

Designing a Computer Classroom

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In the proposal for the NSF grant DUE-9851405 “Using computers to extend reform beyond calculus” we proposed to “extend the pedagogical changes and appropriate use of technology that characterizes calculus ‘reform’ to courses in linear and abstract algebra, geometry, and computer science.” We have developed a significant amount of pedagogical material that is available at our web site, <http://euler.slu.edu> under the heading of “teaching material.” While we are excited about that material, we feel that the nuts and bolts work we did on designing the computer classroom will be of independent interest to the mathematics community.

Considerations in the physical layout of the computer classroom

When we were designing a computer classroom, we were concerned that it be designed so the inclusion of computers in our courses not hinder our efforts to use other aspects of reform pedagogy in our classes. Too many of the “computer classrooms” that we have seen, are designed simply by putting computers on desks in traditional classrooms. Or by putting blackboards in a computers lab. Both of these designs hinder some instructional styles. Since we want to teach the students that computers are simply one more resource to be used when the task at hand calls for it we wanted a classroom that could be flexibly be used in a variety of teaching situations.

A first step in designing the classroom is thus to consider the scenes that a visitor who stopped by at random times would routinely see. After discussing this with faculty that would be teaching in the room we decided that the scenes would include:

- 1) The students are working at computers and the instructor is either moving around the room helping the students or guiding them from the instructor’s machine with the screen image of that machine projected on the front wall.
- 2) The instructor is at the front of the room either lecturing at the board or using the instructor’s machine to demonstrate a concept. The students are taking notes. They

may be using the computers to do the kind of scratch work that is often done in a classroom discussion.

- 3) The students are working in groups either in their places or at the board with the machines not being used on a particular exercise. The instructor is moving from group to group or making comments to the whole class.

We also found that instructors envisioned regularly moving between two or more of these scenes in a typical class period.

Translation to layout design specifications for the classroom:

Practically, the concern for the flexibility described above led to the following specifications for the layout of the room:

- 1) The students should be able to see their computer screens, the instructor's computer screen, and the main board without moving. This led to arranging the students in a traditional row arrangement. The instructor's computer screen can be projected onto the front wall. It can either be projected onto a screen or onto the front whiteboard. (Projecting onto the whiteboard allows the instructor to add annotations.)
- 2) The students need enough room to be able to take notes and do paper work while at their computers. This meant moving from desks to tables.
- 3) Based on our experience teaching in computer labs, we wanted the students to share computers, 2 students to 1 machine, but we also wanted them to be able to form groups of 4 students with 2 machines. This led us to putting tables together so 4 students would be at an extended table with a pair of computers together in the middle of the table. Since the students will be regularly moving as groupings change with the activity, we got chairs with wheels.
- 4) We want several people to see the same screen and we want them to be able to point things out to each other. We also wanted the instructor to be able to see all of the students' computer screens without moving from some point in the room. This led to a decision to use screens on top of the tables rather than ones sunk into desktops. To improve sight lines we wanted the CPUs under the tables.
- 5) To make it easy to switch to group work there should be enough board space to have 5 or 6 groups of students at the board at the same time. To do this we have white board on all available walls.

We also came up with a number of practical points derived from our experiences of trying to teach in other rooms with computers.

