

The ABCs of STEM

Aligning design with pedagogy to engage the next generation of innovators.

In recent years, there has been growing focus on the science, technology, engineering, and mathematics (STEM) disciplines in U.S. education. Waning enrollment and a lack of engagement in these fields is leading to concerns about preparing the next generation of innovators and global leaders as we look to the nation's future.

To address this deficit, new approaches and a renewed focus on STEM teaching—especially at the high school level—stress collaboration, innovation, and interdisciplinary learning. Forward-

thinking educators have begun to embrace these methods, but the design of STEM facilities has, for the most part, not kept pace with emerging educational needs.

New approaches to STEM education must go hand in hand with new approaches to STEM spaces. This research paper is part of Gensler's ongoing effort to understand how STEM pedagogy is evolving and to devise new design solutions that better align with a changing educational landscape.

Our research goals:

- 1 To assess the current state of STEM facilities, identifying best and worst practices through the eyes of educators and experts.
- 2 To understand evolving approaches to STEM education as they relate to design.
- 3 To conceptualize design responses that support emerging STEM needs and initiatives, with a focus on high schools.



Context

The past decade has not been kind to the science, technology, engineering, and mathematics (STEM) disciplines in the United States. Fewer and fewer students pursue advanced degrees in these subjects,¹ and the U.S. STEM industry, once the envy of other nations, has slipped in global rankings.² As a result, industry leaders and government bodies are increasingly calling attention to the importance of STEM education at the high school level to the nation’s long-term competitiveness and the success of today’s children in the future STEM workforce.³

To develop and maintain a top-tier STEM workforce in the U.S., the education pipeline must be strengthened. Problems in high school STEM education translate into a lack of college graduates in science and technology, creating even greater disparities in the workforce. Studies suggest that early engagement in STEM courses is imperative, with high school serving as a vital link for students studying these subjects in higher education.⁴

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1. **President’s Council on Advisors on Science and Technology**, *Prepare and Inspire: K–12 Education in Science, Technology, Engineering, and Math (STEM) for America’s Future*, September 2010

 2. **World Economic Forum**, *The Global Competitiveness Report 2011–2012*, September 2011

 3. **U.S. Department of Commerce**, *The Competitiveness and Innovative Capacity of the United States*, January 2012

 4. **Adam V. Maltese & Robert H. Tai**, “Pipeline Persistence: Examining the Association of Educational Experiences with Earned Degrees in STEM Among U.S. Students,” *Science Education*, September 2011

Process

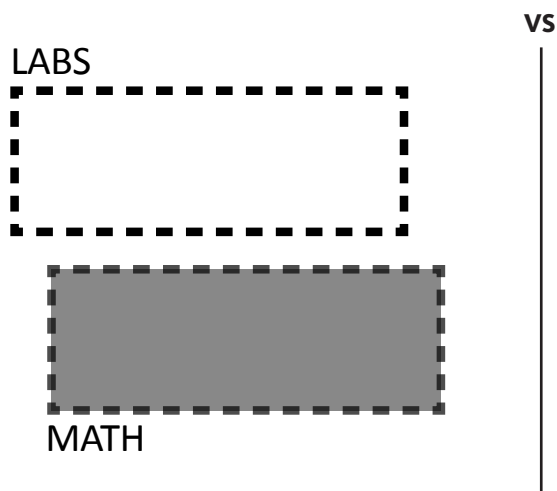
A team of Gensler education experts partnered with a group of educators from New Jersey’s Dwight-Englewood School and visited 16 science and technology facilities over a six-week period in 2011: 10 independent Northeast high schools, each with STEM teaching facilities built within the previous five years, and six higher-education institutions with notable STEM facilities built within the previous decade. In connection with the tours, we developed a discussion guide to help educators look beyond the conventional and take a more expansive view in evaluating STEM spaces and thinking about how an ideal facility might look and function.

Once tours were completed, we brought everyone together for a work session. The result was a catalogue of observations about general facility design, configuration, and specific aspects of the learning environments. To organize the discussion and the results, the group focused on separating observations into innovations, positive aspects, and negative aspects. Parsing the results in this manner highlighted the opportunities available to enhance STEM facilities and education through innovative design.

