

Learning to Weave Collaborative Hypermedia Into Classroom Practice

D. Kevin O'Neill, Daniel C. Edelson, Louis M. Gomez, and Laura D'Amico

Department of Learning Sciences, Northwestern University

Abstract

This paper presents a quantitative case study of the initial adoption of the Collaboratory Notebook, a collaborative hypermedia tool for inquiry learning, by a high school science teacher and his students. We document two distinct patterns of work resulting from the teachers' design of classroom activities and assessments. On the basis of these experiences we argue for the importance of clarifying and prioritizing pedagogical objectives for collaborative hypermedia before designing activities and assessments, so as to reduce the opportunity for resource conflicts in the classroom.

Keywords — collaborative hypermedia, activity design, classroom practice.

1. The Collaboratory Notebook

An important goal for designers of collaborative hypermedia for educational settings is to be able to advise teachers on how to couple these applications with their own curricular activities in order to achieve pedagogical objectives. Just as an experienced teacher is able to anticipate the classroom activity structures that will result from assigning a traditional research paper with a specific methodology and set of evaluation criteria, a teacher who designs activities which include the use of collaborative hypermedia should be able to anticipate the influences that the medium and the means used to evaluate work in it will have on the students' activities and their results. If this is not the case, the technology will fail because it is too difficult for teachers to plan around.

The Collaboratory Notebook is a collaborative hypermedia system which was designed and built as part of the CoVis Project at Northwestern University to serve the project's objective of applying networking and computing technologies to support a project-based approach to science teaching and learning [1]. It provides a shared, multimedia database for use in distributed, multimedia learning environments [2],

particularly ones with a focus on open-ended inquiry. The software is intended to provide students with a structured environment for conducting inquiry, both with one another within the confines of a single classroom and with fellow students and scientist mentors located at a distance. Its internal system of page labels and links is intended to guide students through a series of sensible investigative steps, allowing commentary by collaborators and the cultivation of new questions along the way. (For a detailed description of the Collaboratory Notebook software see [3, 4].)

As a step toward the goal of developing a set of expectations for teachers about particular uses of the Collaboratory Notebook, we conducted a qualitative and quantitative analysis of the early use of the software by a 9th-grade Earth Science teacher and his classes during his first year of participation in the CoVis project. The objective of this analysis was to understand the interactions among the following three critical elements: the work performed by students in the Collaboratory Notebook, the design of the software itself, and the design of the surrounding activities and assessments by the teacher.

2. The Setting and Activities

The two classes involved in the study were honors freshman Earth Science classes with 19 and 20 students each, taught at a suburban Chicago high school. The students came from mostly middle- and upper-middle-class households in which about half of the students' mothers or fathers have graduate degrees. Their teacher is a second-year teacher, new to the school this year, with a previous career as an applied scientist.

The classroom in which the study took place is unique in the school. As a result of the school's participation in CoVis, this classroom has been outfitted with six Macintosh Quadra computers which have direct, 128Kbs access to the Internet. A significant portion of the activity in this classroom is project-based, and twice a week the class period is

doubled in length to provide students with more time to work on projects.

Clearly, this is a resource-rich classroom, in many senses of that term. However, as our analysis shows, it still provides significant constraints on the use of a collaborative hypermedia tool like the Collaboratory Notebook and the activities to which it can contribute.

2.1. The Climate Project

The first of the activities we will discuss here was a long-term, individual research project for which each student selected a topic related to weather, climate or oceans. We will refer to this project as the "climate" project. Students were required by their teacher to produce two main products in this project: a project proposal and a standard research paper between 5 and 10 pages in length.

Students created their project proposals over a period of two weeks using the Collaboratory Notebook. Each project proposal was required to contain the following elements:

- a research *question*
- an initial *conjecture* about an answer to this research question
- a *plan* for confirming or disconfirming the conjecture
- a list of references to background research
- a hypothesis formulated on the basis of the initial conjecture and the completed background research

The teacher reviewed the students' electronic notebooks regularly as the students produced these elements and provided frequent written feedback in the form of commentary attached to their electronic notebook pages. This commentary was usually about the formulation of project *questions* and *plans*, the completeness of the work with respect to assessment requirements, or the appropriateness of the way that the students were using the Collaboratory Notebook's page labels and links.

An analysis of the notebooks created during this project (Table 1) reveals that both the students and their teacher conducted a significant amount of work in the Collaboratory Notebook, and that they found use for most of the inquiry-oriented page labels available in its palette. However, some of the labels, notably *evidence for* and *evidence against*, were rarely used (see Figure 1), and *commentary* was almost exclusively used by the teacher.

