Using a CSCL-Driven Shift in Agency to Undertake Educational Reform[1]

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Abstract: Computer supported collaborative learning has the potential for driving educational reform efforts, but there are many challenges to face before achieving that vision. Two of the most critical are achieving teacher buy-in and motivating students to participate in a knowledge-building community. We have developed a new CSCL tool whose flexibility is inspiring good teachers to create exciting new collaborative learning activities, and whose persistence is an enticement to students. We are now attempting to use this tool to leverage a particular kind of educational reform goal: Achieving integration across curricular boundaries.

Keywords: Community settings, web, discussion forum

Computer-Supported Collaborative Learning for Educational Reform

Marlene Scardamalia and Carl Bereiter built their efforts in computer-supported collaborative learning (CSCL) upon a compelling vision of educational reform: Students as members of knowledge-building communities (Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989). They and their colleagues developed CSILE as an environment in which students might build knowledge for the sake of developing the community's understanding, in the same way that scientists publish research papers for the sake of advancing the research community's understanding (Scardamalia, Bereiter, & Lamon, 1994). The goal of the computer support was to scaffold the students' understanding, to place the agency for learning with the student, and to motivate the knowledge-building community by providing the students with the medium in which to create their communal database (Scardamalia, Bereiter, 1991).

Despite the success of Scardamalia and Bereiter, the path from current practice to knowledge-building community is a challenging one. Still, we believe that CSCL can serve to further the goals of educational reform. The biggest challenge is getting teachers and students to buy-in: To get teachers to put effort and value into CSCL, to get students to want to participate. As seen in our review of multiple systems, the rate of participation and the kind of participation in many CSCL environments is less than what one would hope for in a broad-based educational reform (Guzdial, 1997).

In the last year, we have begun using a new kind of CSCL environment that has been received in a surprisingly positive manner by a wide range of students and teachers. The tool is called a **CoWeb**, a collaborative website. It is striking in its flexibility: Any user can edit any note in the collaborative forum, and any user can create new notes. The response from teachers has been to invent a wide range of activities, with this same simple tool. The response from students has indicated a real shift in agency from teachers to students, as sources of knowledge and owners of the collaborative space. Students and teachers have equal powers in the CoWeb, and students can be the instigators of collaborative activities themselves.

Given the success of this tool, we return to the original goals voiced by Scardamalia and Bereiter ten years ago: To use CSCL to inculcate educational reform. The particular reform that we are seeking is to encourage cross-curricular integration, that is, to get students to recognize the conceptual ties between different classes in computer science, mathematics, and chemical engineering.

In this paper, we briefly introduce the CoWeb, then describe a range of activities that students and teachers have been developing in the CoWeb in only 18 months of use. We present a brief survey-based study of undergraduate students' attitudes in three different classes using the CoWeb. The activities are interesting because they demonstrate the teachers' ingenuity in using the tool, and the students growing ownership and shift in agency. The survey highlights student attitudes in the CoWeb, particularly how the students are taking greater ownership of their learning and of the space. Finally, we briefly describe our relatively new efforts to capitalize on these benefits to attempt educational reform.

Introduction to the CoWeb

A CoWeb is a **collaborative website**. Simply put, any user can edit any page in the website (Figure 1), any user can create new pages by putting *A new page name* in the text, and old pages can be linked by inserting *An old page name* in the body of a page. HTML can be inserted, but is not necessary ó text can be entered as if writing an email note. Graphics and hyperlinks off-site can easily be entered, also without HTML. A "Recent Changes" page lists dates in reverse chronological order and the pages that were edited on the date, so that users can easily see what's new.

The software supporting the CoWeb is built on the Pluggable WebServer (PWS) implemented in the Squeak programming language (http://squeak.cs.uiuc.edu). Squeak, and thus the CoWeb, have been run on a wide variety of platforms including Macintosh, Windows-95, Windows NT, and SunOS operating systems, so they are available on whatever platform a teacher may have access to. The CoWeb was based on the WikiWikiWeb developed by Ward Cunningham.