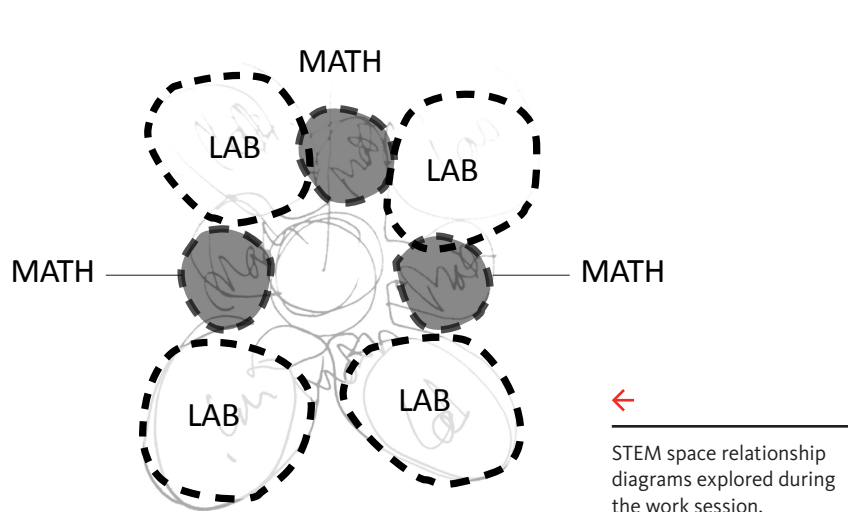
The Gensler team also conducted a review of primary and secondary sources on STEM education. What we learned underscores the importance and urgent need for new approaches and spaces to support STEM education. Although many reports focused on competitiveness, many also noted the increasingly collaborative and cross-disciplinary nature of work in these fields.

After completing the work session and the secondary research, we analyzed the findings to arrive at a set of key research insights and design tactics, outlined in the following sections.

Traditional Approach



Interdisciplinary Approach



Research Findings

Building on our research and analysis, the Gensler team identified three emerging themes around approaches to STEM education that amplify student engagement, described below. In response to each theme, the team conceived design tactics to address the identified needs and opportunities. The design responses on the following pages are supplemented with conceptual illustrations as well as examples from Gensler projects that highlight these particular strategies in action.

These ideas, ideal for implementation in a high school setting but broad enough to promote discussion at every level, are intended to be a starting point for future conversations about STEM spaces and pedagogy—and to inform the design and development of such facilities moving forward.

A

Everything Is Connected

Understanding that all STEM disciplines are intertwined is integral to creating spaces that promote cross-pollination and communication among different fields of study. Fluid connections between disciplines encourage students to make productive connections between subjects, increase the chance for faculty/student interactions, and encourage more productive student gatherings outside the classroom.

B

Anytime Is a Teaching Moment

Learning doesn't just happen in the classroom. The most successful STEM facilities engage students through a variety of mediums and at all times of the school day. A building's design can play an active role in this engagement by integrating the subjects that students are learning into their physical environments. The building itself can be a teaching tool, exposing its structure and systems to promote discussions around engineering, sustainability, and the relationship between the built and natural environments.

C

Learning Happens through Doing

Successful STEM facilities encourage an active, hands-on approach to learning and teaching. Rote learning is proving ineffective in efforts to engage students and convey complex concepts. This means more laboratory time and more experimentation. But it's not just about labs. Hybrid spaces that adapt to changing needs and promote active engagement with the learning environment are key to successful and productive learning.

