Implementing a Math Course on the Internet: A Live Experiment

Par

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1. Introduction

Distance learning is based on educational models that vary according to the country (Henri and Kaye, 1985). In Quebec, the model adopted by the Centre collégial de formation à distance focuses on fully personalized learning. Students are provided with a set of educational documents (textbook and workbook) that enable them to progress on their own. They can phone a tutor who is available four hours a week, although they cannot contact students taking the same course. In other countries, notably in France, individual learning can be combined with team learning. Until recently, teamwork and team learning implied that learners had to travel when they wanted to get together. Distance teamwork was not conceivable before the advent of network computer technologies, especially telematics (Harasim, 1990; Hilz, 1988). In addition, Internet technology provides richer and more complete team learning than electronic mail or videoconferencing. It is also a complex environment, still unfamiliar and in constant evolution, that has to be explored and mastered as a learning environment. This is precisely what the RECTO/VERSO project proposes to do.

As part of the RECTO/VERSO project introduced by Rigault et al. at this congress, the Centre collégial de formation à distance (CCFD) du Collège d'enseignement général et professionnel (CEGEP) at Rosemont, Montréal, Canada, and the Centre Université Économie d'Éducation Permanente (CUEEP) de l'Université Science et Technologie de Lille (UST), in France, were given the mandate to re-engineer a pre-university level mathematics course in integral and differential calculus for the Internet. Work between the two teams is done at a distance, with the tools provided by the Internet, plus videoconferencing and more traditional tools, such as telephone and standard mail.

Distance collaborative work, as well as distance collaborative learning, with the tools available on the Internet, are relatively new fields of study. Results must be conceptualized from studies on team design of courses to be offered and developed on the Internet. There already exists a considerable amount of literature on collaborative

learning supported by technologies (CSCL), especially computer-assisted teleconferencing. In the fall of 1991, Southern Illinois University's Touch of Nature Environmental Center held a two-day workshop for a group of science specialists and practitioners on the emerging CSCL concept. In the spring of 1992, SIGCUE Outlook published a special issue titled "Computer Support for Collaborative Learning: Design, Theory, and Research Issues," covering the workshop's findings. Last fall, CSCL '95 was taking stock of this specific theme. Some of the papers (particularly those by Shotsberger, Smith, Spell and Stahl, Sumner and Repenning) referred to the Internet as a distance collaborative tool.

Following up on these studies, this paper proposes to single out the issues related to the design of a course within the RECTO/VERSO project, and to approach the issues from two different angles:

- Collaborative work by two teams from two different continents
- Collaborative work within the CCFD team

We shall also discuss the Internet's potential in relation to a distance course using this media.

2. Project context

The object of "Re-engineering a mathematics course" is the interteam design, for the Internet, of a course already offered through distance learning by two educational institutions. In their present form, both mathematics courses use the technologies in a limited way (print, mail, and telephone) at the CCFD, and in a non-integrated and rather juxtaposed way (video documents, locally developed software, and printed notes) at the CUEEP.

2.1. Differences in physical organization

The institutions within which the teams work are distinct. The CUEEP team operates within a university framework and has a research, technical, and computer resources laboratory on the premises, whereas the CCFD team operates in a distance-learning course production center, administratively linked to, but physically remote from, a general and vocational education college. The project supervisor and the supervisor of content specialists (the authors of the courses) are the only regular members of the Centre's personnel; the other members are working under contract for a specific term. The CCFD is developing its technological infrastructure. A computer analyst from the CEGEP spends two days a week at the Centre implementing the various technologies.

The situation at the CCFD has led the Centre to jokingly call its team "the flying team." The members are scattered, and they only meet about once a month, which has brought the internal team to resort to distance collaborative work and to equip itself

accordingly. As will be seen, implementing common tools has posed a number of problems.

2.2. Team membership

Both teams include five people. The CCFD team includes two content specialists (the authors of the existing course), an educational technology computer specialist, a distance-learning technology specialist, and a project supervisor. A programmer-computer graphics artist will join the team at a later stage. The CUEEP team includes content specialists, a person in charge of multimedia pedagogical production, a specialist in network communication, and a project supervisor.

2.3 Collaborative distance learning tools

Tool implementation was achieved concurrently with the teams' work in the project. In September 1995, both teams already had e-mail on Eudora, the Netscape navigator on the Web, and a Listserv operated by the UST at Lille, linking all the RECTO/VERSO partners for communications related to the participants as a whole. Microsoft's word-processing software Word 6.0 was also available.

