



## Lessons from the Emporium 2: Help for Computer-Based Learning

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The Math Emporium<sup>i</sup> at Virginia Tech was one of the first large math computer learning facilities, and to the best of our knowledge is still the largest by a factor of at least two. Getting it organized and working effectively has certainly been a learning experience. This article is the second of three describing some of what we have learned, with emphasis on things we did not fully appreciate going into the project.

**Introduction:** Most math students need help, and quite a few will fail without a lot of it. The help system at the Emporium has nearly 80 people participating in some way and a budget over half a million dollars. We see it as the key to the success of the program. Ironically it is invisible to most visitors and new students: they see a computer lab that is unusually large and attractive but apparently similar in kind to hundreds of others. The first item of business in our computer-related courses is to acquaint students with the support available. Those who don't need it will work in dorm rooms or random hot spots, but for a significant number help at the Emporium will make the difference between success and failure.

Our experience is mainly with lower-level computationally oriented math courses. Help for second-year calculus and beyond is more difficult since for example undergraduate helpers are stumped more often. Some methods for dealing with this are discussed in the final section (Remote Help), but have not been fully developed. For courses outside of mathematics we would expect help needs, and therefore appropriate procedures, to be significantly different.

**The Procedure:** At each machine there is a red drink cup. A student who needs help puts the cup on top of the monitor. This charmingly low-tech signal brings personal help, usually within a minute.

Most floor helpers are graduate students and qualified undergraduates. With a little training they deal effectively with most problems. There are usually instructors on duty to help with more advanced courses or tricky problems. Sometimes instructors of classroom courses with computer assignments will have “office hours” when they are available for consultation in the Emporium. Senior professors occasionally have help assignments as a way to acquaint them with the program, but this is too expensive to be a regular feature.

The help system is organized as follows: First there is a director of operations who organizes work schedules and holds training sessions at the beginning of each semester and as needed thereafter. Next there are floor supervisors who ensure floor helpers are properly distributed and that students receive help in a timely manner. Helpers have two-way radios to request assistance or receive instructions from the manager. Finally there are up to 17 helpers who work directly with students.

There are also 5-8 tutors available in a fixed place (students go to them, not vice versa) three hours a day during the week. Tutors operate in the standard manner so we won't have much to say about them.

**Times and Numbers:** The Emporium is open 24 hours a day to holders of University IDs. Each day of the week has a particular pattern and actual numbers deviate from even day-specific averages by up to 50%. Wednesday and Thursday have roughly similar patterns and are probably “typical” in that patterns on other days can be explained as deviations from this. Combined averages for Wednesday and Thursday in fall 2003 are shown in Figure 1.

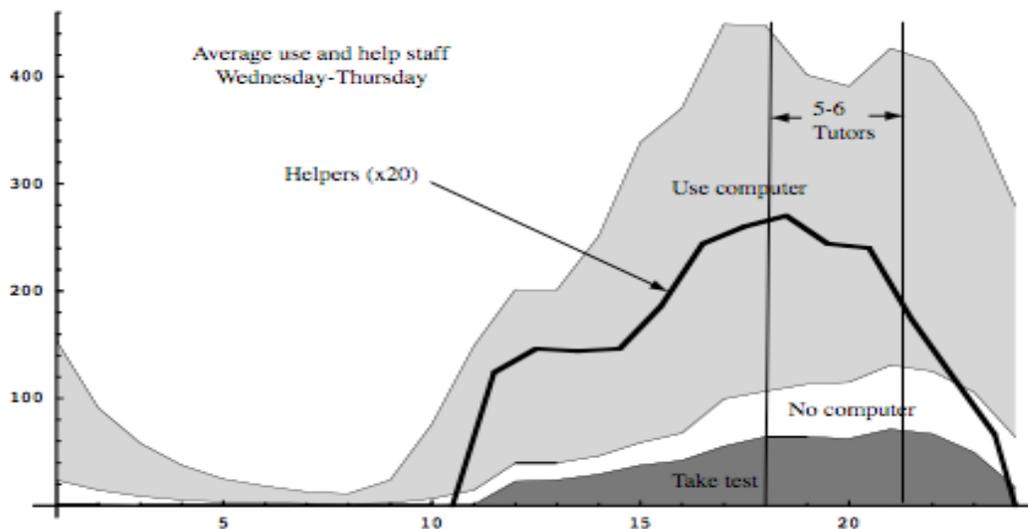


Figure 1 Midweek use and help

The scale for helpers is expanded by a factor of 20 to make it more visible. Help staffing is adjusted to meet actual demand, but the graph suggests a rough ratio of one helper per 30 students. Note that since students decide when to come scheduling must be done at their convenience, not that of the staff.