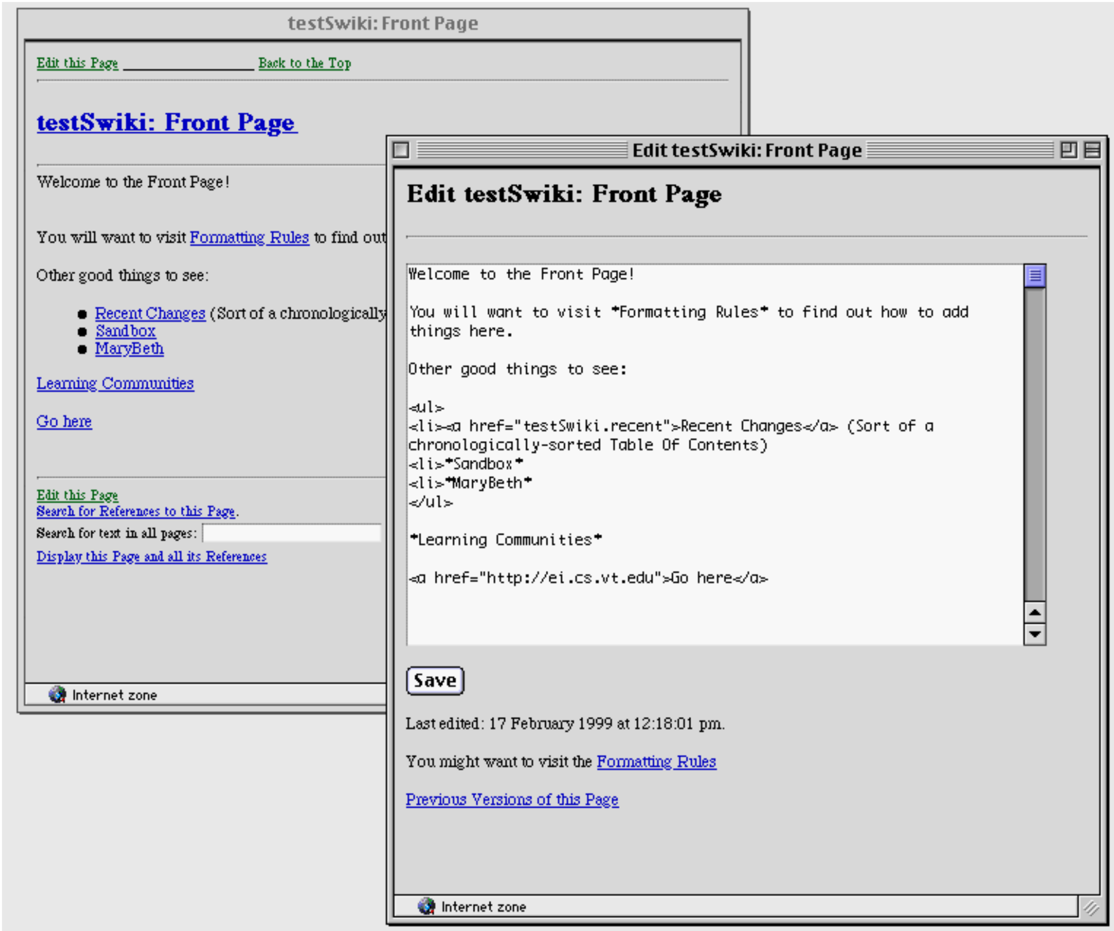

Figure 1: Students viewed CoWeb pages (behind) and edited them (foreground page) in normal browser software

Uses of the CoWeb

Faculty have invented a wide variety of uses for the CoWeb, right from the very beginning of its implementation in January 1998. Almost every term at Georgia Tech has a dozen classes using the CoWeb, and servers have sprung up all over campus.

Information source

The first use for many faculty is simply as a course website. The CoWeb is particularly attractive for those faculty who are uncomfortable with traditional methods of managing a website (e.g., creating and editing UNIX-based files). Further, other students and teaching assistants can easily add information to a course CoWeb.

