FOCUSING ON CRITICAL-THINKING SKILLS: PROBLEM SOLVING AND ARGUMENT ANALYSIS

Homespun Hypertext: Student-Constructed Hypertext as a Tool for Teaching Critical Thinking

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Techniques for creating collaborative student-constructed hypertexts in the classroom are described. The goals of the exercise were to facilitate student-directed learning by doing, help students learn to apply courseware development theory, teach specific computer skills, and promote critical thinking by having students link critical concepts in a hypertext environment. Critical thinking is discussed in terms of informal reasoning and ill-structured problem solving. The contexts were two undergraduate courses on cognition and computer-assisted learning. Students' separate papers were integrated to form the group hypertext. Hypercard procedures for creating the background, text blocks, and button links are presented. An approach to hypertext construction management called a Linking Priority Structure is described, along with two management rules, and a hypertext scavenger hunt. The exercise was evaluated through the success of the scavenger hunt and students' written comments. Strengths and weaknesses of the homespun hypertext are valuable sources of learning.

The goal of promoting critical thinking in many contexts has been increasingly accepted in recent years. For example, efforts have been made to teach critical thinking in domains as diverse as adult education (Garrison, 1992), children's problem solving (Hudgins, Riesemey, Ebel, & Edelman, 1989; Powell, 1987), personalized systems of instruction (Reboy & Semb, 1991), children's literature (Carr, 1988), and general psychology (Ferguson, 1986). The work reported herein represents an effort to teach students to think critically about hypertext and its place in education and society in the context of courses on Cognition and Computer-Assisted Learning (CAL).

Hypertext and hypermedia are interactive nonlinear media made possible (or at least convenient) by digital computers. In books and journal articles, text is presented to every reader in the same sequence. Hypertext, by contrast, presents different readers with different sequences of images, sounds, and text, depending on their behavior (generally, clicking on buttons or touching portions of a screen). Thus, individuals determine what they need or want to read and the order in which they will read it.

Hypertext and hypermedia are of increasing interest to psychological researchers. A recent review of the literature revealed research in domains as diverse as CAL (Hewett, 1989), information retrieval (Gray & Shasha, 1989), intelligence (Rao & Turoff, 1990), learning disabilities (Higgins & Boone, 1990), mental models (Gray, 1990), and reading (Baljathy, 1990).

Bold claims have been made about hypertext, particularly in the humanities. For example, Landow and Delany (1991) claimed that hypertext is an accurate “model of the mind’s activities” and argued “for a natural progression from the printed word to hypertext and hypermedia—alike to the progression from painting to still photography, to silent movies, and now to movies with color and sound” (p. 8). Thus, Landow and Delany (1991) argued, hypertext will change our sense of authorship, authorial property, and creativity . . . [and] in doing so, it promises to have an effect on our culture and intellectual disciplines as important as those produced by earlier shifts in the technology of cultural memory that followed the invention of writing and printing. (p. 12)

Others claim that the nonlinear nature of hypertext will fundamentally change the culture of the United States from one based on linear and hierarchical thinking to one based on relational thinking. If students are to evaluate critically such claims and develop judicious positions on hypertext, they must have direct experience with constructing and using hypertexts. This article describes techniques for creating and using student-constructed hypertexts in the classroom to promote critical thinking.

One component of critical thinking is problem solving, which generally involves recognizing and representing a problem, generating and evaluating solutions, selecting a solution, and applying it to the problem (Halpern, 1989). Solving ill-structured problems when the goals and constraints are not well defined is characterized by a great degree of effort in problem representation. Unlike formal reasoning, in which one proceeds from given premises to inescapable conclusions, informal reasoning is characterized by successive modifications of the “givens” in developing a problem representation. For example, in research on infor-
mal reasoning in the domain of international relations (Voss, Wolfe, Lawrence, & Engle, 1991), my cohorts and I found that experts spent most of their time developing and evaluating problem representations, which formed the basis of specific policy recommendations. Novices spent relatively more time discussing policy itself. In forming a position on an issue or problem, critical thinking may be characterized by the judicious consideration of many perspectives and the integration of experience and other knowledge, values, and beliefs.