At the CCFD, access to the Internet, originally provided by an ordinary telephone line, was changed to an Integrated Services Digital Network (ISDN) link; this has enabled us to gradually create an File Transfer Protocol (FTP) site for software exchange. We have also set up a workstation videoconferencing system.

Last fall, the UST at Lille also set up a group videoconferencing system. In addition, they have a private World Wide Web (WWW) server that may be used by the CCFD team to try out developed and on-line products.

3. Preliminary findings

Although the project is still in the initial stage, a certain number of results are emerging in regard to collaborative work and to the design of a course using the Internet. However, definite results cannot yet be estimated; the other teams involved in the RECTO/VERSO project have been given the mandate to systematize and conceptualize the distance-learning collaborative work and the engineering and re-engineering of the courses on the Internet. Only then will comparisons between results achieved by the different teams become possible.

3.1. Analysis of collaborative work

We have examined collaborative work from two angles: course re-engineering processes and the questions posed by this type of work.

3.1.1 Processes involved in the collaborative re-engineering of a course

For our analysis of the process for re-engineering the mathematics course, we have singled out two types of collaborative work: work shared by both teams (CUEEP and CCFD), and work done locally, within each team. For identification purposes, we have called the first type "interteam work" and the second type "intrateam work." It will be seen that the latter was involved in the actual course design process.

The following diagrams show a preliminary modeling of the interactions and correlations between the processes, actors and inputs/outputs (i.e. documents, software, and data processing tools or equipment) of collaborative work in re-engineering of the math course; the object of the modeling is to systematize the follow up of the process for future analysis and comparison between projects.

The following symbols are used:

- An oval for a process or subprocess
- A lozenge for an actor
- A square for an input or output

Relationships between figures are represented by arrows with a letter across them that identifies the relationship:

- Letter C expresses a composition relationship between process and subprocess. It means that the source process is made up of the subprocesses linked to it.
- Letter R indicates which actor controls a given process or subprocess.
- Letter I indicates which documents, software, tools, or equipment act at the onset of a process or subprocess to effect the transformation that is apparent in the process (or subprocess) output.
- Letter S identifies an example of outputs or inputs.

The diagrams show in detail the interteam work and the work involved in designing the educational specifications.

The programming subprocess leading to the design of a prototype is not included in diagram 2, since it has not yet been initiated.
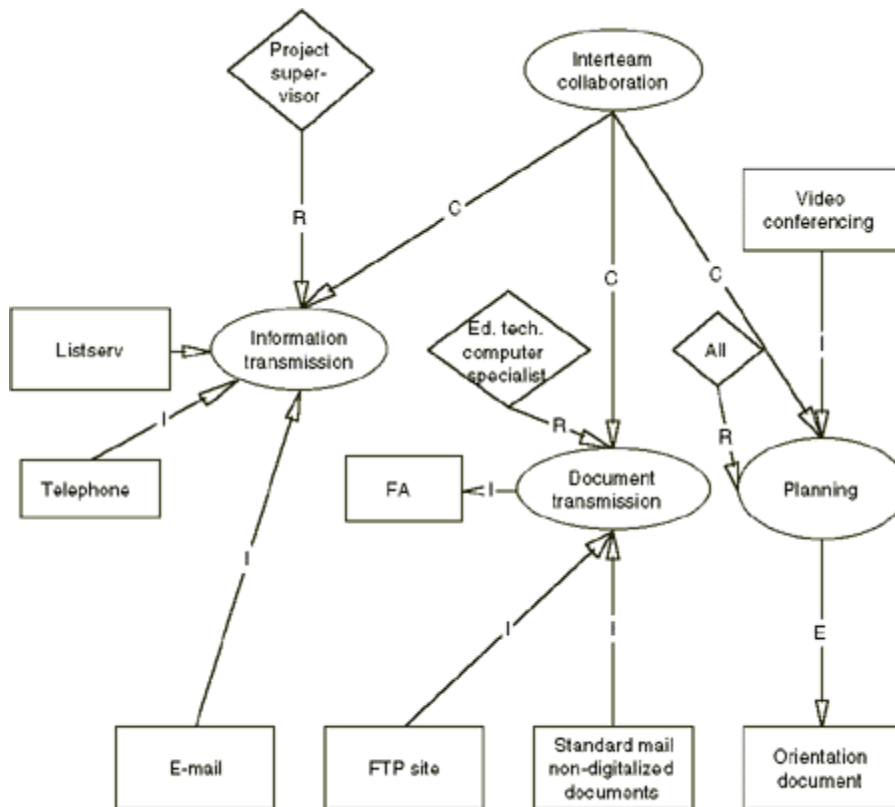
Diagram 1: Detailed interteam collaboration

