Classroom Design - Literature Review

PREPARED FOR

THE SPECIAL COMMITTEE ON CLASSROOM DESIGN

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SUMMER 2013

EXECUTIVE SUMMARY

In response to the Special Committee on Classroom Design's inquiry, this literature review has been prepared to address the question; "What are the current trends in learning space design at Princeton University's peer institutions?" The report is organized into five chapters and includes an annotated bibliography.

The traditional transference model of education, in which a professor delivers information to students, is no longer effective at preparing engaged 21st-century citizens. This model is being replaced by constructivist educational pedagogy that emphasizes the role students play in making connections and developing ideas, solutions, and questions. Already, teachers are creating active learning environments that place students in small work groups to solve problems, create, and discover together.

Classrooms should be profound places of revelation and discovery. Well-designed space has the ability to elevate discourse, encourage creativity, and promote collaboration. Connecting indoor learning space to the natural world through daylight, views, and finishes has proven to improve student performance. Though technology and contemporary design serve an important role in connecting learners to the fast-paced modern world, preservation of historic spaces contributes to an otherwise unachievable gravitas and majesty.

Learning spaces extend beyond classroom walls to every corner of the campus. Planners and designers should create places for informal catalytic interactions. Widening corridors and designating lobbies, atriums, and other common areas as educational spaces promotes spontaneous learning. So too does furnishing these spaces with flexible seating, tables for individual study and group discussion, vertical surfaces for displaying student and faculty work, and a robust wireless network.

Within the classroom walls, learning space should be as flexible as possible, not only because different teachers and classes require different configurations, but because in order to fully engage in constructivist learning, students need to transition between lecture, group study, presentation, discussion, and individual work time. Furniture that facilitates rapid reorganization of the classroom environment is readily available from multiple product manufacturers.

Wireless technology and portable laptop and tablet devices bring the internet not just to every student's dorm room, but also to every desk in the classroom. Coupled with projectors, microphones, and video cameras, the classroom experience is fully connected to the internet. This provides new ways of teaching and new ways of learning that require specific physical support.

By specifying common standards for the design and maintenance of learning spaces across Princeton's historic campus, the university can equip teachers and students to engage in innovative and dynamic constructivist education.

RECOMMENDATIONS

The following recommendations have been prepared for the Committee and are based on the research and analysis that comprises this Literature Review.

Increase the quantity and quality of small flexible classrooms.

- These learner-centered spaces should include:
  o Windows with views to the outside
  o Natural daylight
  o Robust wireless internet networks that support high-speed creation and sharing of media
  o Walls prepared for presentation (blackboards, pin-up, projection)
  o Low-profile electrical outlets evenly spaced around all walls
  o Smooth and flat floor for easy rearranging of furniture
  o Adjustable lighting for group discussion, presentation, and video recording.

- Furnish these rooms with flexible furniture:
  o Tables that accommodate two students working side by side when free-floating and can be combined with other tables to create small-group work spaces, large conference tables, and donut-shaped class discussions
  o Chairs with wheels and storage for bags
  o Teaching stations with simple laptop connections to projector(s) and control over lighting and window shades

- In some cases, these rooms should include group work stations that allow multiple students to share a flat-screen monitor for collaboration and presentation

Classrooms should be linked by dynamic corridors, lobbies, courtyards, and paths.

- Informal gathering areas for groups of two-eight people should include:
  o Comfortable seating and horizontal work surfaces
  o Accessible electrical outlets
  o Wireless internet
  o Vertical collaboration and presentation surfaces (blackboards, whiteboards, pin-up space, plug-and-play flat screen monitors)

- Corridors and paths should be used for ongoing and ever-changing display of student and faculty work

Classrooms should achieve the high level of design excellence that is the standard at Princeton University.

- Durable and healthy materials should be used in furniture and finishes
- Strong connections to the historic campus should be maintained and enhanced
- Lectures and other classroom experiences that are distributed to on-line learners should capture the unique qualities of the Princeton Campus
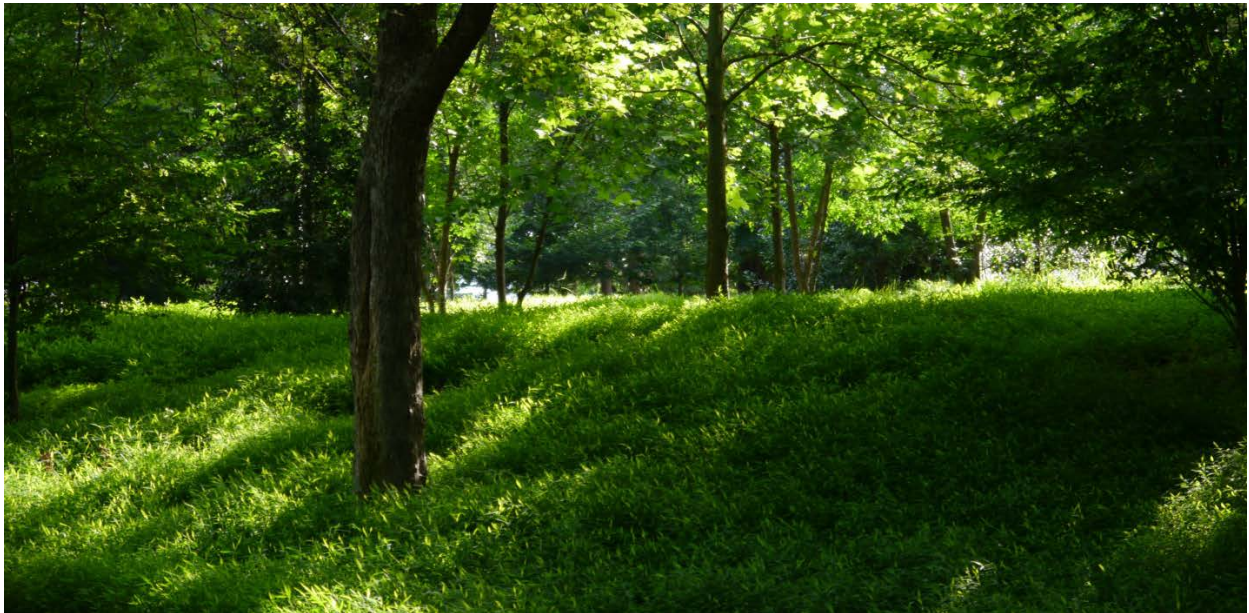
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FIGURE 1. GROUNDCOVER ALONG ELM DRIVE, PRINCETON UNIVERSITY

INTRODUCTION

We know too much about how learning occurs to continue to ignore the ways in which learning spaces are planned, constructed, and maintained.

