

Learning Spaces for Undergraduate Mathematics

Responses from MAA Community
Project NExT

I. In planning our new science building, the mathematics department wanted spaces that nurture community.

- ◆ The formal learning spaces (classrooms and labs) to hold no more than 24 students—so classes could be interactive and collaborative, with large tables instead of individual desks, so materials students working on can be spread out to enhance team work.
- ◆ A computer lab that allowed two/three students to work at a computer together and was spacious enough to enough facilitate community work, as well as group work.
- ◆ Informal spaces for students to congregate between classes. We have beautiful informal spaces now – some with big comfy leather-like armchairs and low tables, some with round wooden tables and chairs, and wanted this environment to be incorporated into new spaces.
- ◆ A space that facilitates and nurtures communities of math faculty and students (we now have a weekly Math Tea for students and faculty).

Our architects had other ideas, which we are happy they talked us into:

- ◆ That each classroom and lab has a similar instructor's station with computer, document camera, DVD player, etc. (However, the instructor's table area should have been larger, in order to hold papers and other materials needed by the instructor.)
- ◆ Whiteboards everywhere. Even though they are a pain to keep clean and the dry erase markers and erasers expensive, we love them, and find the flexibility to write in several different colors makes lectures and all our work more fun.
- ◆ A room/library for students to hang out in and for irregular seminars. All tables in this space have computer/electric outlets.

What kind of learning spaces work for undergraduate mathematics learning communities? This question was posed by an architect with more experience in shaping spaces for learners and researchers in the laboratory sciences.

We sent this question to colleagues at MAA (Mathematical Association of America), who forwarded the question to members of the MAA Project NExT. Their responses, which follow, reveal a vision of a community, one in which learning takes place (almost) 24/7, in formal and informal settings in which students and faculty use hi-tech and low-tech tools in collaborating and celebrating in their learning.

II. Many things worked for us to enhance mathematical learning through the informed design and use of spaces.

- ◆ Informal spaces around the math department that encourage interactions among students and between students and faculty members and that increase the sense of community within the department. The design strategy is simple: wide hallways in the departmental space equipped with tables, comfortable chairs and a few boards for writing (on the wall/portable). All these encourage the kind of interactions and group work that we believe are strategies for deep learning.
- ◆ Close spatial connections between such informal spaces and faculty offices, so if/when a group encounters a difficult problem they can't solve, there is easy access to advice from faculty.
- ◆ Comfortable waiting chairs outside faculty offices which allow for privacy of in-office discussions with students.
- ◆ Lots and lots of boards on which to write— both white and black.

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- ♦ The careful placement of technologies within a classroom. This means a both the projected image and the board can be seen at the same time. Having the screen in the corner of the room allows an image to be projected, while commentary or additional computations can be done at the board. (Another approach 'that works' to the placement of technologies is when projected images go to a blank white wall that has been designed specifically for the purpose directly above the board.)



III. What works for us are spaces that are flexible, yet serve specific departmental/spatial goals.

- ♦ One set of computer labs has rows of tables parallel to the front wall, with computers and screens facing the back wall, chairs facing the front wall, a teacher's computer and projector at the front.
- ♦ A second set of computer labs has rows of tables along the perimeter of the room, with computers and screens facing in towards the center, chairs facing outwards, tables and chairs for conversation and discussion in the center of the room, a teacher's computer and projector at the front.
- ♦ At the back of one of our computer labs, space set aside for 'drop-in' tutoring during open lab times.
- ♦ A designated, informal and flexible space that "belongs" to the Math Club.

- ♦ Making the doing of mathematics visible. This is happening with framed posters hanging in the halls, describing individuals who were math majors and the work they do now in their careers that use math; there are white boards mounted in some less-traveled halls, allowing students to work on math problems together while waiting for class.

What might have been different?

Except for the classroom dedicated to math education courses, most classrooms have the standard arrangement of desks in rows, facing the front. These do not facilitate the kind of collaborative learning and teaching approaches that we are now using.

IV. In our renovation efforts, some things worked and some did not.

- ♦ We have a departmental cluster, with offices around the perimeter of three spaces—a seminar room, a math "library," and faculty lounge—in the center. (Offices for graduate student offices are one floor below.) All rooms have doors that can be closed, important for noise control in our cinderblock building. This works

