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Ideas for Telelearning: WWW, Virtual Classroom & Cyberversity

Anupam Joshi

Elias N. Houstis
Purdue University, enh@cs.purdue.edu

Sanjiva Weerawarana

Mikhail Attallah

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Anupam Joshi
Elias N. Houstis
Sanjiva Weerawarana
Mikhail Atallah

Department of Computer Science
Purdue University
West Lafayette, IN 47907

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Anupam Joshi, Elias Houstis, Sanjiva Weerawarana and Mikhail Atallah
Department of Computer Sciences
Purdue University
West Lafayette, IN 47907-1398

1 Instructional Approaches, Strategies and Materials

We are witnessing the start of a revolution in information technology that has the potential to impact the form and structure of the University beyond anything we can currently imagine. The existing Global Information Infrastructure (GII, Fig. 1), with a vast, interconnected network of networks (Internet) and software(e.g. NCSA Mosaic, Netscape, Arena) that efficiently exploits it, has already impacted many facets of our life. The way we disseminate information, conduct business, manage personal activities, and search for knowledge and information are undergoing profound changes. This technology and its future evolution has the potential of making **telelearning** the new educational paradigm at local (within a given institution) and global(nation wide, even world wide) levels. In the future, universities will advertise and offer telecourses via the internet and customers (students) will choose the "best" telecourse in the educational market place without considering the geographic location where the course originates. Telelearning can be used to support existing classrooms, for continuing education, retraining high school teachers and supporting the Virtual Purdue University (VPU) in the global cyberspace. The potential for VPU is enormous. We feel that Purdue University, and School of Science in particular with its large base of service courses, should explore seriously and immediately this coming revolution. This concept note is a step forward in this direction. It outlines a possible first step which will allow us to experiment with the concept of telelearning and create a prototype. However, significant resources will be needed to realize the concept fully. The following tasks seem to be logical first steps:

1. Develop the software environment of the virtual classroom. This classroom will support the class-on-demand concept. The software environment will be WWW based. A related effort, which combines ubiquitous and High performance computing to create a classroom of the future, is already supported by AT&T, Intel, School of Science, NSF, and the Department of Computer Science.

2. Develop course material for a basic programming course which is language independent and supplemented by tutorials in several imperative languages (C, C++, Pascal, FORTRAN90).

3. Offer a small section of this course (up to 50 students) and measure its effectiveness. The department of CS has already committed a TA for this class.

4. Experiment with the exam-on-demand concept where students are allowed to take many examination on the subject until they achieve their grade goal. This can be easily done in the context of the virtual classroom.

Introductory classes in various subject areas tend to be very large (500-1000 strength). Such classes (e.g. Introduction to Programming in CS) are often reduced to didactic slide shows, with little *classroom* like feeling of one on one interaction with the instructor. This is tolerated since these classes are meant to provide basic, often straight factual knowledge of a subject area to the students. We foresee that in the future, such classes will be replaced by virtual classes, running on a *class-on-demand* server. This server will be accessible via the GII, and will be a part of what has been variously described as an *infosphere* or *docuverse*. The World Wide Web represents the initial phase of this phenomenon. Students, regardless of their geographic location, will be able to access lecture materials. These materials will be more than just

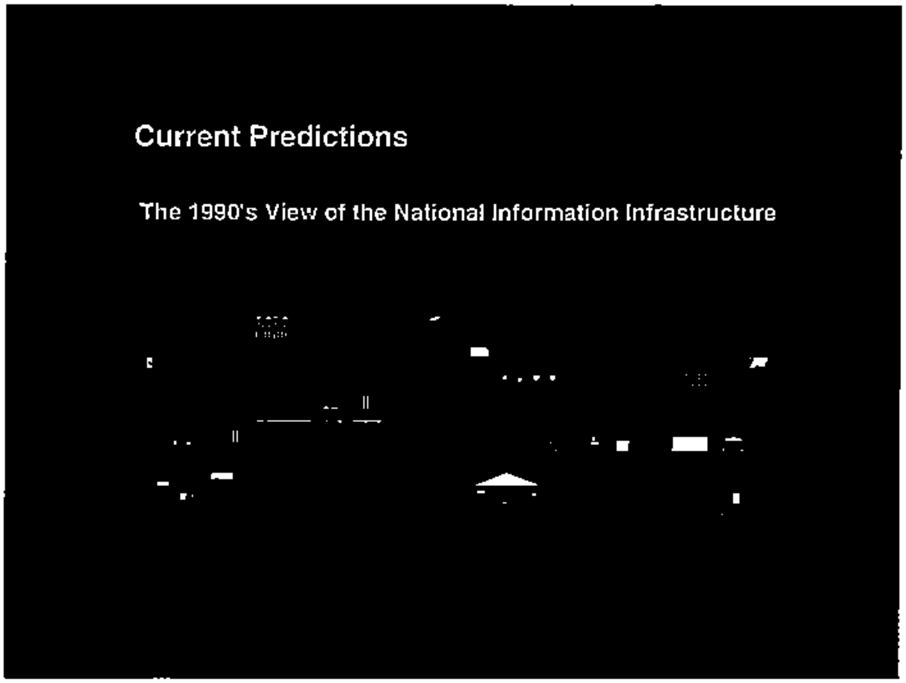

Figure 1: A Predicted Scenario for the Global Information Infrastructure

plain slides, they will be full multimedia presentations. Multilevel hypertext will be used to point students to related and reference material.