—Nancy Van Note Chism, Professor, Indiana University-Purdue University Indianapolis

The Special Committee on Classroom Design at Princeton University (the Committee) initiated this report to better understand the current trends in classroom design at its peer institutions. At the end of the Spring 2013 semester, the Committee chose to commission this Literature Review and after preliminary conversations and basic direction, a broad net was cast throughout the available literature.

What follows is an analysis of contemporary literature addressing questions of classroom design. This document is not a complete summary or intended as the definitive word.

Purposes

This review provides a framework for the Committee to continue its discussions and development of classroom design guidelines for Princeton University. This document establishes a summary of generally agreed-upon design strategies for 21st-century classrooms.

The primary organizing question is "What are the current trends in learning space design at Princeton University's peer institutions?"

Additionally, this report includes an annotated bibliography of selected sources for easy access to more in depth study.

Methodology

The research used three primary portals to material: the University of Massachusetts Amherst Library, the Princeton University Library, and the internet (employing the Google search engine to sort sources).

Research was obtained through search engines, university research databases and scholarly journal subscriptions. Search terms included: *classroom design, college and university architecture, educational pedagogy, biophilia, technology in the classroom, flexible classroom design, space and campus planning.* Thirty-eight sources have been included in the bibliography. These sources include articles from scholarly journals, magazine articles, books, on-line publications, and videos. The sources were identified because of their relevance to the organizing question; with a few exceptions, all sources are within the last decade and are focused on college and university classroom design. The exceptions include articles and books that were written more than a decade ago or address elementary and childhood education, but provide germane information. While this literature review addresses 38 sources, a broader scope that included writing specific to childhood education would yield many more sources. Most of the research about classroom design is targeted towards elementary and secondary school and while a few of these

sources are included, the majority has been omitted.

For this report, Princeton's peer institutions are broadly defined to include colleges and universities with a central focus on classroom teaching and learning. Precedents have been drawn from public and private institutions within the United States as well as abroad.

Findings

Conversations with the Special Committee on Classroom Design in addition to analysis of the literature helped identify five macro-level trends: Learner-Centered Pedagogy, Natural Systems, Spaces Outside Classrooms, Flexibility, and Technology.

A consensus emerged from the literature about a shift in pedagogy towards learner-centered education. To prepare students to be effective agents of change in a complex and interconnected world, higher education is transforming from the transference model to the constructivist model.

Natural Systems is a large umbrella under which design techniques that create a specialness of place fall. Within this trend are writings about biophilia, historic preservation, aesthetics, and form. While this is perhaps the least emphasized trend in the literature, its role on Princeton's majestic campus has been underscored by the committee and staff.

The role of Spaces Outside Classrooms and the ways in which learning extends across campus and over the internet expands the scope and begins to address large-scale planning, and interdepartmental collaborations.

Flexibility merges the needs of space planners to use limited resources efficiently and the goals of educators to create dynamic, learner-centered environments.

The shift in teaching pedagogy is both the cause and effect of networked technology. Ways in which this pedagogical shift affect classroom design range from rethinking the role of the teacher in the classroom to reconsidering the best size for students' writing surfaces. The fully wired classroom is requiring less infrastructure as wireless connections are replacing physical cables. However, microphones, cameras, and projectors continue to require hardwiring, which can place limits on the flexibility of classroom spaces.

Report Organization

A chapter has been devoted to each of the five trends. In these chapters, the major concepts and precedents are summarized. The annotated bibliography includes bulleted notes from each of the sources that were part of this study.

FIGURE 2. NASSAU HALL FROM MCCOSH WALK, PRINCETON UNIVERSITY

LEARNER-CENTERED PEDAGOGY

The ideal college is Mark Hopkins on one end of a log and a student on the other.

—James Garfield 1871, President of the United States of America in 1881

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99 percent of teaching spaces were anticipated either in an image of an ancient Syrian palace school 4,000 years ago or in the Greek amphitheater: rows or rings of seats meant to focus the attention of the many on the one. But education is not about transferring information from one to many; it is about learning within the student. When printed books were new transferring information was vital, but today, information is ubiquitous and readily available, and students can pick it up when and where they want. Instead, the classroom ought to focus on assimilation and application of knowledge to new contexts. The teacher becomes the guide on the side, instead of the sage on the stage, requiring wholly new learning spaces and teaching techniques.

—Eric Mazur, Balkanski Professor of Physics and Applied Physics, Harvard University

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In Constructivist pedagogies the students are discovering new concepts and creating their own knowledge instead of memorizing facts.

—Elise Valoe, Education Researcher, Steelcase

The epitome of higher education used to be a magnificent larger-than-life lecturer standing in front of a hundred eager students sitting attentively in their tablet-arm chairs scribbling notes in composition books; James Garfield simplified this paradigm into a teacher and student sitting together on a log. But educational pedagogy is changing and the industrial hierarchical transfer of knowledge from teacher to pupil no longer meets the needs and aspirations of 21st-century learners.

The industrial economy has yielded to a knowledge economy in which power and wealth are not measured by physical assets (land, natural resources, capital), but rather by networks, relationships, and knowledge. This shift has restructured the purposes of education and the needs of learners. The new paradigm is one of knowledge generation, not transfer (Table 1). Learning is a dynamic, relational and chaotic experience that requires creativity, ingenuity, and multi-faceted approaches to producing and consuming content. (Cornell, 2002)

TABLE 1

Emerging Paradigm of Teaching and Learning	
From an Industrial Economy	To a Knowledge Economy
Passive learners	Active learners
Directed learning	Facilitated learning
Knowledge revealed	Knowledge discovered
Explicit knowledge	Explicit and tacit
Discrete knowledge	Embedded knowledge
Single assessment	Multiple assessments
Single intelligence	Multiple intelligences
Instructor technology	Ubiquitous technology
Alone	Alone and together
Just in case	Just in time
Content	Content and process
Linear and planned	Planned and chaotic

One example of the ways this new pedagogy is reshaping the university classroom is at Harvard Business School's Batten Hall where ten "hives" occupy the top two floors (**Figure 3** and **Figure 4**). These highly flexible spaces accommodate large classes as well as small group discussions and the movable furniture facilitates quick changes between space set-ups. The rooms were designed with HBS's FIELD course in mind, which uses small group exercises to study and develop team dynamics. (Emmons, 2011)