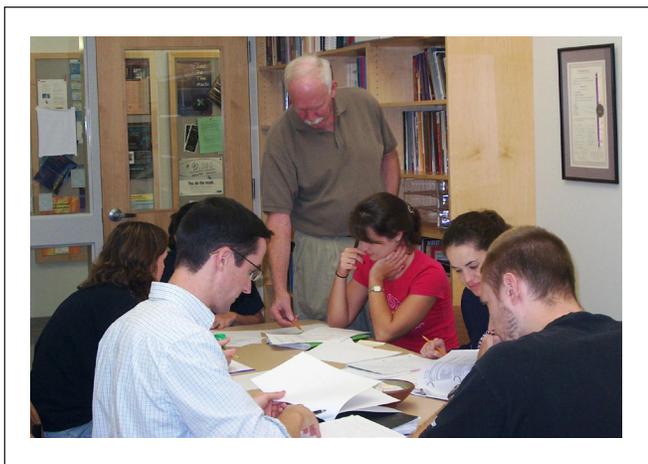
The math library is an open study area at all times, sometimes for scheduled tutoring sessions. There are several large work tables, one wall of chalkboard, and two small couches. This arrangement encourages undergraduates to spend time in the department, fostering community and collaboration. It also enables quick questions of faculty when students are 'stuck' in their studies.



- ◆ We currently have a makeshift computer lab in a small room near the faculty offices. Originally designed for statistics students who needed access to specialized software, its use is now extended to students in other math classes. For example, a technology component is part of each Calculus classes and students often struggle with the learning curve on the software (Mathematica). It has been very helpful to have a lab where students can work on Calculus assignments, more so in that this space is near my office. My students can come for quick help when they're stuck on technical or syntax issues. This significantly lowers their frustration level, and helps them focus on the learning goals of the assignment rather than technical details. We currently have no formal staffing in this lab, but numerous faculty members and graduate students utilize it in similar ways, so there are often others to call upon.

What does not work.

Several years ago one classroom was fitted with individual computers on each desktop. This was impractical, as the classroom was needed for the regular rotation of classes, thus not readily available to students/classes that needed the technologies and sometimes assigned to classes that did not. Further, there was no budget for ongoing maintenance in support of daily usage, updates and fixes, etc. Once reliability was lost, instructors stop using computers in class and they quickly became physical obstacles rather than useful learning tools.



V. What we hope works for us is sustaining and enhancing departmental culture in the process of renovating.

- ◆ Our department currently resides in a "suite" of offices arranged around a central area with tables, armchairs, and white/blackboards, as well as a few bookshelves and a nice big window for natural light. This is just about perfect—there are always students in the math suite—some working on specific problems, some studying math, some studying other things and some just hanging out. What this has meant, over the years, is that there are countless interactions, both among students and between students and professors that have shaped our math community in meaningful ways

Most faculty have an open-door policy, encouraging students to walk in and out. This enables lots of topics to come up and get discussed, often casually at first but developing into good problem-solving or looking up topics. The students sense this is a friendly place, one where they can easily get help from peers or faculty without taking the big step of knocking on a professor's door right away, which intimidating for many students.

I speak for my department in saying that such informal spaces and culture must be part of every math learning environment. The problem-solving sessions ARE our labs, so to speak, and we need space for this to happen, and it needs to be a space where students' and professors' ideas can cross-fertilize.

- ◆ However, now in the process of planning an extensive renovation we are having trouble expressing to the architects just how important this informal atmosphere and space is to the department—to the faculty and to our students.

They seem to understand how to shape spaces for the natural sciences—labs have more tangible requirements and systems, and they understand how to design them (and why). But they are telling us that "but students will have work areas in the atrium, so they don't need more space near your offices."

VI. Informal Comments

- ♦ When I was an undergraduate, the most useful space for informal learning was a simple conference room with a large table (with room for 10 or so people), and lots of blackboard space. This room was in an academic building open 24/7. One semester while taking a very challenging upper-level analysis course, we formed a study group and met in this room the night before each problem set was due—a chance to share thoughts and help each other out, something that was encouraged. I learned as much from those sessions as I did in class! Having LOTS of blackboard space is critical. We didn't need any sort of computer access or computational tools, since we were doing proofs.
- ♦ A feature of our old building that we lost in our new building is that those teaching classrooms had high-quality blackboards all along three walls. This enabled students to work at the board in small groups. This is important because as students are up and physically active, it is easy to share their work with other people, promoting the peer-to-peer discussions that are part of our learning strategies.



- ♦ In conversations with potential firms to assist with our remodeling efforts, we emphasized the importance of classrooms and office spaces that were close to one another and, if possible, open to a central area / lounge. Because of the reality of our existing space, most interactions are centralized within classrooms, although the student lounge is used regularly. The linear layout of the building means that there is one corridor with classrooms and offices on one side or the other.

If someone with a creative approach came along and drew something that were more circular, somehow spaces with some central areas and perhaps with little pockets of offices and with lab space but also allowing for smooth transitions of large hoards of people during breaks between classes, that would be ideal. ■