In the exercise described herein, students without prior programming experience created a multimedia hypertext on the topics of cognition and CAL. An important goal of the exercise was to have students form well-reasoned positions on the potential of hypertext and its place in education. The exercise integrates diverse readings, small-group discussions, cooperative learning (e.g., Thomas, 1992), and experiential learning (Kolb, 1984) to promote critical thinking. Thus, the rationale for this class project was fourfold: (a) facilitate learning by doing, (b) provide students with an opportunity to learn and apply courseware development theory, (c) teach specific computer skills, and (d) promote critical thinking about the broader issues raised by hypertext.

Context

The contexts for this exercise were a course called The Hitchhiker's Guide to the University: Computers, Cognition, and Higher Education, a junior seminar taught in the School of Interdisciplinary Studies at Miami University, and a similar course for first-year honors students. The primary focus of both courses was CAL and hypertext. Fourteen students in the junior seminar, and 8 students in the honors course, with varying backgrounds in psychology and computers, participated. There are no prerequisites for the course, and no previous knowledge of computers is assumed.

The first major assignment for the course was a 5-page paper on cognition and CAL. As explained in the course syllabi, these individual student papers were to be integrated to form the group hypertext. In preparation for this exercise, students interacted with the introduction to Hypercard disk from Apple Computer. They also explored Dougherty's (1990) "Contour" and Dickey's (1991) hyperpoems. Reading assignments included chapters from Delany and Landow (1991); several articles, including those by Dougherty (1990), Irish and Trigg (1989), Brockmann, Horton, and Brock (1989); and Charmey's (in press) review article.

Constructing the Hypertext

We used Hypercard 2.0 and Microsoft Word 5.0 on Macintosh IIx computers. Hypercard is often explained with the metaphor of a stack of index cards that are rearranged according to the actions of the user. Users navigate through a stack by clicking on buttons that take them from one card to another. Hypercard was selected because it is easy to use and available on every Macintosh.

Building the Background

The first step in creating the homespun hypertext was creating the background. The background provides the structure for the entire stack because background information is inherited by every card in the stack. To create the background, we selected "background" from the "edit" menu. The background consists of five buttons, three text fields, a logo, and the title "Homespun Hypertext: Cognition and Computer-Assisted Learning." The first button is called hypertext menu. Its purpose is to bring the user from any card to a main menu. Buttons were created with the "new buttons" command under the "objects" menu. The hypertext menu button was linked to the first card with the "link to" button in the button dialogue box. When the link to dialogue box appeared, we deselected "background" from the "edit" menu and selected "first" from the "go" menu. These commands took us out of the background and brought us to the first card. We then clicked on the "this card" button in the link to dialogue box.

The second button called help and explanation was created the same way as the first, except it was linked to another card. The purpose of this button is to bring the user from any card to a help card containing a brief description of every button and field. Similarly, the third button takes the user to the Hypercard 2.0 home card.

The fourth and fifth buttons permit the user to go forward and back between adjoining cards. Left and right arrows are the icons representing these buttons. Once the button was created, we clicked on the "script" button. The script we wrote for the forward button is as follows: on mouseUp, go to the next card, end mouseUp. This tells the program that when the forward button is clicked and the mouse button is released present the next card. The procedure for creating the back card was the same except "go to prev card" replaced "go to next card."

As the name implies, a text field in Hypercard 2.0 is a place to put text. The next step was to create three new text fields on the background. To aid navigation by helping users orient themselves, two fields were created to show the author of the original text, which paragraph in the original text is being read, and the topic of the paragraph. For example, "Knowledge Representation," and "Wanda Jones, Paragraph 3 of 11."

The third field is for the content of the homespun hypertext, text blocks about cognition and CAL. Each card contains one paragraph from students' original papers. Of course, paragraphs vary in length, and some were quite long. To allow for paragraphs that were too big to fit on the screen at the same time, we selected "scrolling" from the field dialogue box. This created scroll bars that enable the user to see off-screen text.