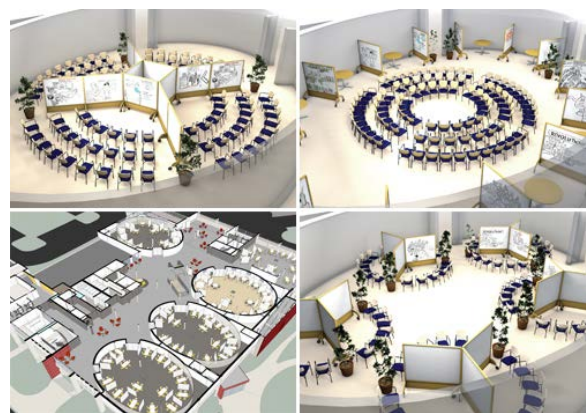**FIGURE 3.** HIVE CLASSROOM, HARVARD BUSINESS SCHOOL

FIGURE 4. HIVE CLASSROOM LAYOUTS, HARVARD BUSINESS SCHOOL

Top-tier universities have not been leaders in the reform of undergraduate education because applications continue to far outpace enrollment. Furthermore, the focus on faculty performance as researchers has often led to an undervaluation of professors' roles as undergraduate teachers. Given these universities' effect on the pedagogy and culture of higher education as a whole, however, it is crucial that they engage more fully with the urgent task of restructuring the teaching and learning environment. Former Harvard President, Derek Bok, identifies three priorities for transforming undergraduate education ("Pedagogy, Classroom Design, Evaluation," *Harvard Magazine*)

- Professors should substitute new, learner-centered teaching for traditional lecturing.
- Faculty should develop new methods for measuring student success as a result of various teaching modalities.
- Departments across the university should prepare graduate students, who are tomorrow's faculty, to be experts in new methods of teaching.

NATURAL SYSTEMS

The most difficult planning problem for an institution is to decide what its visible architectural and natural universe should "look like."

—Neil Rudenstine, Former Provost and Former chair of the Trustee Committee on Grounds and Buildings, Princeton University

The Latin term "genius loci" translates to "spirit of place." Despite the sacred overtones, the term is used by planners and designers to describe the confluence of features that can make a space feel unique and special. Learning environments can – and should be – dramatic, inspiring, and empowering. The classroom should place students at a specific point in both time and space. This is achieved when the design of the room captures both history and location.

FIGURE 5. HISTORIC CLASSROOM, MCCORMICK HALL, PRINCETON UNIVERSITY

Humans have an innate attraction to nature and respond positively to natural elements in built spaces. Biophilia, a term coined by biologist E.O. Wilson in the 1980's, refers to humans' attraction towards nature-based environments, which developed because of an evolutionary need to survive in the natural world. Despite the advances in technology over the last ten thousand years of human civilization, which have increasingly separated human experience from the uncontrolled aspects of life on this planet, humans continue to desire, and even need, connections to nature. (Matteson, 2013)

The design of classrooms should re-integrate the learning experience with the patterns and processes of the natural world. This includes, but is not limited to, daylight, views to the outside (especially trees, plants, and sky), and natural building materials (wood and stone). The subtle variation in quality that natural daylight provides in a space reduces eye fatigue by allowing eyes to make micro-adjustments. In addition to reducing eye fatigue, natural daylight provides the widest spectrum of light, which makes it much easier to see colors and textures.

Studies of both health care and office space have shown that rooms that have a window to the outside improve patient recovery time and worker productivity respectively. This effect is increased when the view includes a natural element like a tree or garden and can be replicated with views to internal atriums and courtyards. Windows also allow students and teachers to change perspective from their desk to the other people in the room to the distant trees and buildings outside (**Figure 6**).

FIGURE 6. WINDOWS IN CLASSROOM, UNIVERSITY OF CONNECTICUT SOCIAL SCIENCES AND CLASSROOM BUILDINGS

While clerestories and skylights are very useful apertures for providing natural light, they do not provide a distant focal point unless there are distinct clouds.

Natural building materials serve many purposes. They can create healthy indoor environments because they contain no volatile organic compounds. Additionally, the texture of wood and stone provides an infinitely varying pattern that moves the eye and spreads focus (**Figure 7**). Natural building materials also serve to connect the interior experience of a room to the provenance of the materials as integrated elements in the natural world.

FIGURE 7. WOOD FINISHES, UNIVERSITY OF CONNECTICUT SOCIAL SCIENCES AND CLASSROOM BUILDINGS

The University of Minnesota Duluth's Bagley Classroom is an award-winning showcase of sustainable design (**Figure 8**). Its commitment to the environment is evident in the net-zero energy and net-zero water classroom space. The connections to the outdoors are enhanced through large windows and exposed glue-lam beams (**Figure 9**).

FIGURE 8. BAGLEY CLASSROOM, UNIVERSITY OF MINNESOTA DULUTH

FIGURE 9. BAGLEY CLASSROOM INTERIOR, UNIVERSITY OF MINNESOTA DULUTH

Spaces Outside Classrooms

> *To truly shift the educational paradigm, learning spaces also must reflect a network of connected places outside the classroom where learning can flow from one space to the next and a sense of community is fostered.*
>
> *—Amy Kiefer, Vice President of Education Marker, KI*

Learning spaces extend beyond classroom walls to every corner of the campus (Van Note Chism, 2006). Comprehensive design of successful educational environments should address the commute to and from scheduled classes. Reserveable meeting and study spaces can serve the wide range of students' academic needs outside of class time. Informal learning happens in corridors (**Figure 10**), lobbies, courtyards, dorm rooms, and dining halls. (Kiefer, 2012)

Planners and designers can promote the seamless transition from in-class learning to across-life learning by thinking about the classroom door not as a threshold, but as a transition.

FIGURE 10. LEARNING SPACE COMMONS, FINE HALL, PRINCETON UNIVERSITY

The tradition of space planning focuses on a seats-per-square-foot mindset that does a disservice to the academic aspirations of 21st-century teaching institutions. Evaluating classroom space solely based on the number of students that fit in the room given the configuration of the space assumes that all seat-time is created equal. Instead, space planners should evaluate learning-per-square-foot and understand that different learning happens in tablet-arm chairs at the back of an over-crowded room than in swivel office chairs gathered around a small table with a few other students. (Kiefer, 2012)

Environments that allow for "socially catalytic" interactions connect classrooms to common spaces where students and faculty can meet informally (**Figure 11**). These environments include commons where students can gather to do group work, corridors where classroom discussion can continue after the bell rings, informal gathering spaces adjacent to faculty offices for unscheduled connections, and nooks, stairwells, and landings for informal and casual interactions. (Kiefer, 2012)

FIGURE 11. LEARNING COMMONS, JADWIN HALL, PRINCETON UNIVERSITY

FIGURE 12. GATHERING SPACE; UNIVERSITY OF CONNECTICUT SOCIAL SCIENCES AND CLASSROOM BUILDINGS

Labyrinth-like spaces can stimulate thought by shifting common expectations of planned and productive use of space. These "left-over" spaces can lead to valuable, unplanned, and informal connections. (Jilk, 2009)

At the University of Connecticut, a new classroom building includes spaces specifically designed for students and faculty to congregate (**Figure 12**). These public galleries which surround courtyards include furniture for small groups to meet and study.