The diagrams specifically relate to the collaborative work. Diagram 1 shows the tasks that are performed through collaboration (information transmission, document transmission, and planning). One can also see who were the performers of these tasks, what tools were used and what documents were produced through collaborative efforts. The interteam collaborative work started in the summer of 1995 and went on until January, 1996. It has enabled both teams to understand the philosophy and practices of each of the institutions as to distance learning, to set common goals, to assess the complementary nature of the approaches and of the existing materials, and to agree as to which contents needed reworking. Following a videoconference held shortly before Christmas, the CCFD issued an orientation document outlining the project's future accomplishments.
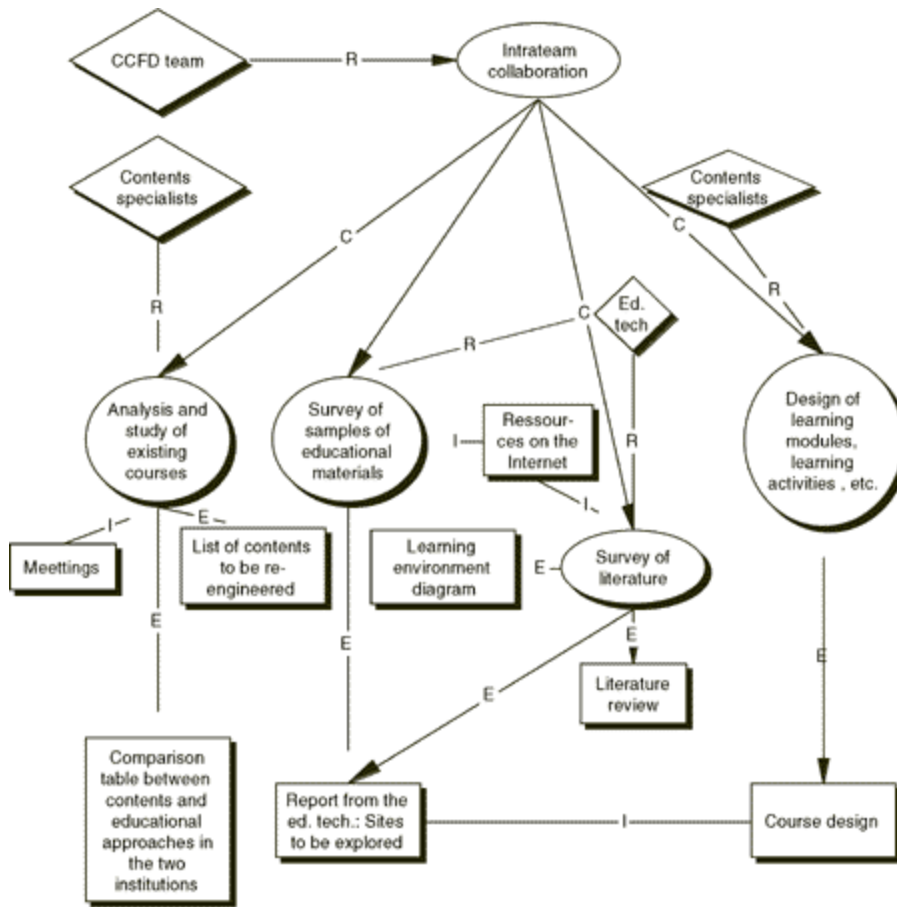
Diagram 2: Detailed intrateam collaboration process

Diagram 2 shows how the actual course specifications design work for the yet uncompleted course was basically due to CCFD's intrateam work. It shows the subprocesses involved (study and analysis of prior courses, study of educational material samples, review of literature, design of learning modules and educational activities, and programming). As with the previous diagram, actors involved in the processes, implementation tools and resulting outputs are identified.

3.1.2 Questions set by collaborative work

A number of questions have come up regarding both interteam and intrateam work. We have tentatively classified these problems into six main categories, to be revised in the light of our increasing experience with distance collaborative work.

A. Problems with mastering the tools

Due to the importance of the tools used, mastering them technically and functionally sets a problem. Other researchers (Cerratto and Belisle, 1995) have referred to this issue. The first tool used, e-mail, causes some problems: users have to find the attached

documents and retrieve them in a readable format regardless of the software used in encoding them and the platform they were created on.

