References

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[3] Course material included most notably: the second edition of the classic *Spacetime Physics* by Taylor and Wheeler an undergraduate text introductionto Special Relativity; an almost finished draft of *Scouting Black Holes* an undergraduate text on "exploring general relativity with calulus"; and a diskette with the programme *Black Hole Orbits*, an interactive simulation laboratory for Mac or IBM PCs. For a sample of the second *Black Hole* textbook send e-mail to Taylor. See also *Am. J Phys.,* **62**, April 1994, pg 292.

[4] The server at MSU was a VaX cluster running VMS 5.1

[5] This is a well know fact to Usenet newsgroups readers on the Internet.

full time day jobs, enrolling on the virtual classroom part time. Some people logged in at dawn, before the rest of their family got up; others used their lunch break to catch up with the latest on rotating black holes and then others worked after their children went to bed...

4 Inherent Difficulties

The main difficulty of such an electronic virtual classroom was the inability of the communication programme, CONFER, to convey synbols, mathematical equations and pictures. Very often formulas had to be typed in english and much of the symbolic elegance was lost in decoding such strangely looking material.

Argument simply made withthe aid of a sketch were impossible. References to outside material was done by the citation-cum-visit-to-the-local-library way.

5 Conclusions

It is shown that even with linear medium and inflexible medium as an electronic mailer programme, a meaningfull Virtual Classroom can be set up and succesfully function as instruction channel. With the pressing need for realistic continuing education programmes for working adults with families, the power of flexibile Virtual Classrooms becomes apparent. As the Web matures it presents itself as the prime medium for Distant Education programmes.

3 Interacting

The first week of the class students and instructor instoduced to each other, tested CONFER and agreed on the house rules. New material was to be assigned for study every week. A pre-assigned pair of students were responsible for making the initial "provocateur" posting of a Discussion Item, relevant to that week's material, early in the week. The rest of the class could start their own Discussion Items or simply to engage in an already started discussion.

Students were rewarded for each posting of an Item or for particiapting to a discussion, up to a maximum nunber of points per week. Experience showed that this incentive was redudant as students "got hooked"[5] early and became eager in participating.

Formal homework problems were assigned each week. These problems were collected, corrected and graded by the instructor. A student could deliver the homework by a private message on CONFER , by fax or by postal mail to the instructor. E-mail time stamp, fax arrival time and U.S. postmark were proof of delivery before the agreed deadline. Answers were distributed by bulletins; printed solutions accompanied the corrected homework, which mailed back to the students.

It is very interesting to note that most questions in Discussion Items were correctly answered by the students themselves. The instructor's role was very much along the Socratic tradition, answering a point by asking an appropriate question and then letting the student chorus to get the correct answer. Occasionally the instructor would post himself a Discussion Item on a point he thought to be important and overlooked by the students.

The material on a "closed" Discussion Item were on themselves made very interesting reading. Apart from containing a "question/puzzle" relating to the class material and its "answer/resolution", by studying them one could see clearly the collective thread of thought of the class as it struggled towards a solution.

Connection records showed that students logged in the server almost everyday. Total login hours per week per student averaged most than the typical traditional classroom sitting (4.5hrs). In addition to direct login students could transfer the Discussion Item material to their local machine, study it, compose answers and replies and then download them to CONFER.

It is very intersting to note that by studying the login records of individual students one could discover their work habits. Most students were holding

lacking access to an internet gateway could use a modem to call a toll free telephone number which in turn connected them to a terminal server at MSU. The cost of the toll-free telephone service was paid by the University, partially covered by the modest registration fee (150 USD) of the course. In addition to the free telephone connection, the course fee covered the cost of instruction material [3].

2 Connecting and Communicating

Participants in the course were issued user names and passwords in order to log in the server computer [4] at MSU. Upon connection to the server one invoked the main communication programme, called CONFER. In simple terms CONFER was an internal electronic mailer system serving the participants of the course.

To communicate with each other CONFER offered three venus: Bulletins, Private messages and Discussion Items.

- Bulletins were messages automatically sent to all the participants. Bulletins had a lifetime switch, by which the sender could assign a lifetime to the message. These messages were shown to each participant once automatically, but there were stored and accesible during their lifetimes. These bulletin messages were used as attention pointer and could not be answered.

- Private messages were canonical e-mail notes exchanged between users. Copies of a private message could be "cc" to other users too.

- Discussion Items were bulletin type messages with the possibility for reply. Responses to a discussion item were all kept in a folder and students could add material and review replies to a discussion item folder at all times. Discussion items were at the core of this virtual classroom.

In the course material a guide to the CONFER programme was included with tutorial and other navigational information for the beginner. The system was intuitive and user forgiving to make user of the programme manula unneseccary after ther first few sessions.

Virtual Classroom: A Case Study

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Abstract

The World Wide Web (WWW) will be used, no doubt, for Distant Education implementations of Virtual Classrooms. I report on the experience from an early computer linked virtual classroom. an advanced undregraduate course, *Topics in General Relativity*, offered in 1993 by the Montana State University at Bozeman, Montana, U.S.A. Instructor and students of the class were dispersed across the continental U.S. and comminucated with each other via the server computer located in Montana.I describe in detail the linking technique and the overall interaction procedure between students and instructor. I will address the special problems related to the communicating on such a system and point to the relevance -and superiority- of a Web server as the natural evolution of the Montana State system.

1 Introduction

During the Spring 1993 semester, the Extended Studies and Summer Session programme at the Montana State University (MSU) offered their second computer-linked distant learning course [1]. *Topics in General Relativity* (Phys 480) was an advance undegraduate level taught by Edwin F. Taylor [2] and built on the experience from MSU's first such course, *Special Relativity*, offered the previous semester.

The instructor of the class lived in Boston and the 14 students enrolled in the course were dispersed along eight States from coast to coast of the USA.

Students and instructor were all linked by a central server located in Bozeman, Montana. This server was accesible by Internet links. Students

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