A.M. Stern's Wassertein Hall, Caspersen Student Center, and Clinical Wing at Harvard Law School include generous lobby space (**Figure 13**) and wide hallways with seating that encourage casual interactions.

FIGURE 13. CASPERSEN STUDENT CENTER LOUNGE, HARVARD LAW SCHOOL

FLEXIBILITY

Pedagogical innovation demands a space that enables exploration by both teacher and student.

–Stern Neill, Associate Professor, and Rebecca Etheridge, Director of the Teaching and Learning Center, University of Washington

To meet the diverse spatial needs of teachers and students, classrooms should be effective in multiple configurations. The campus inventory of classroom spaces should include a range of room sizes with different physical characteristics: large lecture halls, medium sized tiered case study rooms, medium sized flat-floored flexible rooms, and small seminar rooms.

The medium sized flat-floored flexible rooms are the most valuable because they allow mid-class-time shifts in teaching and learning structures (**Figure 14**). The room can reorient from a teacher-focused lecture style set-up to whole-group discussion and then small-group work sessions. Classroom configurations include linear (lecture, presentation, video), horizontal (class discussion), cluster (small group discussion and activities), and network (decentralized instruction). (Neill and Etheridge, 2008)
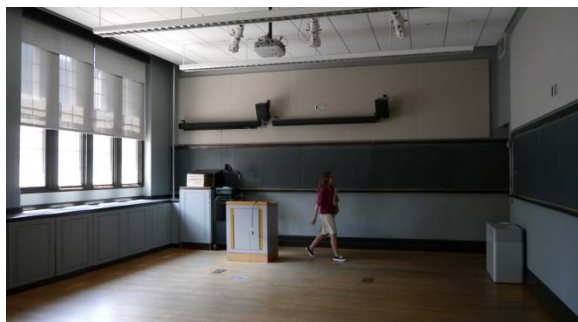

FIGURE 14. FLEXIBLE CLASSROOM, FRIST HALL, PRINCETON UNIVERSITY

While the teacher-centered lecture-based classroom was appropriate for an industrial economy that required a literate workforce in hierarchical organizations, contemporary learning-centered spaces need to support relationship making, networking, and creative problem solving. (Cornell, 2002)

In the article, "The Impact of Changes in Teaching and Learning on Furniture and the Learning Environment," Paul Cornell, vice president of product development and marketing at Vecta (now Steelcase) outlines five functional requirements for classroom furniture:

- Fold-n-go
- Plug-n-play
- Say-n-see
- Relate-n-reflect
- Inspire-n-invite

Fold-n-go furniture allows space to be cleared when tables and chairs are stacked to the side. This allows extra furniture to be stored in the classroom, which minimizes the time needed to change the layout. Plug-n-play allows teachers and students to connect digital devices to power and data quickly and efficiently. Say-n-see devices enable presentation and recording of information and media. These devices should be both electronic (flat screens, projectors, video cameras) and physical (blackboard,

whiteboard, overhead projector). Relate-n-reflect furniture brings students together to build relationships and collaborate. Additionally, this requirement addresses the need for students to work alone and have their own space. This is especially important during tests and exams when students are expected to do individual work. Inspire-n-invite motivates teachers and learners through fun, energetic, and beautiful design. (Cornell, 2002)

Though constructivist teaching pedagogy emphasizes fluidity and versatility in classrooms, technology often undermines those goals. Classrooms wired for distance learning often limit mobility because teachers and students must remain within the camera's view. Similarly, projectors, laptops, and microphones that are hard-wired prevent rapid reconfiguration of the space. (Monahan, 2002)

Within the next few years, as wireless technology improves, the need to physically plug in computers and other electronic devices will diminish. Already, wireless internet networks have eliminated physical Ethernet connections. As battery life expands, all-day use of laptops will be commonplace without the need to recharge. And connecting to projectors is already possible through a wireless network, though security and bandwidth limitations have prevented widespread adoption (OSU, 2013). As these issues are resolved, there will no longer be a need for teachers or students to physically connect computers to the networked infrastructure of a classroom.

Another way to understand flexibility is through five properties that support constructivist teaching pedagogy (Monahan, 2002):

- **Fluidity** represents the design of space for flows of individuals, sight, sound, and air.

- **Versatility** indicates the property of space that allows for multiple uses.
- **Convertibility** designates the ease of adapting educational space for new uses.
- **Scaleability** describes a property of space for expansion or contraction.
- **Modifiability** is the spatial property that invites active manipulation and appropriation.

Designing classroom space to maximize these five properties provides a dynamic space for learning that will serve the next generations of educators.

Industrial designers and product manufacturers have invested heavily in redesigning furniture for the classroom. Steelcase's response to the shift in teaching pedagogy is LearnLabs. These spaces free the teacher from the front of the room and allow her to move throughout the class, interacting with small groups of students clustered around shared worktables. The worktables include huddle boards which are portable whiteboards designed for collaborative thinking and presentation. Media:scape tables, (**Figure 15**) designed in partnership with IDEO, provide connections for student laptops to projection screens – distributing access to presentation space across the entire class. (Goetz, 2013)

FIGURE 15. STEELCASE LEARNLAB WITH MEDIA:SCAPE

IDEO also teamed with Steelcase to design a new classroom chair (**Figure 16**). The Node is designed to replace the traditional tablet-arm chair pervasive at colleges throughout the country. Key features of the Node include:

- A large bucket seat that allows students to move and shift their posture as needed.
- Swivels that allow students to change their orientation quickly.
- Rolling Base that allows the chair to be repositioned in the room without disturbing the class.
- A generously sized attached tabletop that moves to accommodate a wide range of uses.

FIGURE 16. THE NODE BY STEELCASE

TECHNOLOGY

It is paramount that we not only acquire the latest technology, but also work to thoughtfully integrate it into all levels of our curriculum. How we use these resources is just as important as acquiring them.

–Kenneth Ender, President, Harper College

For IT is not only a means of global expansion, it also represents a system for linking students and public institutions intimately to globalization processes, thereby reproducing and reinforcing rationalities of global competition and interconnection. Given this encompassing political orientation, the question posed here is not so much "Do computers work?" but "What social relations do they produce?"

–Torin Monahan, Assistant Professor of Justice & Social Inquiry, Arizona State University

Academic institutions of every variety have begun to offer online learning components to their curricula. Some schools operate exclusively through the internet and have no physical space for students and faculty to meet. Other schools provide a hybrid approach where some courses or components of a course are online, while some are on campus.

