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► **To cite this version:**

Daniel C. Edelson, Roy D. Pea, Louis M. Gomez. The Collaboratory Notebook. Communications-ACM, Association for Computing Machinery, 1996, 39(4), pp.32-33. <hal-00190600>

HAL Id: hal-00190600

<https://telearn.archives-ouvertes.fr/hal-00190600>

Submitted on 23 Nov 2007

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The Collaboratory Notebook

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The recent explosive growth of networking raises the possibility of widespread collaborative, open-ended learning activities. This vision is supported by research highlighting the value of both collaboration and open-ended activities for learning. Specifically, when learners acquire knowledge in the context of a goal-directed activity, they are more likely to use that knowledge later. Similarly in collaborative learning, distributed expertise and multiple perspectives enable learners to accomplish tasks and develop understandings beyond what any could achieve alone. Furthermore, the communication required in collaboration prompts learners to express beliefs in ways that serve to organize what they know and to identify gaps in their understanding.

As appealing as this vision may be, it can be difficult to achieve in practice because open-ended learning and collaboration are complex activities that must be learned and often conflict with the current knowledge-transmission culture in schools. Therefore, students need new environments that allow them to learn through collaborative, open-ended activity, even as they are becoming proficient at it. The Collaboratory Notebook software addresses this challenge with support tailored for inquiry-based collaborative science learning. The Notebook has been developed as part of the Learning through Collaborative Visualization (CoVis) Project,¹ a research and development testbed for project activities in high school earth and environmental science classrooms.

Design

The Collaboratory Notebook is implemented as a networked, hypermedia database. As with similar shared hypermedia databases for learning (e.g., CSILE), students are provided with a fixed set of page types. In the Notebook, the 8-page types correspond to a task model of scientific inquiry that includes questions,

conjectures, evidence for and against conjectures, plans, steps in plans, information, and commentary. Students create hypermedia links between pages according to the relationships between them. For example, students might pose an initial question, link it to competing conjectures that respond to it, and then define plans for investigating them. As they acquire evidence for or against, they may link their evidence to the conjectures.

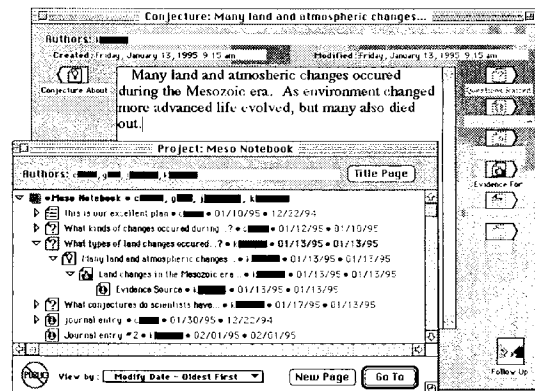


Figure 1.

Foreground: A notebook table of contents. Page types are indicated by icons. Links are indicated by indentation. Background: A conjecture page. Links to other pages are represented by the buttons on the left and right side of the text.

This framework provides learners with a structure for organizing their open-ended inquiry activities and communications. The goal is to free up learners to focus on content by carrying some of the burden of structuring process in the tool. Consistent conventions for the semantics of the link types make navigation through the hypermedia database easier.

The Notebook's user interface aims to make it equally easy to author and browse pages. The database is divided into workspaces called notebooks. Typically, a student group working on an investigation will cre-

¹Additional information on the CoVis Project is available at <http://www.covis.nwu.edu>

ate a notebook and then fill it with an interconnected web of pages containing text, images, or “attached” documents of various types of media. A notebook is navigated by selecting the buttons representing the links between pages (Figure 1, background), or pages from a table of contents (Figure 1, foreground). The task model of scientific inquiry that is built into the user interface suggests sensible next steps for students pursuing an inquiry. When one views a conjecture page, the buttons on the right side of the page serve as reminders that a conjecture might be followed up with evidence for or against it, or a “plan” for obtaining that evidence (Figure 1, background).

Results

In the first two years of availability, the Notebook was used by five of the seven teachers participating in the CoVis Project. The two teachers who used the Notebook most extensively integrated it fully into the activity structure they assigned students for conducting research projects. Their students used the Notebook in early phases of the research process, to develop a research question and inquiry plan. Students entered their initial research questions, conjectures, and plans in notebooks, and iteratively refined them following feedback from the teacher and their own research. The software provided a much shorter feedback cycle between work performed by the student and guidance from the teacher than is ordinarily possible in a pencil-and-paper environment. In contrast with the common practice of only appraising students’ work at the end of the learning process, the software provided opportunities for teachers to monitor students’ progress more closely, and to guide their efforts earlier and less dramatically.

The Collaboratory Notebook has also been employed successfully in a number of inquiry activities. For example, one teacher conducted an activity in which students accessed real-time weather data using the CoVis Weather Visualizer, and then created 48-hour weather predictions. The teacher used the Notebook structure by launching the activity with a question page about the upcoming weather. Student groups created predictions on linked conjecture pages. These groups then sought to support their conjectures with evidence, provided commentary on others’ predictions, and offered hints on making better predictions.

The Collaboratory Notebook has also been used in an undergraduate ecology class for sharing field study data and in a medical school Problem-Based Learning curriculum for sharing and discussing research on hypothetical medical cases. To date, it has been used by students in their early teens through graduate school.

Lessons Learned

Early use of the Collaboratory Notebook has provided important formative feedback leading to several significant software revisions. Two important lessons have been learned:

Incentive structures: Because students are economical in their use of time and resources, they will not adopt new practices without a clear payoff. Therefore, the most effective activities using the Collaboratory Notebook were those well-matched to its specific benefits, such as activities that were easy and natural to record online rather than off, activities in which the Notebook’s networked nature allows participants at different locations or on different schedules to work together, and activities in which the instructor gave value to Notebook work through the assessment structure. From a design perspective, we expected students would recognize the benefits of the Notebook structures in advance, but in practice, they only saw the software’s values retrospectively, and required a concrete incentive to motivate their initial use of the software.

Improving navigation: The major modifications due to formative evaluation have been enhancements to make it easier, especially for teachers, to navigate rapidly and systematically through its contents. Early complaints stemmed from difficulties in quickly locating newly authored entries and in systematically examining the contents of a notebook without becoming “lost in hyperspace.” Both concerns were significant for teachers monitoring and providing feedback for work by many students. We enhanced the functions of the table of contents (Figure 1) to display information about new entries, and to speed the process of browsing entire notebooks.

New Directions

In our current work, we are focusing on three issues: remote collaboration, university settings, and new subject matters and activities. One example of using the Notebook to support remote collaboration is in *telementoring* between members of the scientific community and students participating in the CoVis testbed. The CoVis testbed currently involves thousands of students in over 40 schools across the U.S. At the undergraduate and postgraduate levels where access to networks is more common, the Notebook can help support open-ended learning activities outside the classroom. Finally, we are exploring different page-and-link structures to support subject matters besides science and open-ended activities other than scientific inquiry. □

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This material is based upon work supported by the National Science Foundation under Grants No. RED-9454729 and MDR-9253462.