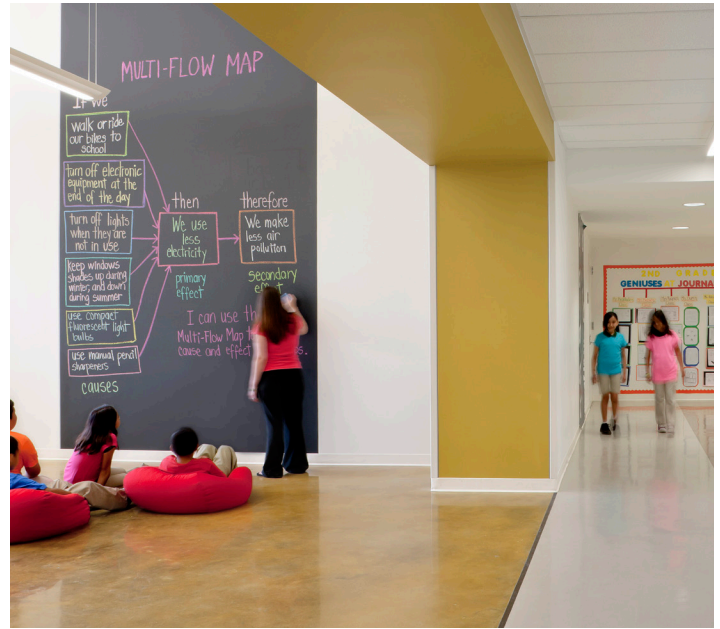
A Everything Is Connected

Goal

Create spaces that encourage cross-discipline communication; increase faculty-student interaction; and facilitate productive gatherings, both planned and impromptu.

