THE SCIENCE OF LEARNING: DESIGNING THE STEM LEARNING FACILITIES OF THE FUTURE
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TAXONOMY OF LEARNING ENVIRONMENTS

Source: Center for 21st Century Universities, Georgia Institute of Technology 2013
INTRODUCTION

As undergraduate science educators adjust to changing science, technology, engineering and mathematics (STEM) curriculum, academic institutions must create new types of learning environments.

New technology and changing pedagogies are influencing how to best teach a generation of learners who have never known a world without smartphones or tablets. Architects and designers must become partners in creating the dynamic science teaching facilities required for undergraduate STEM education.

By understanding today’s students and envisioning how learning will continue to evolve, we can shape the structures and spaces that support new teaching methods and evolving educational missions.
The classes that meet on campus will need additional area per student to accommodate interactive configurations, such as those allowing group work in the flow of the traditional class period.

Typically these will be flat floors allowing easy configuration changes. At the same time, these rooms must be faster, with access to robust bandwidth and ubiquitous digital display.
Several significant trends are impacting the design and function of today’s science classrooms:

- A generation of students who learn and communicate differently from previous generations.
- Integrated technology in classrooms, teaching labs and other student spaces.
- Redesigned course delivery that includes a blend of in-person and online experiences.
- A recognition of the value of small group work where students learn from and support each other.
- Intentional learning, in which students become advocates of their own education.
- A goal to increase retention of students completing their degree in a STEM field.
- The need to equip students to enter a competitive workforce with broad-based skills, adaptability and critical thinking acquired through a high-quality educational experience.

Technology has empowered students to complete much of their learning – whether it’s watching a video lecture, researching information online or completing reading assignments – before entering the classroom. Commonly known as “flipping the classroom,” this approach allows class time to be spent working on problems in small groups where students can learn from their peers and receive guidance from the instructor.

Variations of this pedagogy include problem-based learning (PBL), team-based learning (TBL) and SCALE-UP (Student-Centered Active Learning Environment with Upside-down Pedagogies), all of which emphasize the importance of spending class time – when the greatest amount of help is available – solving difficult problems and concepts.

In fact, small group learning has been demonstrated to be more effective for retention than a traditional lecture format.

Because today’s science education is hands-on and lab-focused, teaching labs must be flexible enough to accommodate diverse disciplines, shifting priorities and new focus areas.

An emerging trend in STEM undergraduate learning is the incorporation of a true interdisciplinary curriculum when possible. This shift creates an environment where students are working in teams with other disciplines and learning about collaboration as they would in the real world.

The first year or two of a program may provide opportunities for courses to be redefined to integrate several STEM disciplines – including physics, math, chemistry and biology – into the teaching lab environment.

By configuring utilities, gases and other core functions along the perimeter of a lab, the center can be left open to facilitate maximum flexibility of tables, chairs and lab stools. Designing all labs based on the same module enables any space to function as a teaching lab, a research lab or a classroom as needed. This same room can be a teaching lab, a team based learning classroom, a computer lab, a lecture classroom and/or a student project work room.

Fewer than 40% of students intending to major in a STEM field complete their degree.

Increasing retention by 10% would supply 75% of the need.³

Relationship-building is one of the greatest benefits of the university experience. It sets a physical university environment apart from online degree programs. While there are several ways to foster a community of learning, an emerging trend is to provide spaces for students to meet outside the classroom to study, work in teams or share a meal. Known as “learning landscapes,” these open collaboration areas and café spaces provide a place for students to remain on campus beyond class time. These are the “sticky” spaces. Because they create opportunities to learn from each other and build relationships, these spaces can help increase student retention.

A robust technological environment is a necessity for delivering content and enabling both formal and informal interaction in classrooms and wherever students gather. Access to the internet and the ability to use wireless devices must be provided throughout the building and campus.

In student-focused buildings, the goal is to provide a 1:1 ratio of scheduled seats (classrooms and teaching labs) to unscheduled spaces (open seating and study rooms). This is a major shift from the classroom and lab focused buildings of the past.

STEM education is truly at a crossroads as traditional scientific silos are transformed into multidisciplinary – and even interdisciplinary – fields. But institutions are struggling to modify their curriculum because of governance issues, class scheduling, teaching hours, tenure, and other institutional challenges.

We help universities address these change management issues and design innovative spaces, such as “think tanks” for faculty members, to facilitate the cross-pollination of ideas.

As boundaries between the life sciences and physical sciences continue to blur, the need for flexible teaching lab spaces that can accommodate multidisciplinary experiments and demonstrations increases.

It’s also important to designate places for academic partnership with industry to occur. These externally focused spaces enable students to participate in research internships and externships as they gain valuable experience and explore potential career opportunities.
As universities and colleges continue to involve students in research at an early stage in their educational experience, students begin to appreciate the remarkable potential of pursuing a career in science.

This hands-on research allows students to effectively function in collaborative environments and be better prepared to enter the workforce.

Creating spaces that can incorporate more sophisticated science curriculums will help prepare the next generation of top scientists to begin working on the many scientific challenges facing our world.

“High-performing students frequently cite uninspiring introductory courses as a factor in their choice to switch majors.”

“The leadership of higher education and STEM-enabled businesses needs to be inspired to generate sweeping changes in higher education to produce the workforce America needs.”

INDUSTRY PARTNERSHIPS

Places for academic partnership with industry within the building are incredibly important. Academic partnerships with companies create the opportunity to place students in research internships and externships, and to stay grounded in the requirements and career opportunities these companies can provide.

EVOLUTION OF INTERDISCIPLINARY SCIENCE

from many departments

physics biology chemistry

to many departments in one building

physics biology chemistry

to a true interdisciplinary facility