Student assignment hand-in

Another common first use for the CoWeb is a "hand-in" site, where students would post their homework assignments when they were ready for grading. While perhaps not appropriate for every class, a public hand-in system provides the students an opportunity to see one anotherís work and even comment upon it. In at least one class, serious and contentful class discussions developed out of students reading and posting comments about one anotherís essays being handed in via the CoWeb.

Collaborative Writing.

In a biology class, students were asked to do collaborative writing projects on the CoWeb. Students in a group would edit the same page to enter their text for the group project. Students could find out when someone had edited their page by checking the "Recent Changes" page.

Design Review

In an architecture class, students were asked to create two CoWeb pages for each of their projects. Students were asked to post descriptions of their projects ("pin-ups") with scanned images of their drawings. On two occasions during the term for this class, expert architects were invited to tour the studentsí pin-ups and comment on the projects. For each expert architect, a "tour page" was set up with the architectís name on it. The architect was invited to visit each of the pin-up pages listed on his or her tour, and comment on the pin-ups either directly on the studentís page or on the tour page. The experts wrote a surprising amount of commentary.

Anchored Collaboration

One of common uses for collaboration spaces at Georgia Tech is **anchored collaboration**, where something to be commented upon (e.g., a paper, a list of exam review problems, an assignment description) is directly linked to a space for commenting on that paper, problem, or assignment (Hmelo, Guzdial, & Turns, 1998). An anchored collaboration is a good structure to use for review activities (such as the design review listed above), but is also useful for supporting focused discussions, such as students studying for a final exam by posting and critiquing answers to sample questions. Anchored collaboration was particularly simple to implement in the CoWeb, since the collaboration space could be literally the same space as the anchor or an easily-linked separate page.

Focused Discussions

Students do use the CoWeb for focused discussions. Students used a mechanism of writing their comments at the end of an anchor or comment page, usually signed. While there was no explicit support for tracking "threads" of comments (i.e., when one note comments upon another note, which comments upon another note), students sometimes spread their discussion across several pages, so that each page served as the marker of a given thread, or they would separate threads of discussion with horizontal lines.

Project Case Library

In some classes, students were invited to post their homework assignments **after** grading, particularly if the grade was high. The CoWeb became a project case library for exemplary projects (Guzdial & Kehoe, 1998). Students used these projects as positive examples of projects, as sources for ideas (particularly when two or more students posted their unique solutions to the same problem), and, in programming classes, as sources for code that could be re-used in new projects.

Cross-Class Projects

In one application of the CoWeb, the involvement of junior and senior students was the explicit goal. Two classes in Chemical Engineering were paired using the CoWeb. The Senior level course had students designing a chemical system then constructing a simulation of the system. The Sophomore level course was on analyzing exactly that kind of simulation. The two Chemical Engineering faculty teaching the classes decided to require a cross-class project where Seniors would create the simulation, pass the data to the Sophomores who would analyze the simulation and return the results to the Seniors, who would use the results to complete the simulation. The CoWeb provided an open forum for sharing data, deciding on formats and other issues for such a technical collaboration, and working together on the solution.

Most exciting was that the teachers aren't the only ones inventing interesting activities in the CoWeb. Students create their own pages and features within the CoWeb in a variety of classes. The below list describes several of the interesting pages and features created by students.

- One of the most useful navigation features on one class CoWeb was a "Hot List" at the top of the CoWeb of pages which were particularly useful or on which there were active discussions. The teacher did not create this set of links. One of the students did. While the teacher does maintain the Hot List in order to raise awareness of a page, students frequently change it themselves.
- Students used the CoWeb to create special interest pages that invite contributions from others. A page on our CoWeb welcomes other students who are running CoWebs to list their sites for others to visit. Our CoWeb also hosted the College list of players of the network game "TeamFortress," which appeared in the first few weeks of the first term using the CoWeb. One TeamFortress player in the class created the page, with a formatted table listing key player information like the playerís "clan." Other students then filled in their information in the table.
- Perhaps the more striking examples of student initiated collaborative activities on the CoWeb are the ones that had little to do with meeting course objectives. In two different courses using CoWebs this last term, students wrote and posted songs about their courses, completely unsolicited. In my class CoWeb, students created an adventure game about one of their assignments, like a "Choose Your Path" book. A student created a situation (based on the simulation assignment that they were working on, started two nights before the assignment was due) with a set of links representing choices that the reader might select from. Other students