To demonstrate the virtual classroom concept, we should develop such material for an introductory programming course. Rather than teach a particular language, we should design the course to teach students the basics of structured programming in imperative languages. In parallel, we should develop examples, tutorial materials, exam questions and projects in several imperative languages. Thus a student will be able to customize the course content she gets. In other words, while Joe would be registered for the class to learn Fortran 90, Jill would be learning C in the same class.

While it may appear that we are seeking to replace the instructor, that is not really the case. We merely free the instructor from the drudgery of regurgitating introductory material in front of a large class with limited or no interaction. This will leave her free to have greater one on one contact with the students outside the class.

Another innovation of this virtual classroom would be the *exam on demand* concept. The idea of most introductory courses is to allow students to acquire basic proficiency in the course material. Yet in a conventional class, we judge the students on his performance at prespecified exam times. We feel that for such introductory classes, the instructors should prepare a large *question bank*. An exam can be composed when desired by automatically and appropriately selecting questions in this bank. Students should be allowed as many exams as they want (within a given time-frame, say a semester) to demonstrate proficiency in the material and be judged accordingly.

Besides developing the courseware for a specific class, we would aim to develop the software environment which will be used to run the virtual classroom over the internet and link it to the web. The software for this application will be based on the electronic notebook concept. This concept is an attempt to emulate the physical notebook that we use ubiquitously. The pen-and-paper physical notebook allows us to write down related or unrelated information in any form we like and to use auxiliary tools (for example, calculators) to augment its usability. The electronic version of this provides an unrestricted editing environment where users can record their activities including problem and solution specifications, computed solutions, results of various analyses, commentary text, graphics and (handwritten) annotations. The notebook interface ideally is multimodal and synergetic; it integrates text, handwriting, graphics, audio and video in its input and output modes. It functions not only as a central recording mechanism, it also acts as the access mechanism for all the tools that support the user's problem solving activities. The electronic version of the notebook is

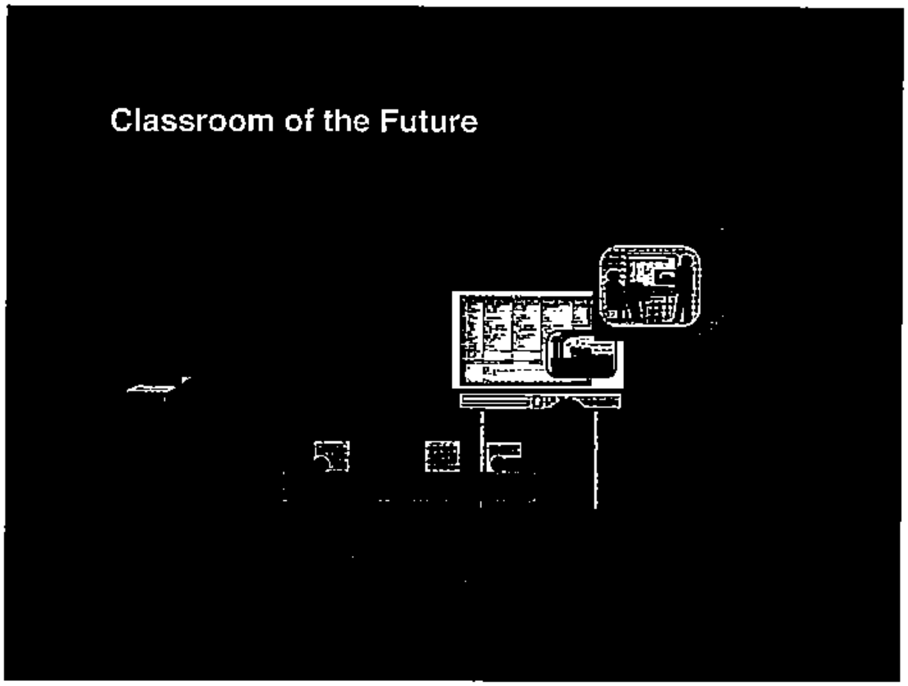

Figure 2: The Virtual Classroom

therefore a "super notebook" when compared to the physical one. It can be viewed as a unifying interface for a collection of software (or other) tools that are needed to define, solve and analyze some problem.