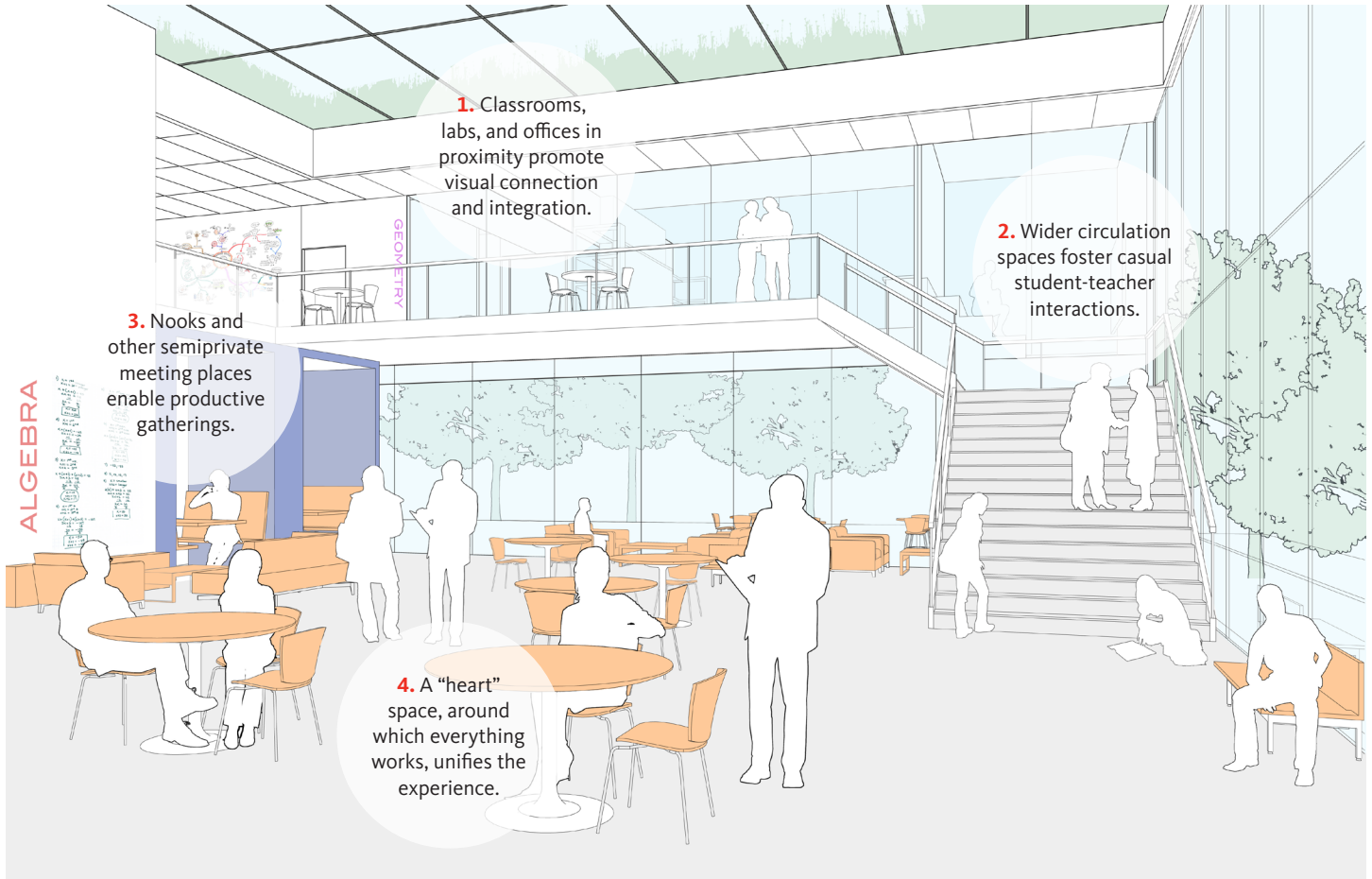
Design Response

Focus on activating and enhancing non-classroom spaces. Avoid blank hallways or corridors. Instead, leverage circulation as an opportunity to provide space and furniture solutions that promote collaboration and interaction between students and teachers across classes, disciplines, and even ages. If possible, these smaller interventions should convene in a “heart” space—a central area where all parts of student life interact. For maximum impact, locate the heart at a key intersection between departments and circulation paths.



James Berry Elementary School, Houston, Texas

Design Recommendations



B Anytime Is a Teaching Moment

Goal

Create teachable buildings that support the STEM curriculum through direct and indirect educational tools, from classroom displays to expressions of the science behind the building itself.

