

On the Progress of Developing Groupware to Support Notetaking

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Background

The Problem

Teachers traditionally write on blackboards and similar devices while delivering their lectures. Often the majority of each student's energy is then devoted to *copying* what the instructor has written into his/her notebook. Only occasionally does a student find time to *listen* to the lecture, *think* about the associated ideas, and appropriately *annotate* the copied notes. The difficulties stemming from the need to copy a large amount of information arise in classes taught in many academic disciplines. However, the problem is perhaps most pronounced in science and mathematics classes where a large amount of information, usually expressed using potentially confusing symbols and notation, is frequently presented very rapidly. A mathematics teacher who is very familiar with the notation of the discipline may very quickly write a formula like:

$$(a+b)^n = \sum_{k=0}^n C(n,k) a^k b^{n-k} = \sum_{k=0}^n \binom{n}{k} a^k b^{n-k}$$

on the blackboard, but students may require several minutes to copy it. Unfortunately, while the students are busy copying the formula they are often distracted from thinking about the instructor's discussion of its *significance*. A recent article in the *Chronicle of Higher Education* summarizes the problem with the following

comment made by a student at Cornell University: "In some classes, you're so busy trying to write down what the professors say that you miss half of the information" [Collison 1992]. Statements like this are quite common and served as a primary motivation for our system design.

Related Work

The situation described in the previous subsection can be viewed as a group communications problem. Simply stated, the teacher needs to efficiently and effectively communicate written information to each student in the group. This information should be transmitted in a way that does not impede the students' ability to perform other tasks which are essential to the learning process (listening, thinking, etc.) *Computer-Supported Cooperative Work (CSCW)* is the branch of Computer Science which deals with developing technology to assist group communications. The term *groupware* is often used to describe software systems related to CSCW. The reader who wants background information on CSCW or groupware is referred to [Baecker 1993].

Several groupware systems have been developed which place an electronic spin on standard blackboards and whiteboards. The software component of such a system is commonly referred to as whiteboarding software. For example the *SoftBoard*[®] [Microfield 1995] is a whiteboard that is equipped with a laser which tracks pens as they write (with real ink) on the surface of the board. Whiteboarding software is provided to display the information written on the *SoftBoard* simultaneously on a computer monitor. Although the information cannot be interactively edited on the computer monitor, it can be printed, saved to a file, or imported into other documents and edited later.

In some senses the *LiveBoard*, developed at Xerox PARC, is an interactive version of the *SoftBoard*. In place of writing on a whiteboard, users write on a large electronic monitor which measures 46 x 32 inches. This enables previously prepared material to be displayed on the screen and then edited interactively [Elrod et al. 1992]. Software has also been developed which allows the *Liveboard* to be used for medical instruction. Using this software students and teachers can gather around the *Liveboard* and collaborate on constructing and evaluating decision trees related to medical problems [Jain et al. 1994].

Programs like *GroupSketch*, *GroupDraw* [Greenberg et al. 1994], and *Colab* [Stefik et al. 1994], provide a shared drawing surface for two or more users. These systems operate in a WYSIWIS (What You See Is What I See -- pronounced Whizzy Whiz) mode. Whenever a user writes or draws something on his/her monitor, the result is immediately displayed on each of the other users' screens. *SlateMate* [Hamilton 1993] provides a similar drawing surface with features designed especially for use in the classroom. Although the system can be used in several ways, it is primarily intended to help a teacher provide rapid feedback to any student in the class. For example the teacher might pose a mathematics problem to the class. Each student works on a solution to the problem by writing with a special pen on their computer monitor. By selecting different icons the teacher can view the progress of any individual student in the class, and can send that student written comments. Thus the teacher can share a writing surface with any student in the class [Hamilton 1993].

The DEBBIE System

Overview

The DePauw Electronic BlackBoard for Interactive Education (*DEBBIE*) is a groupware system designed by the authors to enhance a teacher's ability to share written information with students. The system differs from other groupware in that it integrates a complete student-oriented notetaking system with a restricted form of a WYSIWIS shared writing surface. Most shared writing groupware is designed for a homogeneous group; all members of the group are peers, and whatever is written by one person is displayed on every other person's monitor. The restricted form of WYSIWIS which *DEBBIE* uses was developed based on the observation that, from a note-taking point of view, many classroom groups are heterogeneous with the teacher being a special

member of the group. The teacher may choose to transmit some information to the students in the class. In this case the material written by the teacher should be seen by every student in the class. However, as the students make written annotations on their individual copies of their notes, nothing should be transmitted back to the teacher (nor to other members of the class). Thus the writing surface should be like a one-way mirror sharing information in only one direction. We call this restricted form of a shared surface WYSIWISODO, (What You See Is What I See One Direction Only – pronounced Whizzy Whizz Odo).

