

# **Anchoring Discussions in Lecture: An Approach to Collaboratively Extending Classroom Digital Media**

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Abstract: Collaborative environments typically provide a medium for realizing or capturing discussion. While valuable, the discussion is often decontextualized from the situation in which it makes sense. Anchored collaboration environments provide a mechanism for connecting collaboration to digital media content, such as Web-based syllabi and assignment descriptions. The most significant learning context in most classes is still the face-to-face whole class lecture or discussion. The Classroom 2000 project at Georgia Tech is capturing classroom experiences in multiple media: audio, video, presenter's slides, presenter's whiteboard markings, and students' notes. By connecting the Classroom 2000 captured lectures to a persistent collaboration space, we provide (a) a mechanism for asynchronous collaboration that is anchored in class contexts and (b) a means for treating class activity as persistent learning medium for later comment and collaborative extension.

Keywords: situated learning, discussion forum, computer-mediated communication

## **Introduction: Integrating collaboration with classroom activity**

Many computer-supported collaborative learning (CSCL) environments provide collaboration support in terms of a medium for discussion. Threaded discussion spaces (such as MFK-Speakeasy (Hsi & Hoadley, 1997)) provide a mechanism for asynchronous discussion where the structure of the discussion is reflected in the interface. In chat systems, MUDs, or MOOs (Bruckman, 1994; Bruckman & Resnick, 1995), the collaborative environment is a medium for synchronous collaboration. However, in a classroom context, there is a danger that the discussion forums may be decontextualized from the students' activity.

In some classroom contexts, there are on-line (usually Web-based) resources that can serve as anchor points for discussions. Many higher-education classroom contexts today have syllabi or assignment descriptions available on the Web, which can be used in a structure we call anchored

collaboration where the discussion is linked directly to an artifact of interest to students (Guzdial et al., 1997; Guzdial & Turns, 1999; Hmelo, Guzdial & Turns, 1998). By anchoring the collaboration to material useful to the students (e.g., a midterm exam review, a problem statement, a report to review), the discussion becomes more relevant to the students' activities. In particular, anchored discussions tend to be more sustained than less-connected discussion spaces, such as newsgroups (Guzdial, 1997). Several CSCL tools being used in higher education can be used for anchored discussions (e.g., CoNote (Davis & Huttenlocher, 1995)). In lower grades where significant resources are available on-line, such as in the Virtual High School (Hsi, 1999), anchored collaboration can be also used.

However, in many (if not most) classes, the primary learning context is the classroom. Whether the classroom is used for lecture, discussion, or even face-to-face collaborative activity, the experiences in the classroom are often the central activities that we want students to reflect upon and learn from. We can only use these activities as anchors for reflective, out-of-class discussion if we can make the class activity available as digital media.

We can view the classroom itself as a rich multimedia environment where dense audio-visual information is combined with miscellaneous annotating activities that support the teaching and learning experience. To capture this rich experience for later reflection, typical students develop note-taking skills. However, the student cannot possibly keep up with this barrage of information streams, especially not with traditional paper and pen. Nor is it clear that we would want to encourage the students to hone stenographer-like skills in lieu of understanding and synthesizing the relevance of the lecture and putting it in their own words. Further, the students' personal notes, in isolation, are still hard to use as an anchor for class-wide discussion of classroom activities.

In an attempt to ease the task of capturing the classroom activities and, at the same time, the burden of creating Web-based digital media, we have created an instrumented space that turns the traditional classroom into a multimedia authoring system. In the Classroom 2000 project (Abowd et al., 1996; Abowd et al., 1998; Brotherton, Abowd & Bhalodia, 1998; Abowd, 1999), we use ubiquitous computing technology —electronic whiteboards, large projected displays, networked computers, and streaming digital audio/video— to create a room that automatically captures much of the rich detail of a lecture experience and provides effective Web-based interfaces for both students and teachers to review the lecture. The result is twofold: we are freeing the student to take on a different, more enriching role in the classroom and, at the same time, providing the instructor with a tool to generate Web-based material at almost no cost. Figure 1 presents (a) the actual classroom with the capturing functionality, and (b) a sample interface for reviewing the material on the Web.

By transforming the classroom experience into digital media, we create the opportunity to extend the conventional lecture into a collaborative learning experience. What we present in this paper is an attempt to weave the captured lecture into a long-term collaborative repository of learner-generated dialogue. The classroom experience then can become an anchor for discussions and other forms of collaborative activity between students and instructor.

