Different Roles the Web Can Play
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INTRODUCTION

Much work has been done to incorporate the World Wide Web into classroom life by using it as an information resource or by using it as a medium for long distance collaborative learning (WWW Virtual Library). In our courses we[*] were interested in using the web to replace some of the routine activities of any individual course. We will describe the structures and goals of the three courses, discuss the different roles the web played, and note some lessons that we felt we learned for future web-based course work. Though the Web has developed significantly since we taught these courses, we believe that the basic forms of interaction have not changed.

THE COURSES

Story: Representation and Process was an undergraduate core course in the MIT Media Lab. Students analyzed narrative structure in hypertexts, images, film, and television and learned the basics of how to manipulate each medium along the way. Professors Ken Haase and Glorianna Davenport taught this class with the author as teaching assistant. There were 16 students. Only one or two of the students had ever written a web page before beginning the class, though most of them had used the web. The course was taught in the fall of 1994, when the web was still relatively new, and the concept of "homepage" was just emerging. The main web browser was NCSA Mosaic.

Story was a project-based course; participants met twice a week for one-hour lectures, one hour per week with the author for questions, and outside of class for longer project presentation sessions. The main four projects of the course were building a narrative hypertext (a web-based narrative that took advantage of hypertext in its structure), using digital video editing software to create a short and long movie trailer (preview), exploring how a single composite image can represent a video narrative, and creating a prototype of an "intelligent" TV remote-control (e.g. one with a button labeled, "Skip to the next action scene").

Throughout the course, we asked students to keep design journals of their projects on the course web site and to build pages that presented each project. One of our goals was to explore how the web might complement this traditional project-based course, and to see whether students might benefit from the web "portfolio" that they would accumulate by the end of the course.

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[*] The use of "we" throughout the paper refers to the author as well as to the faculty who designed and taught the courses described below: MIT Media Lab Professors Ken Haase and Glorianna Davenport in *Story*, MIT Media Lab Professors Mitchel Resnick, Matthew Brand, and Justine Cassell in *Tools for Thought*, and Brain and Cognitive Sciences Professor Steven Pinker in *Introduction to Psychology*.

Tools for Thought was also a project-based course in the MIT Media Lab undergraduate core curriculum. This course focused on the type of knowledge that is embodied in "tools" that we use to interact with the various systems throughout our lives. Systems included the physical world (in which we use tools like hammers and toasters), the domain of complex systems (in which we use simple generalizations to understand a situation that contains thousands of variables, like traffic patterns), and the domain of language (in which we use a set of common assumptions to understand people). This class was taught by Professors Mitchel Resnick, Matthew Brand, and Justine Cassell, with the author as teaching assistant. There were 14 students. By the time of the course, Spring 1995, most students had some previous experience with writing web pages. Netscape, with its more flexible page-layout abilities, became popular during our course. The home page for this class may still be at http://mas123.www.media.mit.edu/courses/mas123/.

Tools for Thought met twice a week for one and a half hours. This time was used both for lectures and for project presentations. Sometimes the lecture itself would include a quick 30-minute project. The project assignments included: to use a "toy" construction set of some sort (e.g. Legos, Erector set, Tinkertoys, wooden blocks, etc.) to build a device which performs a mathematical calculation, to use Starlogo software and some computerized Legos to build a "creature" that would exhibit several animal behaviors, to use language-processing software to build a computer agent that could hold a reasonable conversation within a very restricted behavior context (e.g. ordering in a restaurant, flirting at a party), and to turn the classroom into a museum exhibit on a certain theme. Most projects were done in groups of three or four, though we required design journals of each student. For the final museum project, there were two larger work groups.

Two main goals for web use in the courses were to encourage more sharing of ideas by having student presentations readable by all the students online and to encourage better integration of the course material throughout the semester by having all past projects easily accessible. Thus, all student projects were "turned in" on the web. Although project presentations were usually presented live in front of the class, they were recorded with video or photograph and then archived on the web afterwards. As in *Story*, students kept design journals online, and final project grades were based on their live presentation, the web presentation, and their journal. To encourage students to explore other students' work on the course web site, we asked them to add hyperlinks in their design journals to related work of other students.

Introduction to Psychology was the standard core course offered in MIT's Department of Brain and Cognitive Sciences, taught by Professor Steven Pinker. In the fall of 1996, there were 298 students, and the author served as the chief teaching assistant, coordinating 13 other assistants. The course was a traditional lecture course, meeting twice a week for one-and-a-half hour lectures, and once a week for one hour in sections of 12 students and a teaching assistant. Grading was based on a series of three research papers and on a midterm and final exam, all completed on traditional pencil and paper. Our hope was that the web would provide an administrative and time-saving role, making handouts, assignments, and course news available

24 hours a day. The web site for this course may still be available on the Brain and Cognitive Sciences Department web site at http://web-bcs.mit.edu.