Classroom Configuration

A *DEBBIE*-equipped classroom may contain one or more traditional writing surfaces (blackboards, whiteboards, overhead projectors, etc.) In addition the room contains a *SoftBoard* as described earlier. The *SoftBoard* is attached to a teacher station which is a computer running the teacher version of *DEBBIE*. This computer is also a node on a local area network. Each student in the class has a student station, a personal computer which is also attached to the network and which runs the student version of *DEBBIE*.

The computers comprising the teacher and student stations may be any IBM compatible personal computers running Windows™ 3.1 or higher, although we have obtained best results when the computers are equipped with 486 or pentium processors. Since the computers must accept hand-written input, the user will find it most convenient if the computers are either standard computers augmented with a light pen, or specially designed pen computers which have an electronic pen in place of a mouse as an input device.

The Teacher's View

When the teacher speaks, or writes on standard writing surfaces (blackboard, overhead projector, etc.), the students can use *DEBBIE* to take notes in the usual way. Although the students are writing with electronic pens, it is important to emphasize that they are interacting with the teacher in the traditional manner: the teacher delivers oral and written information, and the students selectively copy that information into their (electronic) notebooks.

Only when the teacher chooses to write information on the *SoftBoard* does the interaction mode between teacher and students change significantly. Any information written on the *SoftBoard* can appear on a student's screen automatically if the student so chooses. Thus the teacher is free to write information on the *SoftBoard* that s/he does not want the entire class to spend time copying. For example if a student in a poetry class asks a question about the structure of a Haiku, the teacher may want to show the class a specific Haiku in order to illustrate the answer to the question. While the students may want to have a copy of this Haiku in their notes, there is no benefit to be gained from having the students take the time to *copy* it. In fact the effort spent copying the Haiku will likely distract the students from listening to the teacher's explanation of its structure. Therefore, the teacher might choose to write the Haiku on the *SoftBoard* so that it appears immediately and automatically in the students' notebooks. As the teacher explains the poem's structure, the students can annotate their notes appropriately.

The Student's View

When *DEBBIE* starts to run the screen appears as shown below [see Fig. 1].

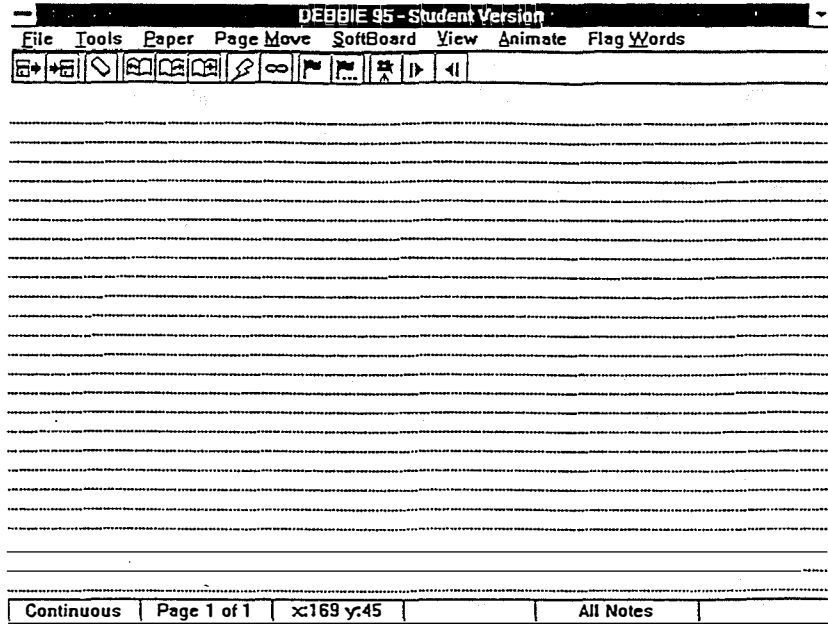


Figure 1: DEBBIE's Initial Display

The next pair of figures show the screen on a student station after the instructor has written some information on the *SoftBoard* [see Fig. 2] and the same screen after the student has added some additional notes to those written by the teacher [see Fig. 3].