We are finding that, when the discussion forum is persistent (e.g., all notes are available at all times, even beyond the scope of the class), the combination of recorded classroom activity and dynamic discussion space leads to the creation of a new kind of learning medium. Any classroom activity can be analyzed, discussed, indexed, and extended indefinitely. In this paper we present our vision for exploiting class activity as collaboratively extensible learning media and discuss results from preliminary experience and evaluation. We conclude with a discussion of how these kinds of forums promote a collaborative learning space that crosses class and classroom boundaries.



*Figure 1: (left) The Classroom 2000 environment with the capturing whiteboard, projectors, cameras and microphones. (right) Web browsers are used for reviewing the captured notes that link presented material from the electronic whiteboard and Web pages visited in class with streaming digital audio/video recorded during class.*

### **Class Activity as Collaboratively Extensible Learning Media**

Our vision is for captured classroom activity to serve as one kind of learning media that is available to students outside of the classroom. We want classroom experiences to be segmentable material that can be:

- Discussed and extended later,

- Persistent over time so that great experiences (like a particularly nice lecture explanation) can be revisited and even reinterpreted,
- Indexed via discussion spaces,
- Searched for relevant pieces that can be linked to a new discussion or topic, even in new classes and contexts.



Figure 2: CoWeb page (background) and its "Edit Page" view (foreground).

To provide such functionality, we integrated the Classroom 2000 environment with a tool that would allow Web-based anchored collaboration, CoWeb (Guzdial, 1999a; Guzdial, 1999b). The CoWeb allows any user to edit any page in the website (Figure 2), new pages can be created (and linked) by entering "\*New page name\*" into a page's text, and old pages can be linked by entering "\*Old page name\*" into a page. HTML can be entered into the page as desired, or text can just be entered as if the page were an email note. This simple structure has supported a wide variety of collaborative activities, from group writing to telementoring.

A feature especially powerful in this context is that the CoWeb is persistent. Pages exist over time. A "Recent Changes" page lists when each page has been changed in reverse chronological order, so that new additions or edits can be easily identified. CoWebs have been used in the same

course across multiple instances of the class, or in related courses to create cross-classroom integration and transfer. When these pages link into external media (such as Classroom 2000 capture classroom activity), the pages serve as a persistent index into the external media, where continued analysis and discussion can take place.

### How captured lectures link to collaborative discussions

In order to integrate the CoWeb and C2000 environments, we have integrated their underlying servers. Without going into the implementation details of this integration, we will describe the integration in terms of the student's experience.

#### Creating a CoWeb entry from the C2000 captured notes

When a student visits the notes from a captured lecture, links to new or ongoing discussion pages in the CoWeb can be created via a simple form interface, as shown in Figure 3. When the CoWeb server receives the link request, it either creates a new discussion page (in the case of a new discussion topic) or appends to the already existing discussion page, adding a thumbnail image of the lecture slide that provides an anchor back to the captured lecture. The resulting CoWeb discussion page is shown in Figure 4. The link established from the captured lecture notes is immediately added to the interface, so that a student can jump right to the discussion space, if desired.

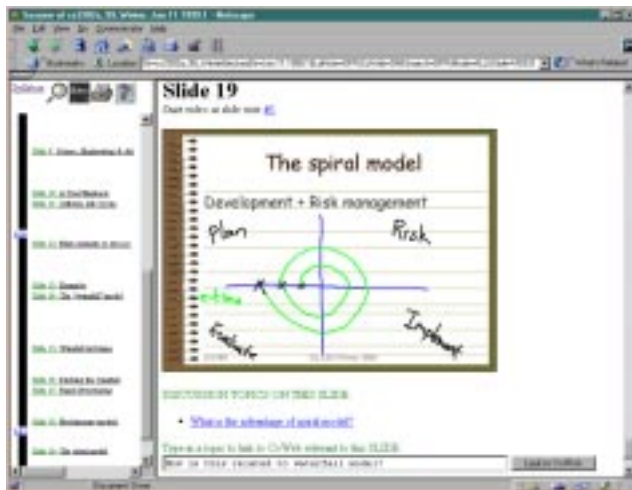


Figure 3: A view of the captured lecture notes. Links to the CoWeb discussion space are shown directly under a slide. A new link can be created after any slide by filling in the simple form beneath that slide. In the example shown here, the student enters "How is this related to the waterfall model?" to create a new discussion page in the CoWeb that will be automatically linked to this point of the captured lecture.