DIFFERENT ROLES

We have considered various ways of analyzing the effects of web use in our courses. In "The Web as Student Communication Medium" (Gilbert, 1996) we discussed web use in terms of "information flow", i.e. whether communication occurred in one direction or more. Instead of using this more abstract framework, we now described the web interactions in terms of how they complement or imitate behaviors that already go on in a typical classroom. We will discuss various roles that the web played in the three courses: administrative, podium, poster, report, class reference collection, teacher critiques, and showcase exhibit.

Administrative
The web played an administrative role by providing some of the information that we would have otherwise spent more time on in class. It allowed us to make handouts and assignments available any time for students who may have lost them or missed class (quite important in *Intro Psych*). Early on in *Tools for Thought*, the web provided a way for us to anticipate the number of students who would arrive on the first day of class and their backgrounds; we had a "introduce yourself" web form that we asked students to fill out before they arrived. The most popular use of the web among the students (according to web server logs of hits) was the "What's New" link that we had on the home pages of *Tools for Thought* and *Intro Psych*. Students could click on this link and jump to a page that was updated before every class meeting. It would remind them of upcoming deadlines, point to our current place in the syllabus, etc.

Podium
By "podium role" we mean that the web played the same role as a teacher lecturing from a podium: it offered educational content in the traditional one-way fashion, teacher-to-learner. Some of our assigned readings were available only online, for example. Also faculty sometimes put their own lecture notes online. MIT Mechanical Engineering professor David Wallace has taken advantage of this role more recently by reformatting entire lectures for the web, telling students to study it on their own time, and using class time to facilitate rich collaborative demonstrations or laboratory projects (Wallace & Mutooni, 1997; Wallace & Weiner 1998).

Poster
To understand the poster role, imagine a poster about the solar system in an 8th grade science classroom. This poster might contain much more information than the teacher really expects the students to learn; it was really placed there to arouse their curiosity and excite them about the material. The web is quite good at this role, since one can so easily link to related sites. On our *Intro Psych* home page, for example, we offered a section of "Related Resources" which included links to animated psychology demonstrations created by other schools' psychology departments. In the two project-based

classes, in which students were creating web pages, we could offer links to graphic design guidelines and examples of good design.

Report/Essay
The students in the two project-based classes turned in all project reports and sections of their design journals on the web. Using a scanner and a digital camera, students could take advantage of the ease of adding images to web pages (See Figure 1 for an example from *Tools for Thought*). A few students also took advantage of the hypertext abilities on the web to link tangential comments to the main body of the report.

Some faculty wondered whether putting all reports on the web brought up issues of student privacy. Students who are used to project-based courses do not seem to consider their work as private as do students who might be used to writing term papers that only the professor reads. Certainly if there had been problem-sets, in which there were a set of correct answers, as in science or math, we would have considered it invasive to post everyone's solutions on the web, possibly embarrassing those who were unsuccessful. We hoped that making the students' work easily accessible to their peers would motivate them towards higher quality, but we found that students often didn't even look at fellow students' pages unless word had gotten around that a certain page was particularly impressive.

While I was tracing all these circles, <u>Chris</u> had an idea which exploited the gear principle. If two gears are connected, then turning the larger one at a constant rate will cause the smaller one to spin at a constant rate that is proportional to the ratio of the sizes of the gears. <u>Chris</u> had the idea to use a tire and a pulley, connected by a rubber band, to divide the length of an input string by the ratio of the pulley to the tire. It eventually worked and after some tweaking, it was stable.
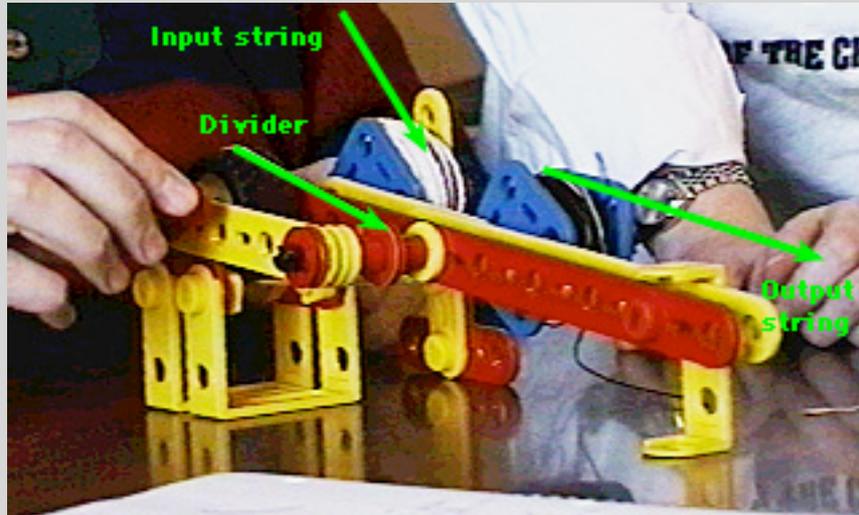
Image credit: Rajiv Manglani