Users also have to cope with the asynchrony and lack of interactivity of written conversation, which are relative when compared to other media such as mail, but obvious when compared to the telephone. In addition, conversation is subject to the delay in responding to messages. We have also found that it is better not to ask multiple questions in one single message, and that it is wise, for the efficiency's sake, to have the other party's last message in front of us when replying.

Mastering the other Internet resources also has its problems; we shall deal with them under information retrieval methodology.

B. Delays in tool installation

Preliminary research, evaluation, and comparison between systems before making choices take up valuable time and resources and delay tool implementation. Our videoconferencing system, for instance, was not operational until mid-February. For the December videoconference, privately supplied equipment had to be used. Still missing is the discussion forum included in the initial infrastructure plans.

There were extensive delays in the installation of tools for the CCFD'S team members. We were so busy setting up the interteam collaboration equipment, that we failed to meet our internal team's minimal requirements. Some of the tools used for our interteam communications should have been available from the project's initial stage. Of course, more extensive use was made of telephone conversations and meetings.

E-mail between all members was not effective until March. Content specialists were only recently given home access to the Internet. They are presently getting used to this tool and can now partly analyze the sites at their convenience.

C. Unexplained loss of messages

It seems that some messages to Lille went astray without our knowing it. Analyzing our e-mail server did not elicit any information on the subject. We decided to ask our correspondents to send a confirmation as soon as they received a message, to make up for the absence of the receipt notification function available with other e-mail systems.

D. The need for frequent exchanges

Exchanges between both teams were deemed inadequate by all CUEEP members. According to the content specialists, for instance, document exchanges and communications related to educational approaches were interesting and instructive, but too inadequate to be useful.

E. The need to find an information retrieval methodology

Finding relevant information on the Internet is a time- and energy-consuming process. At the initial stage, the education technologist, who acted as an advisor to content specialists by showing them examples of possible developments and experiments, was overwhelmed by the wealth of Internet resources on mathematics. In addition, to view the selected resources, one frequently had to download all kinds of utilities or acquire other software. The CCFD, for instance, purchased and installed Mathematica and Mapple; this software enables content specialists to view the applications developed with it and to use it as a guide. The technologist worked at this on both Mac and PC platforms, to provide specialists with the largest possible number of examples.

F. The need to share

Due to its constant development, the Internet's actual technological potential is hard to assess. What was incredible only a few months ago is now possible. Users have to keep abreast of the latest developments by reading specialized magazines and journals and joining trendy networks, and through local experimentation. In these times of scarcity of resources, one has to learn to work with other teams and to share experiences. Sharing includes allocating work and pooling results.

Now more than ever, with projects such as RECTO/VERSO, one of the main keys to success is collaborative work.

Examining the concept of collaboration, whether it is interteam or intrateam, is important for the RECTO/VERSO project because it aims at exploring the potential of distance learning, a promising but still unfamiliar technology. We must look into it, if we are to create models that will bring out its full potential. We will conclude our paper with some reflections on this topic.

3.2 The Internet's potential with regard to designing a distance-learning course

Our design process throughout the project centered on two components: a systematic development approach and an analysis of the proposed learning environment.

3.2.1 A systematic development approach

The analysis of the collaborative work as modeled under 3.1.1 brought out the influence of computer science; the course design is based on the type of systematic methodology advocated by educational technology. In this methodology, emphasis is laid on media selection and production specifications design.

A selected part of the subject matter was targeted for re-engineering, partly because the concepts dealt with were hard to comprehend. It was also agreed that different

approaches would be used in surveying the subject matter, to respect the cognitive style of a heterogeneous clientele. From there, content specialists meticulously analyzed and restructured the subject matter according to the new goals.

Meanwhile, the educational technologist looked for relevant educational material and existing courses on the Internet, as well as reviewing literature pertaining to distance collaborative learning, in order to feed the team for the media selection stage. The analysis of this rather substantial material enabled us to design detailed educational patterns for educational material production.

3.2.2 An analysis of the proposed learning environment

It appears, as confirmed by Stahl et al. (1995), that the Internet learning environment could prove relevant for the educator as well as for the learner. In addition, we have addressed it using a constructivist approach of the teaching-learning process, in which the educator and the learner are active agents in their respective progress. They build up their knowledge from the knowledge already established and organized in their mental structures during prior learning (Wilson, 1996). This implies, as stated by Kaye (1993), that information and communication technologists must go beyond the mere transmission of contents to aim at improving interpersonal communication and distance-collaborative learning. Based on this, we have singled out three distinct workspaces. They meet the needs of both learners and designers, according to the different parts played by the former in their learning process and by the latter in their course design process. It would appear, however, that these workspaces partly overlap.