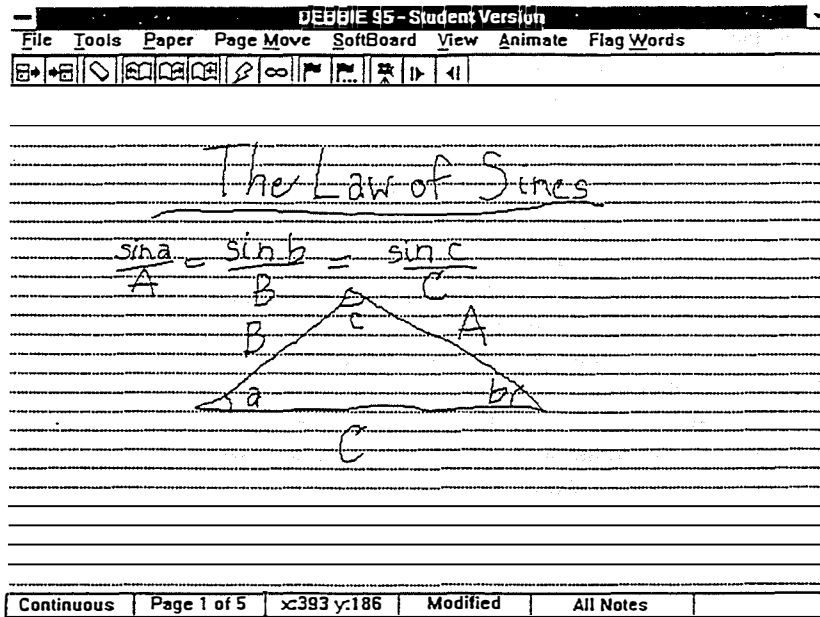


Figure 2: DEBBIE Display with Imported Notes

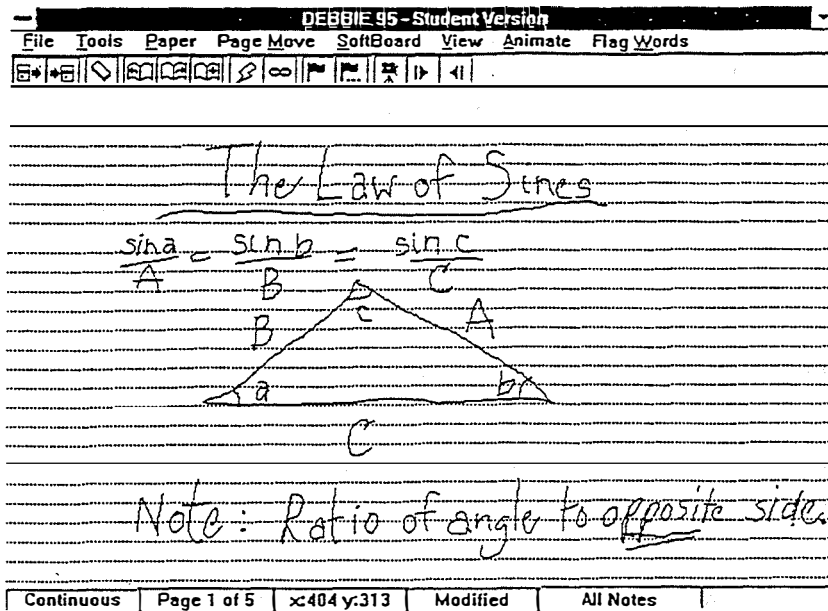


Figure 3: Debbie Screen With Student Annotations

As shown in the preceding figures *DEBBIE* displays several menu options at the top of the screen which can be selected using the pen. Once selected, these options display sub-menus which allow the following tasks to be performed:

- Saving notes to a disk file, and retrieving, deleting or renaming these notes at a later time.
- Changing the thickness and color of the pen (red, blue, black, and green are available), or temporarily replacing the pen by an eraser.
- Changing the way the pages are lined (blank pages, horizontal lines, vertical lines, and graph paper are available.)
- Moving to various pages in the notebook (previous, next, first, last, or a page with a specific number) and creating new pages. The student can view one page while the teacher is writing on another.
- Specifying whether the screen should display only notes written by the teacher, only notes written by the student, or both sets of notes simultaneously.
- Allowing students to take snap-shots of their notes as a complex diagram evolves in stages. This permits students to store an animated set of notes. To take a very simple example, suppose a teacher in a traditional classroom is showing a class how to draw a 3-dimensional cube. The teacher would first draw a square on the blackboard which the students would copy into their notes. Next the teacher would draw a second square shifted down and to the right, and overlapping with the first square. Again the students would copy this into their notes. Finally the teacher would connect the corresponding corners of the two squares (and the students would do the same) thus completing the cube. The problem here is that although the students have a picture of the completed cube in their notebooks, they do not have a record of *the process* that was used to construct the cube. If the *point* of the class was to teach the students *how* to draw a cube, then the students' notes do not capture the spirit of the lecture. Using *DEBBIE*, however, the students can store each step of the process as a frame rather than saving only the final result. These steps can be played back at a later time either continuously or by stepping forward and backward one frame at a time.

• Allowing one or more flag words to be stored on a specific page. For example the student might wish to store the word "velocity" on all pages that contain material related to this concept. The flag words are stored as ASCII text so that the student can search for pages containing specific flag words at a later time. If a pen computer running the Windows for Pen Computing Operating System is used as the student station, the flag words can be entered using the pen and the system will convert them to ASCII text. Otherwise the flag words must be entered at the keyboard.

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