Envisioning the ideal learning environment, Roger Schank, then director of the Institute for Learning Sciences at Northwestern University, stated that students should spend one-third of their day at the computer, one-third talking with others, and one-third making something. (Skill and Young, 2002)

Faculty adoption of new teaching technologies varies greatly. Some teachers are eagerly adopting new tools and techniques while others are stubbornly holding onto the patterns they've learned and practiced throughout their careers. (Dey, Burn, and Gerdes, 2011)

Classroom design supports online learning by facilitating the creation and documentation of content. Video cameras, microphones, and projectors are tools to capture and record teaching material, but software and training are necessary to convert the media gathered into effective online teaching material. Classrooms designed and wired for digital documentation can provide natural light and views to the outdoors through carefully placed windows (**Figure 17**).

FIGURE 17. DIGITAL CLASSROOM, JADWIN HALL, PRINCETON UNIVERSITY

Australian universities that operate multiple campuses have implemented Networked Interactive Whiteboards to connect learning environments across the country. In this way, students on one campus can gather in a classroom and connect with teachers and students at another campus by sharing the presentation screen. These devices allow for in-the-moment annotating of slides and images as well as chalkboard-like outlining and problem solving. (Dawson, 2010)

As course content is generated and distributed through the internet, the personalization of video becomes increasingly important. A study of a physics lecture delivered in both a traditional classroom setting and through on-line video indicated that students are able to retain more knowledge using the video format. Additionally, the inclusion of an image of the professor next to the slides and narration further enhances student performance (Dey, Burn, and Gerdes, 2009). The classroom design implications of this study include the importance of video capture of the professor and space signature.

The space signature is created by distinctive design elements that are immediately recognizable. Perhaps the best example of a space signature is the oversized red letters and red circle of carpet used on the sets of TED Talks around the world. These common design features establish that no matter where the lecture is recorded, it exists as part of the enormous TED library. (**Figure 18**)

FIGURE 18. STANDARD SET OF TED TALKS

Using Mayer's 12 principles of multimedia learning will promote successful web-based learning experiences just as they have traditional lecture presentations.

Mayer's 12 Principles of Multimedia Learning (2001)

1. **Coherence Principle** – People learn better when extraneous words, pictures and sounds are excluded rather than included.
2. **Signaling Principle** – People learn better when cues that highlight the organization of the essential material are added.
3. **Redundancy Principle** – People learn better from graphics and narration than from graphics, narration and on-screen text.
4. **Spatial Contiguity Principle** – People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.
5. **Temporal Contiguity Principle** – People learn better when corresponding words and pictures are presented simultaneously rather than successively.
6. **Segmenting Principle** – People learn better from a multimedia lesson when it is presented in user-paced segments rather than as a continuous unit.
7. **Pre-training Principle** – People learn better from a multimedia lesson when they know the names and characteristics of the main concepts.
8. **Modality Principle** – People learn better from graphics and narrations than from animation and on-screen text.
9. **Multimedia Principle** – People learn better from words and pictures than from words alone.
10. **Personalization Principle** – People learn better from multimedia lessons when words

are in conversational style rather than formal style.

11. **Voice Principle** – People learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice.

12. **Image Principle** – People do not necessarily learn better from a multimedia lesson when the speaker's image is added to the screen.

Computers are not merely tools like paper and pencil; they are media that can be used for creation of new rules and structures for learning; they are part of complex systems of interdependencies. When used as "contexts for creative expression and knowledge production, computers catalyze empowering learning activities because constraints and interconnections become the explicit terrain for practices." (Monahan, 2004)

Chickering and Gamson's "Seven Principels for Good Practice in Undergraduate Education" (1987) are as applicable to the hybrid model of teaching as they were when written exclusively about instructor-led classroom environments.

- Good Practice Encourages Student-Faculty Contact
  - o Whether in a shared classroom, or through an online community, the relationship between learner and teacher is central to the successful educational experience. Promoting ways for students and faculty to interact directly before, during, and after class time is an effective strategy for building a trusting and respectful relationship.
  - o Building design should provide student-controlled spaces adjacent to faculty-controlled classrooms

where students can continue course work in proximity to faculty.

- Good Practice Encourages Cooperation Among Students
  - o Providing shared calendars for students to coordinate meeting times is one tool administrators have that promotes student-to-student learning.

- Good Practice Encourages Active Learning
  - o The physical classroom too often limits the range of active learning experiences. Space for group-driven activities, access to multimedia display and creation tools, and flexibility in room layout are all aspects of a well-designed learner-centered teaching space.
  - o Virtual spaces for collaboration as well as media production and consumption can often compensate for limitations in physical space.

- Good Practice Gives Prompt Feedback
  - o Face-to-face conversations are a highly valuable tool for instant feedback; shifting away from the "sage on the stage" model of lecturing to a "guide on the side" model of facilitated discussion provide students with peer-to-peer feedback.

- Good Practice Emphasizes Time on Task
  - o Virtual environments that allow students to extend the "time-on-task" beyond the classroom walls deepen and strengthen the educational experience.

- o Wireless networks and robust web-based learner portals that link students to videos, lectures, discussions, and each other can blend the lines between living and learning spaces or between public and private spaces across campus.

- Good Practice Communicates High Expectations
  - o Flexible learning environments provide multiple paths for student achievement.
  - o Blending diverse e-learning opportunities with a robust portfolio of active-learning experiences within the classroom creates a learning-objectives-driven curriculum.

- Good Practice Respects Diverse Talents and Ways of Learning
  - o The responsibility of creating successful learning environments does not rest solely on the faculty in the classroom.
  - o Implementation of good practices requires cooperation of everyone at the university: from students to deans, facilities staff to faculty.

Following the recommendation to design for flexibility requires these four strategies (Skill and Young, 2002):

- Design larger spaces that are more flexible than smaller spaces.
- Partitions should be movable and demountable to allow for reconfiguration.
- Quantity of space allows teachers and students to control the environment without conflicting with each other.
- Buildings should be always evolving and the result of constant manipulation and adaptation.

CONCLUSION

Among the many methods employed to foster student development, the use of the physical environment is perhaps the least understood and the most neglected.

—Banning and Canard (1986)

Equipping the next generation of students to deeply engage in the pressing challenges that face our economy, society, and planet requires a commitment to constructivist pedagogy and learner-centered education. The complex and interconnected questions of the next century will not be answered by expert-specialists operating in isolated silos. Rather, creative generalists with interdisciplinary passion and experience will identify the disparate relationships and synergies that change the way our world operates. Educating and inspiring these creative generalists requires a comprehensive shift in the way teachers relate to students and students relate to each other. This shift has already begun to reshape the modern classroom.