Figure 1: Excerpt of a report on a calculating device the students built from an Erector set. The underlined words are links to the design journal of another student in the work group.

Class Reference Collection

Because students put so much of their own writing online, these documents became, in effect, a collection of references that students could cite later on in the course (See Figure 2). To enable students to link directly to the relevant paragraph in another student's document, we asked that they include the appropriate "name" tags in the HTML so that each paragraph could be referred to individually.

...It seems that the exploratory stage used by many of the groups led directly into a decomposition-type of solution. (<u>Jeff</u>) pointed out that ..."we didn't know we were going to construct this device until the concept manifested itself from seemingly non-connected parts." (<u>Matt</u>) notes that "as apparently useless as they seemed on their own, these (the smaller individual constructions) would eventually become the building blocks for the machine." I find this aspect very interesting as it is typically assumed, and was noted by (<u>Neil</u>) that we can't build a tool unless we know what we're building first. ...

Figure 2: An example of web enabling a class reference collection; a student links directly to other students' online work.

Teacher Critiques

The web allowed faculty to create summary critiques of a project more easily than ever before. Because all student work was online, a faculty member could create a web page for a project that commented on each student's approach to the project and linked directly to relevant parts of the students' work. Figure 3 shows a re-created excerpt of such a page. The Covisualization Project at Northwestern University reports similar interactions between students and teachers using their Collaboratory Notebook software (Edelson & O'Neill, 1994). Because the web does not allow easy annotation or "marking up" of web pages, however, some faculty were frustrated because they could not make notes on the reports directly. They preferred to print out the web sites and comment on the hard copy.

Interesting themes in your toy analyses
(I've put an occasional summary, edit or response of mine in [*brackets*].)

Melanie Jones (action figure transformer/drama stage)
- [*toys for storytelling...make reference to known narratives (movies)...serve as mnemonics for specific scenes in the movie...allow the child to work out alternative plot lines*]
- Very important is the idea of an ENCLOSED world, a complete world in miniature. This is a finite space over which the child has complete control.
- These toys are particularly clever because they took this idea of an enclosed world and made it LITERAL. The child can actually close up their world with the characters inside and carry it (or wear it like a necklace). There's a definite feeling of satisfaction and control to that.

Max Robertson (tensegrity construction kit)
- provides a concrete illustration of these two fundamental physical principles...building with it, children (and adults) can actually feel the forces acting [*and becoming part of the structure's dynamic equilibrium*].
- kinesthetic understanding of structures

Figure 3: An example of an online teacher critique; Professor Matt Brand summarizes student responses by quoting and linking directly to them on a web page (student names changed).

Showcase Exhibit

By the term "showcase" we mean literally the glass showcases that one might see in a school hallway, full of student work. In the project-based courses, we hoped that collecting the students' work online would both provide a portfolio of work for them and create a gallery of role models for students in following years. The two museum projects done at the end of the *Tools for Thought* course provide particularly good examples of this. The assignment was to bring interactive presentations into the classroom that illustrated a theme by demonstrating different representations of it. We encouraged the students to be aware of how the physical placement of presentations in the room would lead visitors through the exhibit. We hoped this project would prepare them for later producing interactive multimedia experiences that must accommodate different users' paths through the software.

The final aspect of the museum assignment was to create a web site that would represent the exhibit. Unfortunately, because the web at that time allowed only static text and images with little interaction, the web sites paled in comparison to experiencing the actual exhibits, which were quite impressive. The two themes were "mathematical integration" and "time". The Time exhibit featured presentations such as "Time and the Environment," "Representing Time," and "Discrete vs. Continuous Time." The "Six Degrees of Integration" exhibit featured presentations such as "Integration with LOGO," "Mechanical Integrators," and "Gestural Integration." Each presentation consisted of a poster and something physical to interact with. The corresponding web sites were able to reproduce the poster material and describe the potential interactions, which made a good showcase of the exhibit, even though they did not replicate the experience.