Use after-hours (over 150 at midnight) and without computers indicates a substantial number of users not needing help. These may be more-independent students, students making “appropriate” non-academic use of machines, or students meeting in groups in the lounge areas. Many students find the Emporium a comfortable and effective place to study, although this did fall off a little when we stopped allowing pizza in the lounges.

**The Job:** A student who requests help typically has a specific and focused difficulty. The main task of the helper is *diagnosis* of this difficulty. The ideal response is short and targeted: the minimum required to get the student unblocked and back to work. Most of the communication is from the student to the helper: speech, writing, talking, pointing, and body language. Sessions with stronger students are often shorter since they usually have made a good start on the diagnosis. A goal with these students is to show them how to complete their own diagnosis rather than simply giving a fix. Weaker students tend to have to communicate more to enable a diagnosis, but they may not need a longer response.

Help should not be thought of as “information delivery”. Experienced classroom teachers sometimes slip into “lecture mode” and give an extended lesson with the needed material embedded somewhere in it. The student becomes impatient, has to dig the key piece out himself, and other students may be waiting for help. We have had to learn to listen more and talk less. The slogan “guide by the side, not sage on the stage” has come to life in the Emporium. In cases where extended lessons are appropriate the student is referred to the tutors.

Helping is a very positive way to interact with students. They want help, are primed to receive it, and they recognize and appreciate effective help. It is pure mentoring, with no stressful critical or evaluation aspect. We often get students from disadvantaged backgrounds who have never had help guaranteed free of criticism or put-downs. It can be difficult to get these students to try it the first time, but they can be the greatest beneficiaries.

**Course Materials:** An unclear segment in a traditional text can usually be addressed by a classroom teacher without great difficulty. An unclear segment in a computer course may result in hundreds of nearly identical questions for the help staff. Even something as minor as a decoration can be a problem if students think it is a link that isn’t working. Some of our observations are:

- Embellished, animated, or stylized materials (e.g. graphic illustrations of limits and continuity) invite trouble;
- Optional or “enrichment” materials are frequently sloppy and can be a liability. They should generally be avoided or not supported
- Feedback mechanisms for fixing pedagogical problems seen repeatedly by helpers can be very worthwhile; and
- Well-designed materials can aid helpers as well as students. For instance ongoing notational conventions or implicit assumptions can be difficult to untangle, while careful compartmentalization reduces the need for help as well as making diagnosis easier.

Sometimes help issues can determine whether or not something is feasible. For example at one time we had modestly difficult calculus labs using Mathematica. Mathematica can do some seriously obscure things, but for the most part a session executed one line at a time and recorded in a notebook can be diagnosed for errors. Later there was a change to compiled and executed Matlab programs. Instead of mathematical errors we saw programming errors that were beyond available time and expertise to diagnose, so this could not be supported. Next Matlab was used line-at-a-time. This was better than compiled programs but still harder to diagnose than Mathematica. For the present we have essentially abandoned support for computer-math work.

**Remote Help:** Our course materials are available anywhere online, but we do not consider them “on-line courses” because the help component is available only at the Emporium. For several years we experimented with remote help. The immediate objective was expert help on-site, but we hoped it would evolve beyond that.

The need came from Mathematica calculus labs. Weekly briefings on common problems enabled the floor helpers to deal with most of them, but there were still problems requiring significantly greater expertise. Floor helpers with such expertise were economically impossible, so we tried a single remotely-available expert as a backup.

The remote expert could see a copy of the student’s screen, control the machine, and use a primitive audio link. Students could initiate an expert help session by clicking a link, and floor helpers could communicate by radio. We found it was significantly harder to get enough information through these channels to diagnose problems, and also harder to communicate solutions. In particular body language seems to be more important than we had expected. Most students strongly preferred in-person help that might not succeed to remote help that always succeeded. The system was most successful when it was used as a resource by helpers rather than students. When helpers got stuck they could call in their preliminary diagnosis and get a solution to relay to the student. The end result was an improvement of on-site help, not a replacement for it.

This expert help system was over-budget for the use being made of it at the time. In principle we could have “financed” it by moving more of the learning process into labs and reducing lecture time. Instead the labs were rewritten so they could be worked by hand. Now students are encouraged to work labs with computer-math systems, but if they get stuck they switch to pencils. Remote support was discontinued. We hope to try this system again, but for economic reasons it will require conversion of a large-enrollment course to a mode that heavily depends on it.

**Summary:** Overall success, and in particular the one clear benefit (better performance by weak students) of our computer-based courses are largely due to the one-on-one help available in the Emporium. The key activity is diagnosis of problems, not “information delivery”. Help with more complex material (computer-based math or advanced courses) can be improved by providing helpers with remote support. Helping students remotely is, so far, both less successful and economically infeasible.

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<sup>i</sup> See <http://www.emporium.vt.edu> for more information.