The proposed environment includes three distinct workspaces:

- A *presentation* workspace corresponding to a *consultation* function. This space refers to the media through which the subject matter is transmitted to the learner.
- A *production* workspace correlating with a *consultation* function. This space includes educational activities aimed at promoting acquisition or deeper understanding of the subject matter through assignments or exercises, or at assessing the learner's knowledge.
- A *communication* workspace corresponding to a *learner-support* function. This space includes all exchange activities between the teacher-tutor and the learners, on educational issues and on matters related to the course's progress; it also includes exchanges between learners.
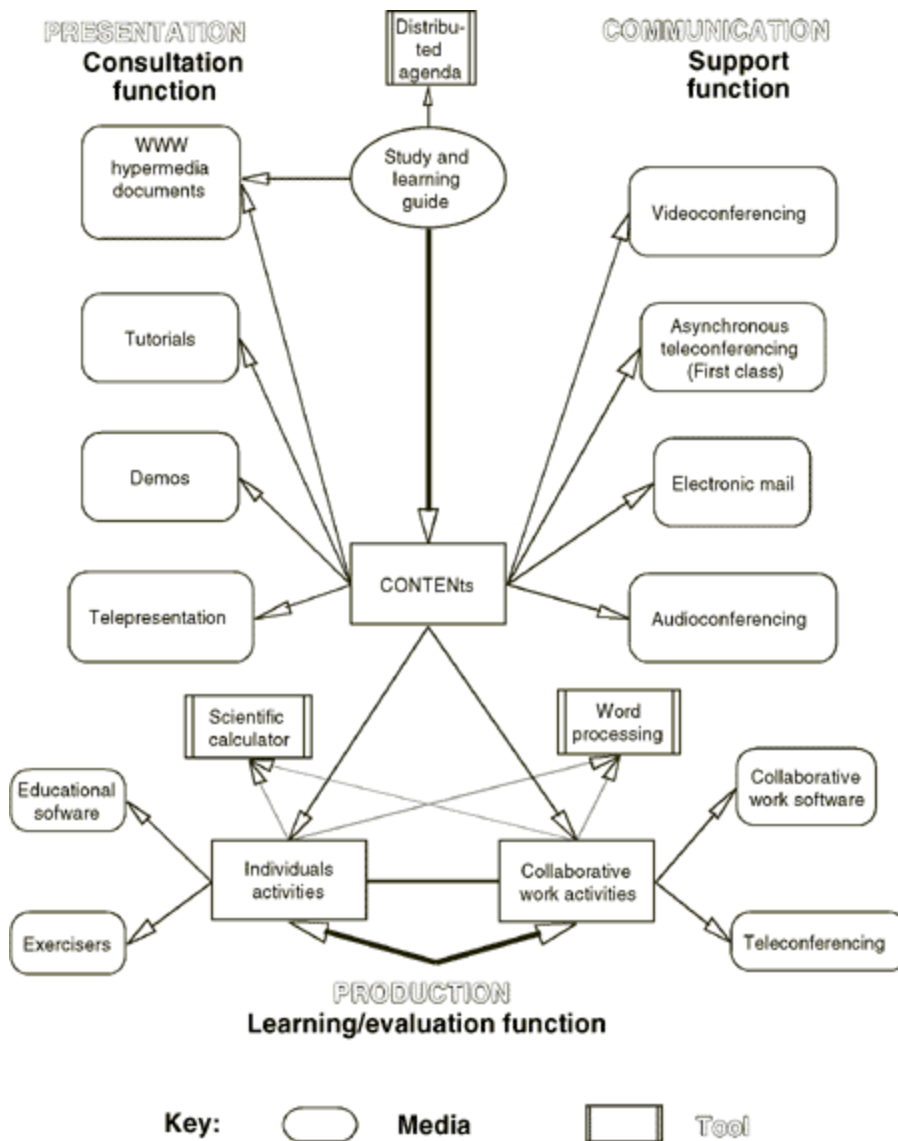
Diagram 3: Internet learning environment

Diagram 3 shows the integration of these three workspaces as the learning environment adopted for the mathematics course. The different components of the mathematics course on the Internet will be developed on the basis of this environment.

4. Conclusion

With the Internet, resources can be shared and skills can be traded on a global scale, making it an extremely powerful learning environment. It is also an extremely complex environment, subject to technical hazards and to other hazards due to users' inexperience in the field. It is estimated that most of the technical hazards will shortly be eliminated, but hazards due to inexperience will most likely call for an extensive research program. Projects such as RECTO/VERSO are participants in this program.

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