Creating Cards and Adding Text

Having created the background, the next step was to create new cards and fill each field with appropriate text. For the sake of convenience, the stack with the newly created background was duplicated for each student and labeled with the student's name. Every student was responsible for
copying each paragraph of text from his or her paper to a new card. Students entered the paragraph topic in the first field and their names and the paragraph number in the second. Students were also responsible for devising appropriate “tags” for the topic field of each card and taking notes on key words that would lead to the most appropriate links. These tags and key words were shared in class, and common synonyms were adapted. Results of these procedures can be seen in Figure 1, a sample card from the homespun hypertext.

Linking

Links among blocks of text are the heart of the homespun hypertext. The mechanics of linking cards in Hypercard 2.0 are easily mastered. However, the art of creating meaningful links determines the ultimate success or failure of the project. Our hypertext may be described as handcrafted (Alschuler, 1989) because links were created manually rather than automatically. The process was guided by Jonassen’s (1988) work on integrating learning strategies into courseware and Landow’s (1991) rules for hypermedia authors (with several important exceptions). Our goal was to create a useful and meaningful hypertext.

It is difficult to create a richly interconnected hypertext without making so many buttons that the user experiences information overload. Our solution was to create a Linking Priority Structure (LiPS). The LiPS is a simple grid on which the separate stacks created by each student are represented by columns, card numbers are represented by rows, and individual cards are represented as cells. The first step was to draw the LiPS grid on a large sheet of paper. Then, students created links to the next stack (with the last stack linking to the first one). After creating links between their stack and their neighbor’s, students went to the board and drew a line connecting cells representing the links and labeled each link with the button name. Different colored markers were used for different link types. After the first round, all link labels were reviewed and standardized. Students then proceed to the second stack to the right. The procedure was repeated except now Homespun Hypertext Rule 1 was evoked: Never create a direct link between blocks of text if an intervening link of the same kind already exists.

In an attempt to reduce the number of links, Homespun Hypertext Rule 2 was proposed: Proceed until you encounter a stack for which no new links are necessary. However, in practice, each stack yielded at least one new link for each student. After the second and third rounds, the link labels were reviewed and standardized. It was not necessary to repeat this review more than three rounds. Applying these rules produced circular bands of related text blocks.

The first step in actually creating a link between two stacks is to create a button on a card, as described earlier. After clicking on “link to,” students went to the “file” menu and selected “open stack.” From here, they selected another student’s stack and searched for appropriate text. To help the user establish a relation between the point of departure and the point of arrival (Landow, 1991), unique transitional effects for each button type were selected by clicking on the “effects” button of the button dialogue box.

There were three ways of finding appropriate links. The first two were to create links among related tags in the topic fields and among the reference sections of each stack. The third and most productive approach was to search for a key word or phrase using the “find” command under the “go” menu. The “find” command searches through a stack and locates the first match of the key word, sending the user to that card. When a match was found, the student read the text. If the relation was judged appropriate, he or she clicked the “this card” button on the link to dialogue box, and the link was completed.

There were two sources of key words. The first was the set of terms each student selected for each of his or her cards. Students must be quite specific in selecting key words; thus, it was useful to discuss this as a group before linking. Computer, cognitive, and psychology were obviously too broad

![Figure 1. A card from the homespun hypertext.](image-url)
to form the basis of meaningful links, whereas adaptive feedback and formative evaluation were better. The second source of key words was the names of authors being referenced. This created bands of text blocks referencing the same author. For example, a series of “Papert” buttons link text blocks citing Papert’s work.

The end result is an interconnected hypertext with each block of text linked to several others by appropriately labeled buttons. To complete the homespun hypertext, the menu and help cards were created. The menu card is the first card of the original stack and the first card the user sees when he or she opens the stack. Here, buttons for each of the main text bands were created that arbitrarily link to appropriate cards in students’ stacks. The help and explanation card has text describing all of the background buttons and a more detailed description of the entire homespun hypertext. We asked students and other users to comment on the helpfulness of this card and revised it accordingly.