This is not to say, however, that the expert-specialist does not continue to play a role. On the contrary, the responsibility of the sage-on-the-stage to transfer knowledge and illuminate lines of inquiry deep into subject matter is as crucial as ever. But this method of teaching, where one person stands in front of many and presents information to be memorized, should not be the default classroom experience. Princeton University has a long tradition that supports the balance between lecture-based teacher-centered learning and learner-centered discussion.

In addition, rooting the lecturer in a place will aid in linking the viewer to the physical space of the classroom. Like the red circle of carpet and large letters that unify the many TED stages, Princeton should develop an aesthetic language that roots online learning to the physical space in which the video was recorded.

Learning environments across campus should be redesigned to support catalytic interactions, interdisciplinary collaboration, and creative problem solving in groups and alone (Jilk, 2009). While maintaining the historic integrity of Princeton's noble campus, classroom spaces should provide flexibility, interconnectedness, and inspiration.

Now more than ever, the liberal arts education plays a central role in preparing the leaders of tomorrow. Princeton's history of excellence provides a foundation for the highest aspirations of 21st-century teaching and learning.

Unanswered Questions

A number of questions were identified through the research process of this study. These questions have not been explicitly addressed in this report. The questions are included here for the Committee's further consideration.

- What are Princeton's classroom needs?
- What is the best teaching and learning pedagogy for Princeton University?
- What is the cost-benefit analysis for updating and renovating classrooms?
- What is the optimum balance between flexible classrooms and fixed seating classrooms?
- How do teachers need to be trained to use renovated classrooms?

FIGURE 19. NASSAU HALL, PRINCETON UNIVERSITY

A NOTE FROM THE AUTHOR

While I have done my best to research, analyze, and summarize the available classroom design literature objectively, I feel it appropriate and potentially useful to acknowledge and reveal my own bias. Though I approached this project primarily as an academic researcher, many other identities influenced both the collection and interpretation of source material.

The lush forests of the Ohio River Valley were my childhood playground. From our dining room, I watched the sunrise over verdant landscape and move across the horizon throughout the year – marking the shifting relationship between earth's tilted axis and the center of our solar system. Much of my connection to the natural world was formed in those early years, and as an adult, I have developed a rich philosophical grounding for our shared need to re-integrate with the natural systems that support life on our planet.

My understanding of and advocacy for learner-centered education began on the campus of Bennington College, where I earned a Bachelor of Arts. The role of the teacher-practitioner as muse, guide, and facilitator for an education driven by students' individual passions placed the responsibility for success squarely on the students' shoulders. Bennington uses a system called the Plan Process. The box-checking major and minor selection process that defines typical undergraduate experience often leads to an education akin to dining at a food court – you're presented with an array of restaurants, but once you choose which line to stand in, your dinner selection is based on the best available item on the menu at the time. The Plan Process, on the other hand, requires students to define for themselves what line of inquiry organizes their own passions and educational aspirations. Students write and re-write their plan constantly throughout their education, instilling the expectation that making decisions is an ongoing and dynamic process.

The Office of Residential Life at Bowdoin College was my first employer after graduating. It was there, as an Assistant Director that I learned about the importance of the residential and social aspect of a successful liberal arts education. The relationships and connections made outside of the classroom were crucial to getting students to think beyond the confines of discipline-centric questions. Since the classroom experience was focused on imparting knowledge rather than experiencing it, interpersonal skills were learned in the dorms and on the playing fields. The interdepartmental collaboration that was the norm at Bennington was rare at Bowdoin. Therefore the non-academic experience filled the gap left by traditionally organized education geared towards specialization rather than generalization.

I have always engaged with the world spatially. To deepen my understanding of how the spaces where we live, work, and play affect our relationships to each other and our world, I enrolled in two graduate programs at the University of Massachusetts Amherst. Studying Landscape Architecture alongside Architecture provided breadth and context to an inquiry into the effects of the built world on the non-built world. A central aspect of my experience as a graduate student was the three years I spent as a Green Building Researcher in Facilities Planning. The focus of my work was advocacy and facilitation of LEED Certification for new construction projects. This experience

exposed me to the power of rating systems and policies at the institutional level. Through committee-led approval of guidelines, we were able to change the ways buildings were built at the flagship campus of the Massachusetts state system.

These lenses: environmentalist, educational philosopher, community builder, designer, and researcher have colored my research and set the tone for this document. It is my hope that the analysis is helpful in providing a framework for further discussion and as a benchmark for the broader conversation.

FIGURE 20. LAKE CARNEGIE, PRINCETON UNIVERSITY

ANNOTATED BIBLIOGRAPHY

1. "7 Things You Should Know About Wireless Projection." Office of the Chief Information Officer. *The Ohio State University, n.d.* Web. 1 Aug 2013. **<https://ocio.osu.edu/elearning/toolbox/brief/wireless-projection/7-things-you-should-know-about-wireless-projection/>**.

   - Wireless projection technology exists, but is not yet widely adopted. The prospect of connecting computers to projectors without cables will free teachers [and students] from the need to plug-in and promote flexible uses of classroom space.

2. "360 Degree Classroom Furniture." KI. *KI.com,* n.d. Web. 20 June 2013. **<http://ki.com/products/44/Classroom_Collections/360%c2%ba%c2%ae_Classroom_Furniture.aspx?ncat=7&sitecat=59>**.

   - KI has produced a line for classroom furniture called 360° Classroom Furniture (**Figure 21**). This furniture is a chair and individual table that are attached to each other and can be reconfigured into lecture, collaborative, and individual set-ups. Self-locking rollers allow mobility and safety while the adjustable swiveling seat means that every student can be comfortable.

FIGURE 21. 360° CLASSROOM FURNITURE

3. "A Landmark Gift for Learning." *Harvard Magazine.* Harvard Magazine, 18 Oct 2013. Web. 21 June 2013. **<http://harvardmagazine.com/2011/10/harvard-initiative-learning-teaching-gustave-rita-hauser-gift>**.

   - The philanthropic gift of Rita E. Hauser, L '58 and Gustave M. Hauser, J.D. '53 to Harvard University in 2011 focused on strengthening teaching pedagogy throughout the university. The gift helped create the Harvard Initiative for Learning and Teaching. Among the Initiative's projects were the planning and construction of a new pilot classroom that

provides access to new teaching technologies, encourages active learning and international interactions during class time.

[We are at] a very significant moment in higher education. There is a whole generation of new students who require new teaching and learning methods.

–Gustave Hauser

- The article also introduces a working group of faculty members and deans thinking about new ways of teaching led by Eric Mazur, whose research has focused on real-time feedback from students during class.