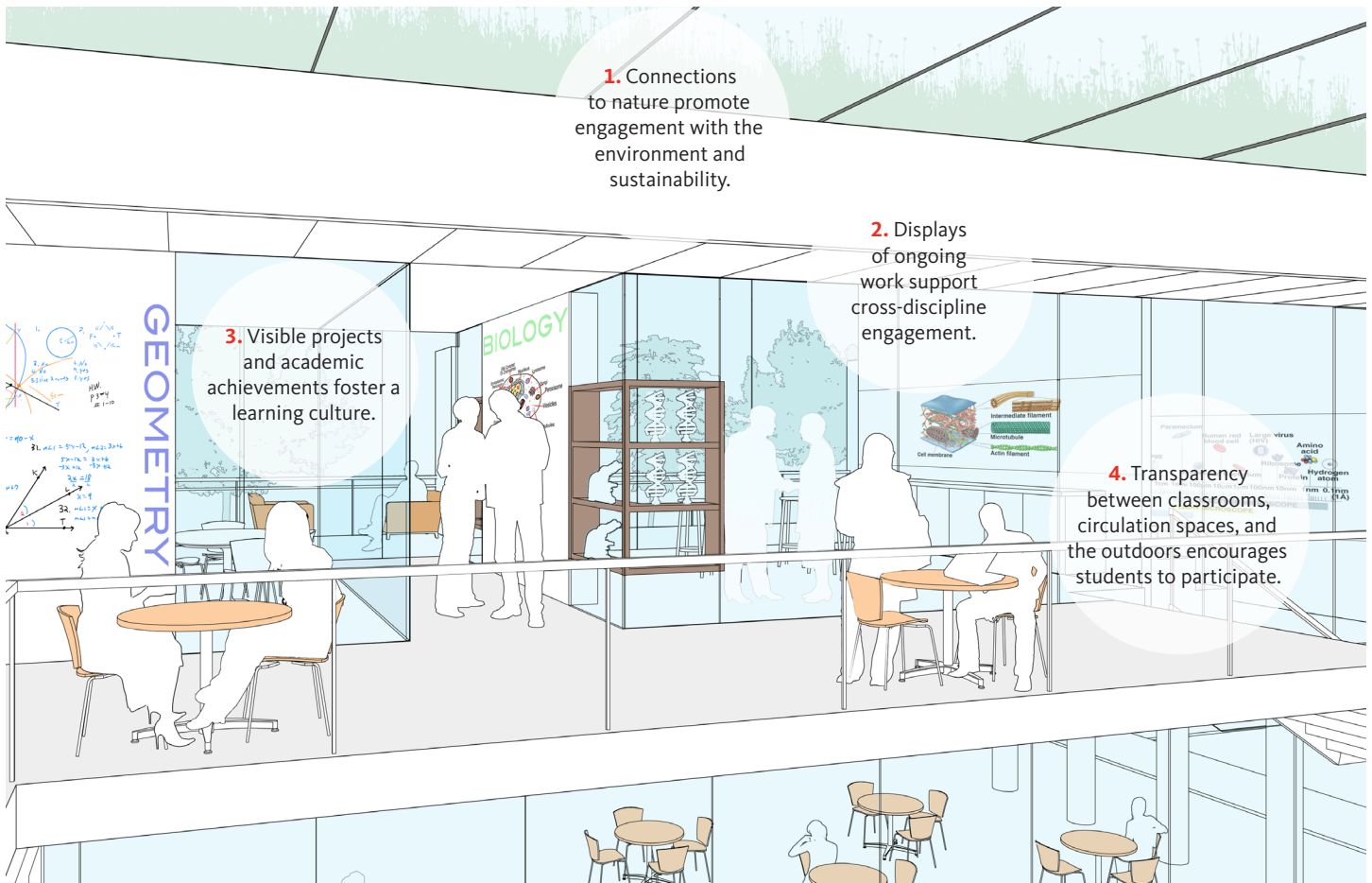
Design Response

Leverage the design and construction of STEM facilities as an opportunity to expose students firsthand to engineering and sustainability principles. Make structure “transparent”—exposed beams, energy strategies, and raw materials, for example. Classrooms should be transparent as well, with in-progress work on display. Incorporate sustainable practices and natural or outdoor space whenever possible, then actively integrate these spaces into students’ daily learning and life.



St. Philip's Academy
Newark, New Jersey

Design Recommendations



C Learning Happens through Doing

Goal

Create flexible, multizone teaching spaces that promote hands-on interaction, provide opportunities for experimentation, and build in the ability to change over time.

