00	...	...	...	...	...
	Max	98.00	96.00	...	...	...	...	...
	Avg.	79.91	81.82	...	...	...	...	...

Figure 5. An instructor's view of the online gradebook.

User interface evaluation is included in the field trials but is also conducted in the laboratory prior to the release of the system. The major user interaction problem has been to design within the constraints of the web browser/html capabilities and with consideration for students who may be using a laptop with a small VGA interface.

Discussion and Conclusions

Global virtual learning environments are now a reality. Based on the Internet and the open architecture world wide web, learners have easy access to courses offered by institutions throughout the world. One example of what is possible is a course offered on Virtual-U from

Simon Fraser University in January 1997. This course, FPA 229-3, Dancing in Cyberspace, was offered by Professor Iris Garland of the SFU School for the Contemporary Arts. The course was taught over 13 weeks and was totally online. There were 22 enrollees who were regular, continuing students at the university, but in addition there were 16 special students from around the world - Australia, Hong Kong, United States, Spain and the United Kingdom. The students had no serious technical problems and judged the course a major success.

Although effective global learning environments are becoming available, they can be substantially improved and extended. In particular, there is a need to implement more pedagogical tools, such as concept maps (Niguma, 1997), to better support advances models of learning. There is also scope for improved tools which automatically assess the learning through discourse analysis and provide timely feedback to the learners and instructors. Many of the current systems, such as Virtual-U, which is described here, make use of web tools which are currently available. While supporting easy access and an open architecture, these tools substantially limit the interaction which is possible. To address this, Virtual-U is currently being reimplemented using Java and other systems to avoid the limitations of html and cgi scripts.

There is every reason to expect rapid progress in this field. The global learning environments of tomorrow promise to provide advanced pedagogical tools and extensive access. The impact on learning can be substantial.

Acknowledgments

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