added to the set of choices and created a variety of pages in the adventure game. Almost three dozen pages were created in this adventure.

Results of Survey of Student Attitudes

A survey of student attitudes and experiences was developed and distributed to three classes during the Winter 1998 quarter at Georgia Tech.

- A 40+ person Biology class that used the CoWeb for collaborative writing. 38 students completed the survey
- A 15 person Chemical Engineering class that used the CoWeb to coordinate cross-class collaboration. Three students completed the survey.
- A 100+ Computer Science class that used the CoWeb for a variety of activities including building a case library, reviewing for exams through an anchored collaboration structure, and discussing programming assignments. 52 students completed the survey.

Attitudes

Students were asked to respond to the following questions on a five point scale, where 1 is Strongly Agree and 5 is Strongly Disagree.

Statement	Bio	CS	ChemE
The CoWeb was useful	2.1 (0.6)	1.7 (0.8)	2 (1.7)
The CoWeb is easier to use than email for sharing information with the class.	2.4 (1.0)	1.8 (1.0)	1.7 (0.6)
The CoWeb is easier to use than newsgroups for sharing information with the class	2.2 (0.9)	2.4 (1.3)	1.7 (0.6)
I liked using the CoWeb	2.2 (0.7)	1.9 (1.0)	1.3 (0.6)
The CoWeb frustrated me.	3.6 (1.0)	4.0 (1.0)	4
I have my own page (or pages) in the CoWeb	2.5 (1.1)	3.1 (1.8)	4
I was motivated to maintain my own page (or pages) in the CoWeb	3.0 (1.0)	3.6 (1.1)	3.3 (0.7)
My main reason for using the CoWeb was to get information from my teacher.	3.1 (1.0)	2.5 (1.1)	1.7 (0.6)
The CoWeb helped me to perform class assignments.	1.8 (0.8)	1.7 (1.0)	2
The CoWeb helped me to learn.	2.8 (0.7)	1.8 (1.0)	2 (1.7)
I learned more from other students in the CoWeb than the teacher in the CoWeb.	3.4 (0.8)	3.0 (1.0)	5
I would like to use the CoWeb in other classes	2.5 (0.9)	2.1 (1.2)	3.3 (1.1)
Reading and updating the CoWeb was a chore.	3.1 (0.9)	3.4 (1.1)	4
I will come back to visit this CoWeb after this class ends.	3.6 (0.9)	3.0 (1.3)	4

We also split some data between those that reported that they had created CoWeb pages (49 students) and those that hadn't (44).

Statement	Create	No-Create
I liked using the CoWeb	2.0 (0.9)	2.1 (0.9)
The CoWeb frustrated me.	3.9 (1.1)	3.8 (0.9)
I have my own page (or pages) in the CoWeb	2.3 (1.4)	3.6 (1.4)
I was motivated to maintain my own page (or pages) in the CoWeb	3.1 (1.1)	3.5 (1.0)
The CoWeb helped me to learn.	2.4 (1.0)	2.1 (1.0)
I learned more from other students in the CoWeb than the teacher in the CoWeb.	3.3 (1.0)	3.2 (1.0)
Reading and updating the CoWeb was a chore.	3.2 (1.0)	3.4 (1.0)
I will come back to visit this CoWeb after this class ends.	3.1 (1.2)	3.5 (1.1)

Using averages and standard deviations to analyze Likert scale data is certainly not the best way to study this data, but it does serve to give an overview without breaking out the distribution for each of the five possible values. It is useful to, at least for the one question, point out that 33 of the creators Agreed that they had their own CoWeb page, and 18 of those Strongly Agreed.