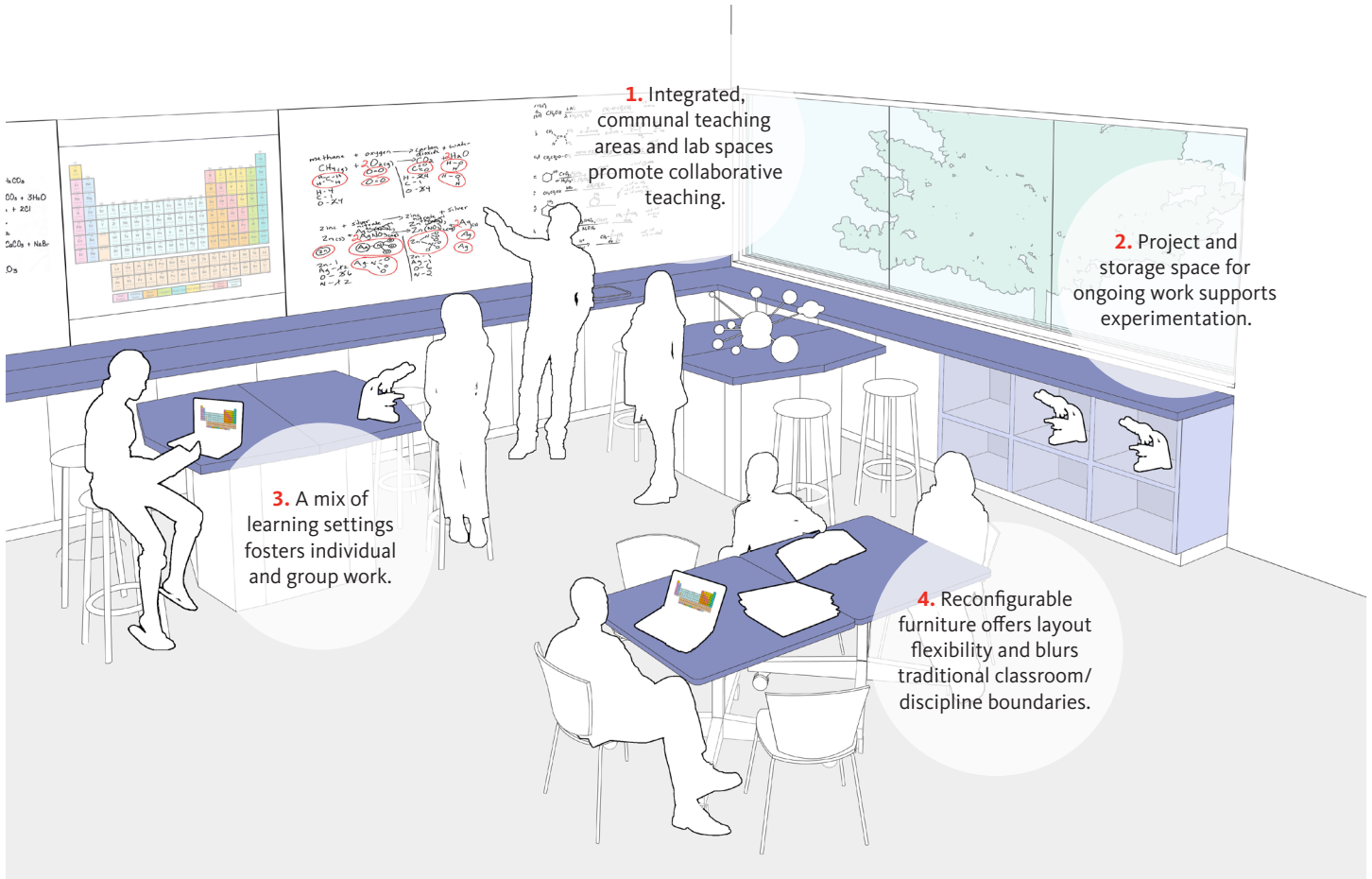
Design Response

Avoid silo-ing space types or uses whenever possible. Instead, consider environments that incorporate fixed infrastructure (labs, workshops, etc.) alongside more flexible teaching zones. This creates opportunities for a seamless transition between doing and teaching, and keeps ongoing investigations on display even when not being actively engaged. The tools and technology that support these spaces will be constantly evolving, so building in the ability to easily evolve these spaces to accommodate is of prime importance.

Design Recommendations



Dwight-Englewood School
(Preliminary Concept Rendering)
Englewood, New Jersey



Research in Brief

As the systems and technologies through which we manage and interact with our world grow more complex and interrelated, the importance of cross-discipline approaches to teaching, learning, and making will only increase.

Strategies that merge disciplines have long existed in the realm of the liberal arts. It is important to recognize that while the need to integrate STEM disciplines is similar, the spaces that support them may require a distinct set of strategies and design tactics. Achieving flexibility and productive interrelationships without sacrificing the resource-heavy environments needed for science, technology, engineering, and mathematics is of key importance as we design the STEM spaces of the future.

Opportunities for Further Investigation

A discussion about STEM spaces leads to a discussion about STEM pedagogy, and vice versa. The design concepts shown in this document are just the beginning of the conversation. As Gensler puts these ideas into practice through our ongoing project work, we continue to pose questions to ourselves and to the STEM community—such as the ones below.

1 A number of these design strategies are most easily applied in new construction or major renovation scenarios, yet many schools struggle with financing such projects. How can we develop feasible strategies for transforming existing environments?

2 There have been recent calls to move “from STEM to STEAM” in an effort to include the arts in the conversation about advancing the sciences. How would STEM environments need to adapt to integrate the arts?

3 What can we glean from the space and design strategies employed in other countries, especially those where precollege STEM education appears to be more successful than it is in the U.S.?

4 At the K–12 level, STEM pedagogy is part of a school’s core curriculum; at the university level, it is largely a matter of student choice. Yet engagement with subject matter is essential to effective STEM education at every stage. How do the design principles discussed here transfer to the college campus?

Gensler Research Team

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Other Gensler Educational Research

Changing Course: Connecting Campus Design to a New Kind of Student: October 2012

No More Teachers, No More Books?: November 2011

Both documents may be downloaded at gensler.com/research.

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