### Viewing a CoWeb entry from the C2000 captured notes

When a student is viewing captured lecture notes, all links to the CoWeb discussion space are shown, as in Figure 3. If the student selects a link to a discussion page, that CoWeb page is shown in a new browser. The CoWeb page will include a thumbnail image of the slide that links back to the captured lecture.

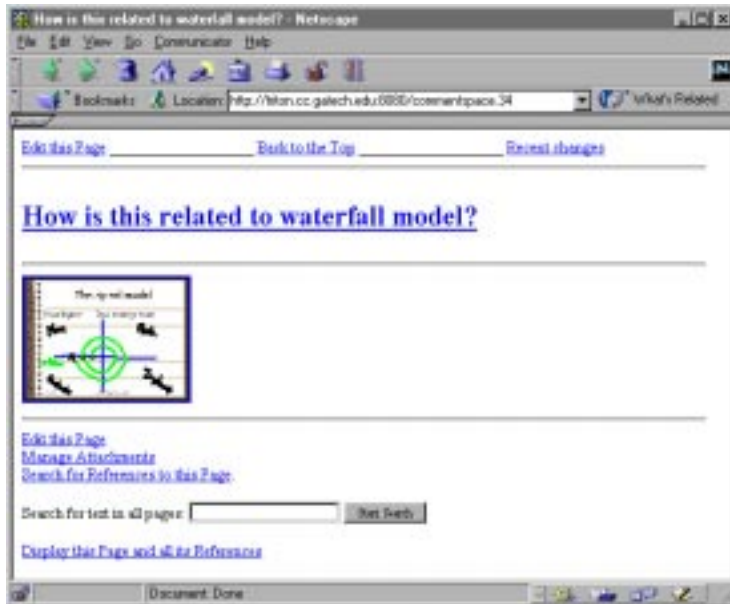


Figure 5: A view of a CoWeb page. This particular page corresponds to the entry created from the captured lecture notes shown in Figure 3. The thumbnail image is a link back to the captured lecture and was automatically created when the link request was made.

### Preliminary evaluation results

We have started using the integration between the CoWeb discussion space and the captured lecture notes provided by Classroom 2000 in two computer science graduate courses. We used a survey to collect information from how students perceived the integration of the discussion space and the captured notes. A total of 35 students filled out the survey. The survey was taken at a fairly early stage (week five of a ten-week course), so the data can only be used to indicate trends and opinions.

The two courses differ markedly in what happened in the classroom and how the integration was used:

- Course C1 (2 instructors and 31 students) uses a combination of both traditional "presentation" style lectures as well as discussion-oriented classes. Class sessions are 90 minutes long, resulting in an average of 19 annotated slides. Course assessment is based

on documents (reading summaries, research essays and group projects) that are posted in the CoWeb by students. Therefore, an intense use of the CoWeb is expected, and after 18 hours of captured classes, 173 pages were created in the CoWeb space. In this course, the instructor explicitly created many links between the lecture and the discussion, to facilitate the discussion and demonstrate this capability to the students. Once demonstrated, the responsibility for linking between lectures and the CoWeb was made a requirement of students when they prepared summaries of readings discussed during lecture.

- Course C2 (one instructor and 15 students) is entirely discussion-oriented. Class sessions are 60 minutes long, and generate an average of 2.7 annotated slides. Course assessment is based on reports, papers and projects but those are not necessarily posted in the CoWeb. After 14 hours of captured classes, 52 pages were created in the CoWeb space. In this course, few links were created between the captured classroom activity and the discussion area, and most of those were created by the instructor.

In general, the students make more use of the CoWeb than the C2000 captured notes. 51.4% state that they visit the captured lecture notes at least once a week, while 85.7% visit the CoWeb discussion space at least once a week. The access in the courses is different. In Course C1, 71.4% of the students visit the captured lecture notes at least once a week and 95.2% visit the CoWeb discussion space at least once a week. In Course C2, the numbers are 21.4% visiting the captured lecture notes at least once a week and 71.4% visiting the CoWeb discussion space at least once a week. These differences are explained by the facts that (a) Course C2 uses discussion-oriented classes while Course C1 uses presentation-oriented discussion classes and (b) Course C1 uses the CoWeb as the media for its deliverables.