Discussion of Survey Results

This is a preliminary survey, and not even particularly well-designed. For example, there is often only one statement for each concept, rather than several statements to serve to verify or triangulate around a concept. However, there are some very interesting trends in these data that are worth exploring in future studies.

It's clear that, in general, students liked the CoWeb. Students found it useful, they liked it, they want to use it in other classes, they weren't frustrated by it, and they didn't find reading and writing a chore. (Biology students were almost ambivalent about whether reading and writing was a chore.) In general, they found it easier to share things with a class than email or newsgroups. Students also (on average) found that the CoWeb helped in class task performance and in learning.

The beginning of a shift from a teacher-centered culture can be seen in these data. There was a strong indication that the teacher's involvement was important (i.e., students agreed with the statement "My main reason for using the CoWeb was to get information from my teacher") to the Computer Science and Chemical Engineering students, though the Biology students actually slightly disagreed with the statement on average. Most surprising was that the Computer Science students are ambivalent (on average), and Biology students nearly so, about the statement that "I learned more from other students in the CoWeb than the teacher in the CoWeb." That's quite a shift in attitude from a lecture-based perspective where the teacher is the main source of information, to one where the teacher is valued, but others are valued too. In particular, it is in marked contrast to the previous research on collaboration conducted by our colleagues on us (Hmelo et al., 1998; Newstetter, 1997; Newstetter & Hmelo, 1996; Turns, Guzdial, Mistree, Allen, & Rosen, 1995), which suggested that Georgia Tech students tend to dislike and to **avoid** collaboration.

Students who created CoWeb pages seemed to agree that they "had their own page" in the CoWeb. That sense of ownership is interesting, because it can help to explain the students' motivation in creating the collaborative activities we see them engaging in. However, it's not clear what that "own pages" means. Students who created their own pages were more likely to claim that they would return to visit the site after, which suggests that some of them did in fact plan to revisit their page, as we had observed. We see that as an interesting and unusual cultural shift toward a more apprenticeship model of education, where senior students visit with and help younger students.

The Value of an Unusual Tool

These survey results are clearly quite preliminary. They need to be followed up with a host of qualitative and quantitative studies to determine exactly what students are, what they are in contrast to a suitable control, and what (if any) learning may be occurring through use of the CoWeb. However, the survey results do suggest that an unusual tool can lead to some unusual attitudes by students and unusual activities by teachers. These data suggest that a tool that leads to no enforced distinctions between students and teachers can lead to students taking ownership of the collaborative space, finding value in the postings of their peer students, and not finding the information in the space less trustworthy.

It is certainly not the tool alone that leads to this kind of shift. The teacher's attitude and involvement is critical ó since so many students were in the CoWeb mostly to hear from the teacher, a missing teacher might lead to less student involvement. The activities encouraged in the CoWeb are also related to the cultural shift. Collaborative writing and case-building by students affords students the opportunity to see the value in others' work.

There is the obvious concern about such "free-for-all" among students in a flexible space such as the CoWeb. Will students go around sabotaging each othersí pages? Will the quality of the contributions degrade until there is little useful, trustworthy information available? In short, in our two years of using the CoWeb with literally dozens of classes, we have had no malicious damaging of other studentsí pages. Why that is true would make a fascinating follow-up study of its own, but we have several suspicions. Part of the answer is simply distributed responsibility and social pressureóanyone can mess something up, but anyone else can fix it to restore the common space. Part of the answer is that every version of every page is stored, so it is always possible to recover from damage. We may find that this trend changes as use continues to increase and a more diverse community uses the CoWeb.

The issue of the quality of the content is a real one. It has not yet been a problem because the users of the last two years have been teachers who have sought out use of the tool, and accordingly, have been active participants in the shared space. Teachers and

Graduate Teaching Assistants, as well as more senior students, are frequent visitors to all the CoWebs. Incorrect information does get corrected. The question of how (or if) inaccurate information gets corrected at a larger scale is an interesting question that we are attempting to study as our use scales up.