Table 1. The total number of pages and words in a sample of 39 student notebooks.

	Mean	Min.	Max.	Std. Deviation
Student pages	9.33	3.00	23.0	4.17
Teacher pages	3.31	0.00	8.00	1.95
Total Words	609	156	1666	352
Words/page	48.7	17.1	119	25.9
# page labels used	5.64	2.00	8.00	0.973

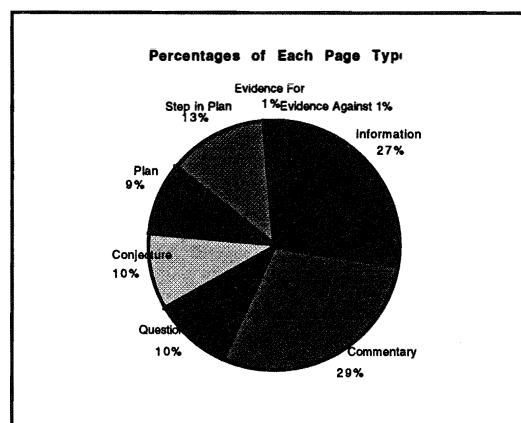


Figure 1. Percentages of pages written in the climate project (student and teacher) which were given each page label.

2.2 The Geotime Project

The second activity planned by the teacher, which we will refer to as the "geotime project", differed from the climate project in three important ways. First, this activity was conducted by project teams rather than individual students. The teacher made the decision for this to be a group project largely because he found it time-consuming to regularly read and comment on an electronic notebook for every student during the climate project. Second, students had less flexibility with respect to their project topics than they had been given in the first project cycle. Rather than being free to explore any question they found interesting within a broad topic area, each student group was required to master materials about a specific period of geologic time, mostly using traditional resources found in the library.

Last of all, and significant for our later discussion, the proposal format for the first activity cycle that was outlined above was not made a requirement by the teacher. Since the research project seemed well

circumscribed he felt this formality was not necessary, although he hoped that students would continue to follow his proposal format regardless of his grading criteria. In place of a formal proposal, students were asked to write narrative "journal" entries in the Collaboratory Notebook, reporting how their groups had spent the project time allotted to them in class, how they had divided their labor and so on. Thus in this project, the Collaboratory Notebook was used more as a diary of activity than as a log of or support for discrete milestones associated with scientific inquiry.

3. A Comparison Across Projects

As mentioned earlier, the object of this analysis was to begin to address the question of how classroom activity, as designed by the teacher and realized in a particular resource environment, shapes Collaboratory Notebook use by students. Here we will use the size of notebooks and notebook pages and the use of page labels as primary indicators of software use in each project.

3.1 Size of notebooks and pages

We began by comparing the size of students' electronic notebooks, as measured by the total number of notebook pages, and students' verbosity in these pages (bytes per page) across projects. We also compared students' verbosity in notebook pages given each of the 8 available labels. Some of our results are presented in Figure 2.

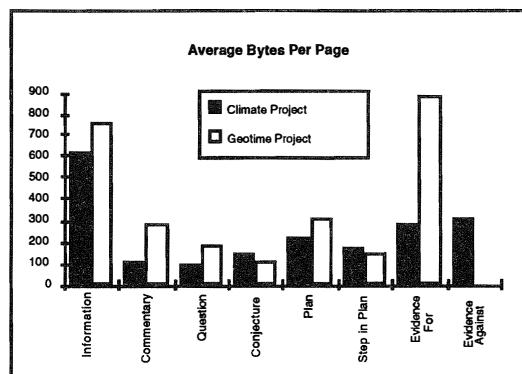


Figure 2. Comparison of bytes per page type by project and page type.

On average, students working on the climate project produced roughly the same number of notebook pages as students working on the geotime project (12.83 vs. 11.83, $F(1,329) < 1$). However, as Figure 2 shows, pages from the geotime notebooks were, on average, longer than those from climate notebooks (382.64 vs. 214.83, $F(1, 329) = 3.87$, $p < 0001$). There are at least two possible explanations for this.

The pages of the geotime notebooks may have been longer because the teacher requested collaborative work and as a result, more students contributed to each page. However, an equally strong hypothesis is that they may have been longer simply because narrative journaling was easier for students to do than the more formal proposals, allowing them to produce more text in the same period of time. There is corroborating evidence for this second hypothesis in the students' use of page labels.