Table 1 presents a summary of the scaled questions in the survey. Considered separately, the students report that they believe that they have a better understanding of the material in class with the use of the CoWeb space (74.3% agree, 17.1% neutral, 8.6% disagree) than through the captured lecture notes (40% agree, 48.6% neutral, 14.3% disagree). This is expected since that the captured lecture contents are directly related to the activities within the classroom, while the CoWeb space has material that underlies the discussions held before, during and after the class experience.

However, considering the integrated environment, it is interesting that about half of the group (48.6%) perceived that they have a better understanding of the material in class through coordinated use of both C2000 notes and CoWeb discussion space (40.0% neutral, 11.4% disagree). The results for the courses in separate are as follows. Course C1 has a more favorable result (66.7% agree, 28.6% neutral, 4.98% disagree) than Course C2 (21.4% agree, 64.3%

neutral, 14.3% disagree). This clearly indicates that, in particular for a course of the format of Course C1, the integration of the access to the material, as provided, gives further supported for the learning tasks from the user's perspective.

*Table 1: Summary of subjective evaluation*

Question	Course C1+C2			Course C1			Course C2		
	Agree	neutral	disagree	agree	neutral	disagree	agree	neutral	disagree
I find it useful to be able to access the CoWeb discussion space from the captured lecture notes.	51.4	48.6		57.1	42.9		42.9	57.1	
I find it useful to be able to access the captured lecture notes from the CoWeb discussion space.	45.7	51.4	2.9	52.4	42.9	4.8	35.7	64.3	
It is useful to be able to create a link to the CoWeb discussion space from the captured lecture space.	65.7	34.3		76.2	23.8		50.0	50.0	
It is useful to be able to create a link to the captured lecture notes from the CoWeb discussion space.	60.0	34.3	5.7	71.4	23.8	4.8	42.9	50	7.1
I understand material in this class better through use of the CoWeb discussion space.	74.3	17.1	8.6	85.7	9.5	4.8	57.1	28.6	14.3
I understand material in this class better through use of the captured lecture notes.	40.0	48.6	11.4	57.1	38.1	4.8	14.3	64.3	21.4
I understand material in this class better through coordinated use of both the CoWeb discussion space and the captured lecture notes	48.6	42.9	8.6	66.7	28.6	4.8	21.4	64.3	14.3

Students did believe that the integration was useful, even though the students did not create many of the integration links themselves. We believe that the students and teachers are still trying to understand how to use this integration. Five weeks is a short time to learn to use a new tool and understand its value in an educational setting. That said, we were excited by the kinds of integration that we did see:

- Student notes for presentations (with links, references, and other material) linked to the recording of the student's actual presentation.
- Link from the first class introductions of students to the CoWeb "Who's Who" page listing all the students' home pages.
- Lecture points extended by linking to discussion spaces where issues could be questioned and elaborated.

### **Conclusion and Future Vision**

While the pilot study results are not overwhelming, they do suggest that students find the



integration interesting and potentially valuable. The few examples of linkages that we did see point to some exciting possible uses for collaborative extension of in-class activities.

A point yet to be exploited is the integration of students' personal notes, associated to the Classroom 2000 captured material, generated during the class experience (Truong & Abowd, 1999). This scenario offers an opportunity to include student's personal contribution created during class into the collaboratively created CoWeb space.

We are most excited about the potential for this kind of integration provides over time. The next time that both of these graduate courses are offered, these CoWebs and captured classroom activity will still be available. Previous discussions can be revisited and even extended. All of the material become a rich, searchable resource. The discussions can be an index into the many hours of recorded material, which might otherwise not be revisited due to their length.

We are also excited about the potential for this kind of integration between classes. An undergraduate class in a course might use the discussion and capture space from a graduate class as a living resource for research projects. It's a benefit that the captured material is not canned video from a studio, but recordings of fellow students and teachers whom one might see in the hallway. The discussions are not closed, but are available for undergraduates to search, read, and even extend. We see a potential for using this kind of integration to create a learning community that crosses course and age boundaries.

We also see the potential for using the same CoWeb to index multiple captured classes and other media as well. The discussion space can become an extensible and collaborative index and archive to valuable learning resources. The CoWeb and Classroom 2000, in this way, can be seen as a way of gaining collaboration among teachers across and off campus, to pool resources to create the best possible learning opportunities.

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