Given this background, we think that the student's software environment should have the following properties:

- Integrated view of information access and computation
- Multimedia/multimodal:
- Ability to access different tools:
- Ability to share information between disparate systems:
- Input/output reuse:
- Customizability:

A preliminary design of such a notebook has been done by Joshi & Weerawarana, and a NCSA Mosaic based preliminary implementation has been put together by Weerawarana as a proof of concept. We will build an augmented version of NCSA Mosaic that supports the functionality listed above and also build a specific WWW service that offers telecourses over the web. We will also use the software infrastructure that is already available as a part of the World Wide Web, as well as other software that is bound to come out from the Commercial world

2 Expected Outcomes

This project will allow us to demonstrate the effective use of this new technology in learning, and prepare a prototype implementation. It will also serve to make the administration, both at the school of science and university levels, see the impact this technology will have and better prepare for it. Specifically, we expect that the virtual classroom will result in

1. Improved learning: The *programmed educational modules* that will have to be built for this project will have many other advantages, including the following:

(a) They will make possible an educational approach based on a finer granularity than the usual "course-based" traditional one: *Customized knowledge*, the kind of knowledge "a la carte" that might appeal to busy executives or engineers who might want to come to Purdue with the specific goal of promptly acquiring what one could call a *nugget* of very specific knowledge (say, on X). The availability of programmed modules to both help impart and certify the specific knowledge on X, can act as an attraction for many working professionals who are otherwise too busy to leave their job for too long, and are really only interested in learning about X or in certifying their present expertise in X. An individual who is already an expert on X without having formal training in X could be attracted by the availability of a certification process.

(b) They will make possible, at little extra cost, a *certificates program* for our students, whose rationale we develop next. A Master's degree, together with a listing of the courses and grades of a student, provides valuable information to a prospective employer, but that might not be enough in the following sense: A student might have achieved extensive proficiency outside of the formal framework of courses and degrees (by individually studying a topic, or learning about it through involvement in a particular project, or perhaps by gaining the experience during the student's previous industrial employment). It would be desirable for us to have a way of certifying the proficiency of a student in such a specialized topic as networking, or software testing, or computer security. However, the human resources needed for administering such a *Certificates Program* would be exorbitant. The answer is to automate the process by using programmed modules for doing the job, through the use of the proposed interactive technology. In fact, our educational modules would probably be "exportable" to other educational institutions, since this need certainly exists on a national scale.

(c) They will be much better than traditional approaches at *accommodating special educational needs* (learning disabilities, etc). We noted above that the *type* of knowledge acquired or certified becomes more customized with the availability of the programmed educational modules. Equally importantly, the *pace* at which the knowledge is acquired or tested becomes also customized, an important advantage in view of the wide disparity in learning styles and abilities found among the students of a typical classroom.

2. Improved teaching: The techniques developed here will facilitate the use of state–of–the–art multimedia and hypermedia resources for teaching. Subjects like programming language involve using dynamic objects like programs for examples. Our software environment will allow instructors to embed programs within the presentation. Moreover, by allowing courses to be tailored, they will remove the need to offer multiple specialized courses dealing with the same subject matter. Currently, for instance, the CS departments offers 8 courses (110, 110P, 110M, 110N, 145, 150, 180, 190A) to teach introductory courses to students with different majors and in different imperative languages. With our approach, this could be combined into one (or perhaps two) courses, which students could customize based on what requirements are imposed by their major and/or personal interests. This would free up faculty members to have greater one on one interaction with the students in the time they would have otherwise spent in front of multiple sections repeating material that was quite similar.

3. Exam–on–demand: This concept will go a long way in removing the dependence of grade on exam taking skills of a student, and potentially provide a truer measure of accomplishment. It will also motivate the students to continuously strive to improve, knowing that they can always retake any exam they have not done well on. Students often tend to loose interest in a course if they don't do well in one of the early exams, our approach will avoid that. Moreover, it will provide students with the ability to test out if they can go through and learn the material faster than their classmates.

3 Evaluation of the approach

We propose to evaluate this approach on one of the introductory programming courses offered by the CS department. We can run one section of this course via the virtual classroom. This section will have a dedicated Teaching assistant to answer student questions and grade exams etc. Other section(s) of the course will continue to follow the conventional approach. Two strategies can be used to measure the effectiveness of this technique:

- Student responses: During various points in the semester, students will be asked to give their comments and suggestions. This (subjective) qualitative feedback will be used to judge the student response, as well as iteratively improve the courseware and software environment.

- Comparative study: We will compare the performance of the students using the virtual classroom (test set) with those studying in the conventional manner (control set). The grades obtained by the students (overall and on specific exams/projects), the change in GPA and other similar indicators will be used as quantitative measures. Careful design will be required to chose appropriate indices, and two(multi) factor analysis will be needed to appropriately judge the result.