Ninety-nine percent of teaching spaces were anticipated either in an image of an ancient Syrian palace school 4,000 years ago or in the Greek amphitheater: rows or rings of seats meant to focus the attention of the many on the one. But education is not about transferring information from one to many; it is about learning within the student. When printed books were new transferring information was vital, but today, information is ubiquitous and readily available, and students can pick it up when and where they want. Instead, the classroom ought to focus on assimilation and application of knowledge to new contexts. The teacher becomes the guide on the side, instead of the sage on the stage, requiring wholly new learning spaces and teaching techniques.

–Eric Mazur, Balkanski Professor of Physics and Applied Physics, Harvard University

4. Architects of Group Genius. "Architects Of Group Genius – Labs." Online video clip, *Vimeo.* Vimeo, 26 Oct 2011. Web. 19 June 2013. **<http://vimeo.com/31153360>.**

- **Abstract:** A Lab is a space dedicated to experimentation, prototyping and co-design of new powerful solutions to address complex organizational issues. Architects Of Group Genius has designed, produced and facilitated Labs for the most admired organizations in the world. This movie portrays the diversity of needs and purposes for which temporary and permanent Labs have been built worldwide, with the common objective of accelerating innovation and change, and fostering learning and collaboration to help organizations and communities create new solutions, new strategies and new inspiration to change the(ir) world.

5. Banning, J. H., and Canard, M. R. "The Physical Environment Supports Student Development." *Campus Ecologist,* 1986, 4.1. Web. 5 Aug 2013. **<http://www.campusecologist.com/1986/01/05/volume-iv-number-1-1986/>.**

Among the many methods employed to foster student development, the use of the physical environment is perhaps the least understood and the most neglected.

–Banning and Canard (1986)

6. Chun, Leanne. "Designing Classrooms of the Future." Leeward Community College. *Slideshare,* 6 March 2009. Web. 10 June 2013. **<http://www.slideshare.net/leannech/designing-classrooms-of-the-future>.**

- Trends in education include:
  - o Technology rich environments
  - o New modalities for teaching & learning
  - o Flexible physical spaces

- Though lecture halls continue to serve an important purpose, they are beginning to be designed with flexibility in mind; specifically, well-designed lecture halls accommodate laptops and other electronic media as well as provide swivel chairs for students to engage with each other.

7. Cornell, Paul. "The Impact of Changes in Teaching and Learning on Furniture and the Learning Environment." *New Directions for Teaching and Learning* 2002.92 (2002): 33–42. Print.

- Traditional classroom furniture was designed for students to sit and listen to a teacher while taking notes quietly.

- The teacher-centered lecture-based classroom was appropriate for an industrial economy that required a literate workforce in hierarchical organizations.

- User-centered design places the needs of the end user at the center of the design process. For learning spaces, this includes teachers and learners; each population has distinct as well as shared needs.

- The industrial economy is yielding to a knowledge economy in which power and wealth are not measured by physical assets (land, natural resources, capital), but rather by networks, relationships, and knowledge.

Emerging Paradigm of Teaching and Learning (Cornell, 2002)	
From an Industrial Economy	To a Knowledge Economy
Passive learners	Active learners
Directed learning	Facilitated learning
Knowledge revealed	Knowledge discovered
Explicit knowledge	Explicit and tacit
Knowledge is discrete	Knowledge is embedded
Single assessment	Multiple assessments
Single intelligence	Multiple intelligences
Instructor technology	Ubiquitous technology
Alone	Alone and together
Just in case	Just in time
Content	Content and process
Linear and planned	Planned and chaotic

- Classroom furniture should be designed with four dimensions in mind: functionality, comfort/safety/health, usability, psychological appeal.

- Functional requirements for classroom furniture include:
  o Fold-n-go
  o Plug-n-play
  o Say-n-see
  o Relate-n-reflect
  o Inspire-n-invite

- The fold-n-go and plug-n-play requirements often conflict, but as battery technology and wireless connectivity improve, the plug-n-play requirement will shift from physical connections to virtual ones. In the meantime, facilities managers may need to assist the reconnection of wired tabletops as needed.

- Varying table heights in a classroom create a coffee-shop atmosphere that encourages networking and informal learning.

8. Dawson, Phillip. "Networked Interactive Whiteboards: Rationale, Affordances and New Pedagogies for Regional Australian Higher Education." *Australasian Journal of Educational Technology* 26. 4 (2010): 11. Print.

- **Abstract:** This article presents an argument for the use of networked interactive whiteboards (NIWBs) in regional Australian higher education and identifies new pedagogies for this context. Most Australian universities operate multiple campuses, and many use video conference facilities to deliver courses across these sites. For students at remote video conference sites, their classroom experience is often one of isolation and limited student-to-student contact. In this article, NIWBs are proposed as a tool to enhance this mode of delivery and exploratory research into the additional affordances they provide is presented. By using networking with IWBs, annotation and gesture can be shared across distances. Emerging possibilities from the integration of NIWBs with video conference, web

conference, and lecture capture systems are also explored. Three new pedagogies for regional Australian higher education are proposed based on these new capabilities.

- On-line learning should be as learner-centered as classroom learning. Cross-site collaboration is possible through video conferencing and networked interactive whiteboards. These tools augment lecture-capture and distribution technology that extend the traditional pedagogy of teacher-centered learning to the internet based learner.

9. Dey, Eric L., Helen E. Burn, and David Gerdes. "Bringing the Classroom to the Web: Effects of Using New Technologies to Capture and Deliver Lectures." *Research in Higher Education* 50. 4 (June 1, 2009): 377–393. Print.

- **Abstract:** Technology expands instructional options for faculty, and this study examines the differential learning effects of offering a lecture on physics to students in a traditional classroom versus internet video formats. Based on an experiment conducted in a natural educational context, results indicate enhanced transfer of lecture information in the video formats relative to the live condition, with students also responding more positively to personalized video presentation.

    The ideal college is Mark Hopkins on one end of a log and a student on the other.

    –James Garfield, 1871

- Faculty adoption of new teaching technologies varies greatly. Some teachers are eagerly adopting new tools and techniques while others are stubbornly holding onto the patterns they've learned and practiced throughout their careers.

- When presenting course content through digital media viewed by students on their own computers, the inclusion of an on-screen visual presence of an instructor increases student motivation and attention.

10. Elen, Jan, Geraldine Clarebout, Rebecca Léonard, and Joost Lowyck. "Student-centred and Teacher-centred Learning Environments: What Students Think." *Teaching in Higher Education* 12, no. 1 (Feb 2007): 105–117. *EBSCO Host.* Web. 5 Aug 2013.