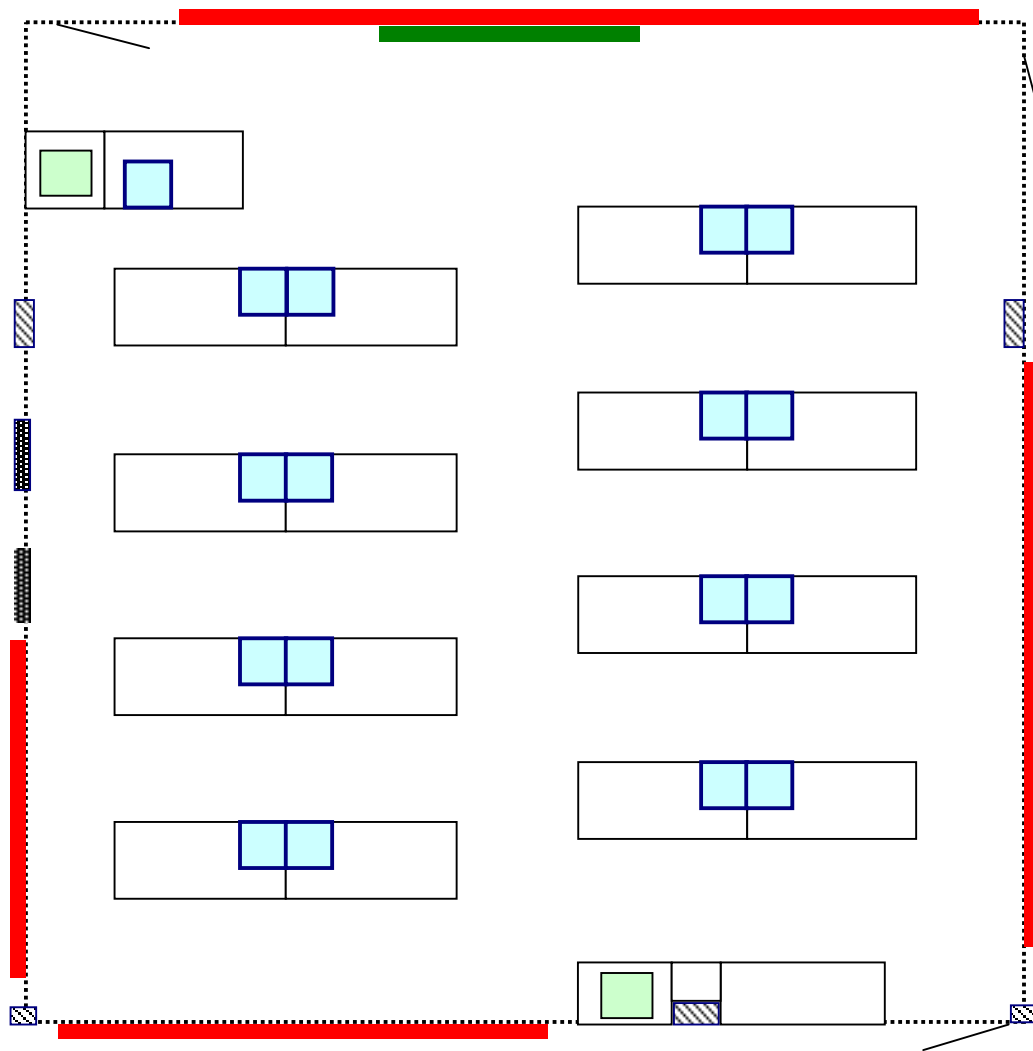
- 6) The tables should have enough space that an instructor can move behind the students when they are working and reach over a student's shoulder to point to a screen. We found that this translated into a spacing of 6 feet from table front to table front.
- 7) While computer work can be saved electronically, it is useful for the students to be able to make hard copies of their work, both for notes to study, and to be able to add

notations by hand. We included two printers in the room both to avoid congestion and to allow for the case when one would develop problems at an inconvenient time.

- 8) Unlike a traditional classroom, a computer classroom needs a place to store supplies. For the usage we envisioned that would include both computer supplies and teaching materials, like manipulatives for the mathematics for teachers class. This led us to include locking cabinets in the design of the computer classroom.
- 9) Another way that computer classrooms differ from traditional classrooms is that one regularly needs to change the lighting as one switches from board work to looking at a projected computer screen. We found that the room should have adjustable zone lighting controlled from the instructor's station.

Computer Classroom Floor Plan

Diagram shows table positions (with computer placements), printer tables, casework, whiteboards, screen position, pillars, doors and windows.