3.2. Use of page labels

Because the geotime project required group work, we might have expected the project notebooks created by students in that project to make richer use of the Collaboratory Notebook's palette of page labels. For example, we might have expected to see students posing *questions* to one another, offering *commentary* on one another's work, or contributing *evidence* to confirm or disconfirm one another's *conjectures* in the team notebook. However, we did not find this. In fact, the collaboratively-authored notebooks actually contained a *smaller* variety of page types overall. Approximately 2 fewer types of page labels were used per notebook in the geotime project than in the climate project ($t(47) = -5.038$, $p < 0001$). How could this be?

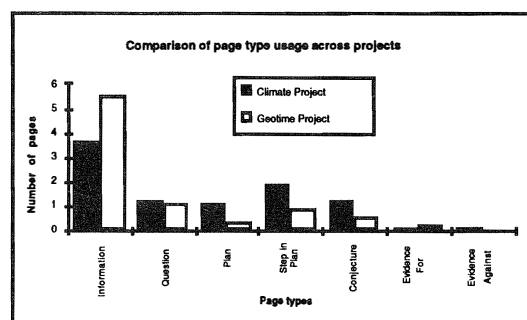


Figure 3. Comparison of page label usage across projects.

In discussions with the teacher, it became evident that the requirement of maintaining narrative journals of project activity in the Collaboratory Notebook was creating a resource conflict with the process of project refinement that the teacher had also hoped would be part of the students' work. Because there were a limited number of computers and limited time available for students to use the Collaboratory Notebook, students were forced to make a choice between spending their time creating journal entries or on using the Collaboratory Notebook to draft *questions*, *conjectures*, and *plans* to develop their proposal. The teacher, who was experimenting with journaling as a means to develop the students' reflectiveness, placed a strong emphasis on this activity, and as a result, students chose to spend their time on journal entries. These entries, most of which were labeled as *information*

pages, contributed to the significant increase in the use of the *information* page label from the climate project to the geotime project (3.6 vs. 5.5, $t(47) = 2.57$, $p < .01$), and a significant decrease in *plan* pages (1.05 vs. 0.33, $t(47)=5.08$, $p<.0001$) and *conjecture* pages (1.24 vs. 0.058, $t(47)=2.21$, $p<.05$). See Figure 3 for more detail.

One may note that there are approximately equal numbers of *question*, *evidence for*, *evidence against*, and *commentary* pages in both sets of notebooks. We believe that the number of questions remained similar between both projects because posing questions is the first step in students' investigations and may have been completed before the resource conflict reached a critical level. Very few *evidence for* or *evidence against* pages were created by students in either project, consistent with the use of the Collaboratory Notebook mostly during the project planning phase rather than the later evidence-gathering phase of the projects. There was also no significant difference in the number of *commentary* pages written between projects. This constancy in the number of *commentary* pages written can be confidently attributed to the teacher's diligence in providing frequent feedback to his students in the form of *commentary* pages.

4. Conclusions

Although we hope to scaffold students' investigative thoughts and actions with the Collaboratory Notebook's page labels and links, we recognize that teachers are the ultimate designers of classroom activity. We have seen from this case study of teachers' and students' initial adoption of the software that the teacher's activity design shapes the use of collaborative hypermedia just as it shapes how students use many other classroom tools. In the classroom, students' time is definitely not their own.

In this study, the teacher crafted two relatively different projects, and his project assignments led, sometimes unintentionally, to very different patterns of Collaboratory Notebook use. When the teacher created a project whose primary written component was proposal writing, students used the Collaboratory Notebooks' page labels and links with some sophistication. When, subsequently, the same students were asked to write narrative journals with the software, they experienced a resource conflict between two types of composition for which the Collaboratory Notebook could be used and wound up using fewer of the Collaboratory Notebook's inquiry-scaffolding features.

This result points to a complex set of concerns about the adoption of collaborative hypermedia in classroom settings. Our limited experience shows that it is important for teachers adopting such media to clarify and prioritize their expectations for students' work in them and to design assessments which will

clarify these priorities for their students. Teachers cannot hope, any more than software designers can, that the design of the new medium itself will strongly influence the directions in which students put forward their effort, regardless of the assessment schemes put in place or the resource limitations under which students work. When weaving collaborative hypermedia into classroom practice, success will depend on the attention paid to the variety of countervailing forces which can work against the expressed and implied intents of the instructional designer.

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Authors' Addresses

School of Education and Social Policy, 2115 N. Campus Dr., Evanston, IL 60208. {oneill, edelson, gomez, damico}@covis.nwu.edu.