Results and Discussion

Creating the hypertexts was not without difficulties. Most students had little prior computer experience, and some appeared anxious about the project. It was also apparent that not everyone could envision the final product from the beginning. Although I was always available to provide assistance and answer questions, I encouraged students to struggle with the assignment lest I undermine their “learning by doing.” When the stacks were completed, I spent less than 90 min editing each stack, testing buttons, linking the main menu to appropriate cards, and fixing minor problems.

The junior class produced an integrated hypertext of 166 cards, each of which provided the user with from 7 to 15 options. The first-year honors course produced a stack of 77 cards. The success of the exercise was evaluated by the success of a scavenger hunt for a specific quotation and students’ written comments about their experience.

Students used the completed hypertext for free exploration and the scavenger hunt. The purpose of the scavenger hunt was to demonstrate the functionality of the hypertext itself and the ability of students to use it. Students were given a quotation to locate in the hypertext developed by the other class. Thus, students in the junior seminar were asked to find a quotation hidden in the honors hypertext, and the first-year honors students had to find a quote in the junior hypertext. Students were instructed to navigate the hypertext using only the buttons (not the “find” function) and locate the quotation as rapidly as possible. Students produced a record of their search by printing a hard copy of each card examined in the search process. Results of this exercise were shared with students in each class.

All 14 students in the junior seminar found the quotation they were asked to look for in a stack of 77 cards. The mean number of moves was 11.15, with a median of 8 and a range from 5 to 33. By chance alone, we would expect students to find the quotation in 38 moves. Each of the eight first-year honors students found a quotation in a stack of 166 cards. The mean number of moves was 12.5, with a median of 11.5 and a range from 4 to 26. By chance alone, we would expect students to find the quote in 83 moves. These results indicate that students could use these stacks to find specific information.

Another source of information about the success of the project is students’ written comments. Comments were collected immediately following the scavenger hunt and as part of the routine course evaluation. These comments were, for the most part, positive and informative. Nine of 14 juniors explicitly wrote that the hypertext exercise should be kept, and none said it should be eliminated. On the Honors Program Seminar Evaluation Form, the first-year honors students were asked “which of the course assignments (exams, papers, group projects) seemed most useful to your learning process? Which seemed least useful? Why?” Four students wrote that the hypertext project was the most useful, and one said it was not useful.

Students indicated an awareness of the strengths and weaknesses of our homespun hypertext and of hypertext in general. One student wrote, “you had to think critically and adapt new ways of thinking to your own.” It appears that direct experience with building and using a hypertext helped students think critically, develop well reasoned positions, and question some of the more extravagant claims about hypertext.

Using the framework of ill-structured problem solving and informal reasoning, efforts to facilitate critical thinking were directed toward developing students’ representations of hypertext. These efforts included a diverse set of readings that sometimes contradicted one another, group discussions about hypertext, and collaborative group work on the computer. My goal was to create an active learning environment that facilitated critical thinking, a collaborative context in which students exchanged and applied ideas, compared theories to experience, and discussed relations between the readings and the project. The successful completion of the homespun hypertexts and students’ oral and written comments suggest that most were able to develop a cognitive representation of hypertext sufficiently to form the basis of arguments and actions. These are precisely the abilities that computer literate students will need as they enter the next century.

References


Note

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Using Riddles and Interactive Computer Games to Teach Problem-Solving Skills

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Cognitive flexibility, which is defined as the ability to generate several categories of possible solutions, is identified as the most critical aspect of creativity training. Word tables, interactive computer games, and riddles are used to develop cognitive flexibility. Preliminary results from analyses with quasi-experimental designs provide promising evidence that these methods are effective in enhancing creative and other forms of critical thought in college students.

Ruggiero (1984) took the approach, popular among psychologists, of characterizing the problem-solving process as having two complementary phases: production and judgment. In the production phase, which he associated with creative thinking, potential solutions to the problem are generated. In the judgment phase, which he associated with critical thinking, the ideas generated are evaluated. This approach seems to elevate the importance of teaching stu-