Non-roles
It is worth noting that although we hoped the internet might be a useful medium for discussion among students, e.g. through web-based threaded discussion groups or class mailing lists, we didn't find that any online community developed. We noted that students in the smaller project-based classes talked with each other around the computer lab anyway, and they could talk with teachers before and after class. The proffered discussion web page seemed unnecessary. Students in the larger *Intro Psych* class didn't have many opportunities to bond with one another; small group sections happened only once a week for an hour. Also, the requirements of the course did not require any collaboration, so many students felt that any additional emailing would have been additional work. Our experience should not discourage those seeking to build online communities, however. When such communities are both feasible and useful, they can flourish (O'Day, et al., 1996).

LESSONS LEARNED

With hindsight on both individual web assignments and the courses in their entirety, we offer a collection of several conclusions that we made after all the work was done. We think of these not as strictly studied experimental results, but as advice from experience to pass on to others.

Faculty need technical awareness to grade fairly
When students were producing web pages (or using any sort of technology with a significant learning curve), it was important that the faculty understood the amount of technical work the students put into their projects. Only then could student projects be fairly evaluated in terms of both their content and their technological savvy. It was important in *Story*, for example, when Mosaic was the popular web browser, that the faculty knew the precise limitations of web page layout so that they could recognize a startling deviation from the typically constructed graphic design when they saw it.

Students must be coaxed

Despite general web hype, students often only used the web if they had to. Even when other students' work was online, few students read it thoroughly unless it is assigned. After the novelty of the course web site wore off, students' many other school demands seemed to take priority.

One exception to this idea arose when the students were doing something "cutting-edge." During the beginning of *Story*, when the web was just catching on, almost any web page was an exciting web page. During the next semester, however, in *Tools for Thought*, Netscape grew popular and the idea of a simple homepage became boring. Wild background images and unusual text formats became the exciting goals. Eventually students become so accustomed to the web as a medium that they considered the stylization of their content much like they would have with traditional media such as the canvas or drawing board. At this point, the tasks of an assignment had to motivate the students instead of the medium itself.

Make sure the web is necessary and make it easy
In a related point, although students were motivated to spend time on web pages for a creative assignment that would take advantage of the medium, they protested using HTML to do what a word processor could do more easily off-line, e.g. on their online reports. The drudgery of writing HTML by hand could have been significantly reduced if web authoring software such as PageMill or FrontPage had existed at that point. Students were ambivalent about whether the advantages of having their reports online (e.g. allowing teachers to critique online, sharing class knowledge, etc.) outweighed the hassles of HTML formatting. Thus, we learned that we should more carefully consider whether the web would serve as a useful medium for a given assignment.

Anticipate the workload for the teacher
Maintaining a class web site in which students created their own pages required a surprisingly significant amount of work. We had to administer various accounts, set up class standards for the site, and explain various details about the web server to the students so that they could use its latest features. Even in a course like *Intro Psych*, in which the web served mainly as a source of information, as opposed to a platform for student work, the initial setup of the site and the weekly maintenance proved to be surprisingly sizable (probably two hours per week on average). This burden will decrease, however, as more schools or departments provide a standard web server infrastructure for courses, such as LearningSpace, Virtual-U, Web Course in a Box, etc.

Collaboration shortens technical learning curve
When students could work on their project-based assignments in the same physical space, they often learned a significant amount from each other and enjoyed the experience much more than otherwise. The first assignment in *Story*, for example, allowed students to do their out-of-class work on four computers in one corner of the Media Lab. When we visited this cluster in the evening, students had few questions. Mostly we heard them speaking to each other, saying "Wow, how did you do that?" or "Did you ever see graphics that did this?" Unfortunately, we didn't learn from these good results immediately; we later gave an assignment that required students to use

computers that sat in various isolated locations around the building. During this assignment, students had more questions and reported more frustrated attempts at progress in comparison to working in the computer cluster with peers. We finally realized how important it was to schedule time, machines, and lab space so that students could work together.

SUMMARY

After using the web to supplement three undergraduate courses in a variety of ways, we found both that the web can be a useful medium for student projects and that it serves as an efficient method of making information available to the students. As our ability to create web sites easily, to carry on real-time interaction online, and to perform other group work between distant collaborators improves, we will surely see the web become more incorporated in many learning environments.

For examples of other courses that have used the web, see the web page called "Educational Uses of the WWW at MIT" at: http://web.mit.edu/acs/www/acaduses2.html.

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