Considerations in designing the classroom computer network:

As the physical set-up of the computer classroom affects how it can be used for teaching, one also needs to pay attention to the set-up of the computer network. We once again started by asking how the instructors envisioned the students using the computers. Following up on the question used in deciding on the room layout, we asked what the students would be doing on the computers if a visitor drops in during class and the students have the computers on. Answers for student activity included:

- 1) Have the students work on a prepared worksheet with a variety of programs. The worksheet should be distributed without resort to floppies. Depending on the worksheet the students would be able to print their work, save their work to continue it outside of class, or turn their work in electronically. (The students may be working on computer specific activities designed for that class period.)
- 2) The students should be able to access both the internet and the various computer systems on campus. (The students may be using the computers to access resources outside the classroom, with resources being either information or software.)
- 3) The students should be able to easily use the software on the machines when they find it appropriate for the tasks assigned them, whether or not the assignment mentions the use of a computer. (The students may be using the computer as a tool for an activity that was not described as a computer activity. They have decided it is a useful tool at the time.)

A second question to consider when designing the network looks not at what the students will be doing, but how the network needs to work for the instructor to be able to use it effectively. Considerations that this brought up include:

- 1) The system should be dependable. The instructor should be able to count on all students finding the same thing in the same place on all the machines. If a student trashes an important file, or crashes a machine, or gets on a machine that a student from a previous class has done something strange to, there should be an easy way to fix the machine.
- 2) The set-up on the machines should be flexible. The instructors should be able to bring new material in for class use on short notice. In particular the instructor's machine can use material that can be installed during the 10 minute break between classes and the student's machines can be updated to include new programs or files on 24 hours notice.
- 3) The system should be easy to maintain.
- 4) The machines should run whatever pedagogical software the instructors find.
- 5) Distribution and retrieval of files should be easy. The option should be there for doing this with or without a password.

Translation to decisions made on hardware, software, and networking:

These considerations lead to a number of practical decisions in choosing hardware and software for the classroom and in configuring the network:

- 1) We wanted the computer classroom networked by ethernet, segmented from the larger campus network by a router or switch. (Segmenting the network increases reliability and protects the network in high bandwidth operations like file backups.)
- 2) For the base machine in the classroom we decided on Macintosh G3 mini-towers. (Given the personnel in the department, it was easier to get everything running with Macintoshes. The G3 was the mid level machine available when made the purchases. Based on the needs of the planned courses we decided on 17" screens.)
- 3) The computer classroom is backed up by a Macintosh G3 server to give a base for files sharing and routine back-ups. The Macintosh file sharing software allows file sharing that is either open without password, or restricted by password to specified users. In particular, instructors can set up one area from which students can copy files for use without being able to change the original, and another area where students can deposit files, but not be able to see or change the files after depositing them.
- 4) We are running a program named Assimilator on all the machines. Whenever a machine reboots, the program looks at a master image on the server and restores the machine to a standard file set. Extra files are deleted and missing files are replaced. Since the machines automatically reboot every morning, changing the master image installs software on every machine in the computer classroom by the next day.
- 5) A program, Screen-to-screen, on the instructor's machine allows the instructor to see thumbnails views of all the students' computer screens. It also allows the instructor to project a student's screen onto the front board or to project the instructor's screen to all the students' screens. (The thumbnail view allows a fast check that all machines are running. It also allows an easy check that the students stay on task. Projecting the instructor's screen is an easy way to lock the student screens during tests if they are not supposed to use computers on the test.)
- 6) To allow use of software that does not run on the Macintosh platform, each machine has a copy of VirtualPC for Windows emulation. Each machine also has a partitioned hard drive with a partition reserved for eventual use with Linux.
- 7) The standard software set for the computer classroom currently includes a general CAS package (Maple), specialized freeware algebra programs (Gap, Group Analyzer, and FGB (Finite Group Behavior)), software for specific mathematics courses (a freeware calculus program named xFunctions, IDE (Interactive Differential Equations), and Geometer's Sketchpad), a programming environment (Codewarrior), a web page editor (Homepage), and an assortment of software for internet use and general productivity.