The issues of dealing with malicious behavior and inaccurate content are certainly important ones, particularly with making practical the broad use of this tool and approach. Nevertheless, we are excited about the trends we see in terms of student and teacher innovation and attitudes through use of the CoWeb and the kinds of activities that we describe in this chapter. The CoWeb does, in a concrete sense, place more of the responsibility of learning, helping others to learn, and documenting that learning on the shoulders of the students, which is an important direction of educational reform.

Leading to Reform

Given these trends, we have the opportunity for trying to **generate** educational reform much more explicitly. We are coming to this from a different direction than Scardamalia and Bereiter. While they started out with a reform goal in mind, we have stumbled upon a tool that seems to have important uses and benefits, and we are now identifying the reform goal that best fits the characteristics weíve discovered.

The particular problem we have chosen to focus on is curricular integration across disciplinary boundaries. Probably most faculty in higher education have complained that students seemingly forget everything from their previous classes when entering a new class. Yet, we have also found that faculty do not actually **know** what goes on in previous classes. Even among the authors of this paper, we have found that Chemical Engineers sometimes expect that one kind of solution method is taught in Calculus, when another (actually much preferred) method is actually being taught. When the faculty don't value and explore connections, it's not surprising that the students don't either.

We are currently beginning a project to create a CoWeb on the topic of "Computer modeling" (http://pbl.cc.gatech.edu:8080/model.1): The **Computer Modeling for Curriculum Integration (CMCI) Project**. Computer modeling is a key concept in engineering education, and students visit the topic in several disciplines. In introductory Computer Science, we teach them to program in a computer modeling language called MATLAB. In Calculus, we teach them differential equations and their solutions, sometimes using MATLAB. In Chemical Engineering, students use differential equations to model systems, and then these equations are simulated in MATLAB. However, none of these classes actually refer to one another, and in fact, different language for the same kinds of concepts are used in the different classes. Traditional practice actually makes it difficult for students to transfer concepts between these classes.

Our plan is to fill the CoWeb with a large number of valuable resources (e.g., worked out examples, cases, etc.) on the topic of Computer Modeling, encourage students to contribute with extra credit opportunities, and create connections between classes through these materials. We have research assistants from each of the domains whose job it is to post material and to create connections between the domains. We want a Calculus student visiting a page for help on a particular kind of differential equation to see that this kind of equation actually gets used in some examples from Chemical Engineering and that this kind of equation can be solved using MATLAB code learned in Computer Science. We are also encouraging the right kinds of material by hosting explicit cross-curricular collaborations in this space, e.g., this semester students in a Math class on ODEs will be teamed with a Chemical Engineering class, both using the CoWeb.

Of course, we recognize that real reform requires much more than simply the placement of an interesting collaborative space in the studentsí hands. Real educational reform requires infrastructural changes, political changes, and broad-based support. Reform is very difficult to achieve in higher education (Cuban, 1999). Higher education reform differs from reform at other levels (e.g., (Means et al., 1993)) because of shifts in participantsí focus and resources. For example, Meansí report identifies lack of hardware as a problem for using technology to sustain educational reform at some levels of education. At Georgia Tech, where every student is **required** to purchase a computer, and a portion of the stateís lottery revenue is earmarked for purchasing technology for higher education, hardware is simply not a problem.

Nevertheless, we do hope that our small effort is a **start** toward significant educational reform. Our hope is that the resources that we place in the space and the innovative nature of the CoWeb will encourage students to participate. Through participation, we hope that they will see connections between disciplines that they might not otherwise note, and thus develop better transfer and retention between courses. Further, we hope that if the students are there, the faculty may fellow. By involving both students and teachers in finding and creating connections between different disciplines courses, we hope to inculcate reform in how undergraduate learning and teaching takes place at Georgia Tech, and perhaps later, elsewhere.

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Notes

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