- **Abstract:** This contribution explores the relationship between teacher-centred and student-centred learning environments from a student's perspective. Three different views with respect to this relationship can be retrieved. The balance view suggests that the more teacher-centred a learning environment is, the less student-centred it is and vice versa. The transactional view stresses the continuous renegotiation of teacher- and student-roles. The independent view argues that teacher- and student-centredness are independent features of learning environments. Results from three survey studies of higher education students' conceptions of quality education are discussed. While the practice-oriented literature regularly seems to adopt a balance view, factor analyses did not reveal evidence for the

balance view in any of these studies. In students' minds student-centredness and teacher-centredness seem to be mutually reinforcing features of high quality education. From a curricular point of view, and especially with regard to teacher training, the results warrant to argue for the development of so-called powerful learning environments rather than for the transition from teacher-centred towards student-centred learning environments.

- The shift from teacher-centered to student-centered learning environments is often understood to imply a reduction of teachers' responsibilities and tasks. However, this study showed that student perceptions view student and teacher centeredness as mutually beneficial to high quality education.

11. Emmons, Garry. "Welcome to the Future." *Alumni Bulletin - Harvard Business School.* HBS Alumni Bulletin, Dec 2011. Web. 19 June 2013. **<http://www.alumni.hbs.edu/bulletin/2011/december/ilab.html>.**

   Batten Hall's top two floors, reserved for HBS, are devoted to ten curved, modular learning spaces (called "hives") and other areas created with team exercises and creativity in mind. These spaces are designed to enable and facilitate HBS's new required FIELD course, which focuses on intensive small-group exercises and team dynamics, activity not well-suited for Aldrich-style amphitheater classrooms.

   - To facilitate diverse teaching and learning structures, Shepley Bullfinch designed hives on the top two floors of Harvard Business School's Batten Hall. The hives are highly flexible spaces that can accommodate large classes as well as small groups because of the moveable chairs, tables, and partitions. Unfortunately, these spaces do not have windows and are therefore sealed from exposure to exterior stimuli.

12. Georgecopa. "Interview with Bruce Jilk." Online Video Clip, *YouTube.* YouTube, 8 April 2009. Web. 2013. **<http://www.youtube.com/watch?v=Wfwouu0mcQM&feature=youtube_gdata_player>.**

   - "Designing to degree zero" means that the designer and administrators get out of the way. By reducing or eliminating the imprint of the designers and administrators in the design of schools, teachers and learners define the space, pedagogy, and structure for the learning experience.

   - Environments that stimulate thought begin to shift common expectations about the planned and productive use of space. Labyrinth-type spaces that push students and teachers through unexpected spaces produce surprise interactions and informal learning.

   - Contingency-driven learning environments challenge predetermined curriculum and encourage fluid readjusting to students' and teachers' in-the-moment needs. Like designing to degree zero, this strategy allows teachers and learners to navigate through a course like paddling through whitewater – reacting to stimuli, interruptions, and distractions.

- Biopolitics is Jilk's term for the issues we face including climate change, stem-cell research, and other biological-related issues and the politics connected to these issues. The design of learning environments is part of the way we should face these issues.

13. Goetz, Kaomi. "How Steelcase Redesigned the 21st Century College Classroom." *Co.Design*. Fast Company, n.d. Web. 6 June 2013. **<http://www.fastcodesign.com/1662898/how-steelcase-redesigned-the-21st-century-college-classroom>**.

- Though corporate offices have been redesigned with collaboration and flexibility in mind for years, colleges and universities are just beginning to create classrooms with a similar focus.

  Instead of students doing rote memorization of facts, there's a new demand for students to be critical thinkers, have great communication skills and collaborate.

  –Elise Valoe, Senior Design Researcher, Steelcase

- Steelcase's response to the shift in teaching pedagogy is LearnLabs. These spaces free the teacher from the front of the room and allow her to move throughout the class, interacting with small groups of students clustered around shared worktables. The worktables include huddle board which are portable whiteboards designed for collaborative thinking and presentation. Media:scape tables, (**Figure 22**) designed in partnership with IDEO, provide connections for student laptops to projection screens – distributing access to presentation space across the entire class.

FIGURE 22. MEDIA:SCAPE TABLES, STEELCASE

14. Grayson, Jennifer. "Facilities of the Future." *Campus Technology* 23, no. 4 (2009): 25–26. Web. 5 June 2013. **<http://campustechnology.com/articles/2009/12/01/facilities-of-the-future.aspx>**

- **Abstract:** The bricks-and-mortar infrastructure of community colleges has not nearly kept pace with increases in student enrollments. Not only are colleges bursting at the proverbial seams, but, according to the American Graduation Initiative, many two-year institutions "face large needs due to deferred maintenance or lack the modern facilities and equipment needed to train students in technical and other growing fields. Insufficient classroom space can force students to delay needed courses and reduce completion rates." As part of the initiative, President Obama is proposing a new $2.5 billion fund to catalyze $10 billion in

community college facility investments that will "expand the colleges' ability to meet employer and student needs." One Illinois community college is already fixing its focus on the future, revamping its classrooms to provide top-notch training for 21st-century jobs.

- Though Harper College is a small community college outside of Chicago and doesn't have access to cutting edge research technology, they are able to offer a 2-year degree in nanotechnology because their smart classrooms connect students and teachers to equipment and people at other institutions like Penn State and the University of Minnesota. These classrooms have multimedia, online learning, and remote collaboration capabilities.

It is paramount that we not only acquire the latest technology, but also work to thoughtfully integrate it into all levels of our curriculum. How we use these resources is just as important as acquiring them.

–Kenneth Ender, Harper College President

15. "Harvard Undergraduate Residences Reimagined, with New Academic and Social Spaces." *Harvard Magazine.* Harvard Magazine, 20 May 2011. Web. 18 June 2013. **<http://harvardmagazine.com/2011/05/house-renovation-designs-revealed>.**

- The renovation of Old Quincy, one of Harvard University's historic houses, includes a multi-purpose social and academic space (**Figure 23**) designed for flexibility and learner-centered teaching pedagogy.

Learning takes place not only in quiet individual spaces, but also in group study for problem sets, or debating ideas based on a reading….The test project will create places for new interactions between students and faculty, and also accommodate a student population with diverse learning styles and needs—from quiet individual study to group work in large, technology-enabled spaces.

-Lee Gehrke, Quincy House Master, Professor of Microbiology and Molecular Genetics, Harvard University

FIGURE 23. RENOVATION OF OLD QUINCY RENDERING, HARVARD UNIVERSITY

16. Kiefer, Amy. "Learning Per Square Foot." *American School & University* 84.6 (2012): 22-24. Web. 7 Aug 2013.
    <http://ehis.ebscohost.com.ezproxy.princeton.edu/ehost/pdfviewer/pdfviewer?sid=df69d355-8993-49a7-a721-77254339e189%40sessionmgr113&vid=4&hid=104>.

- **Abstract**: Despite the transformations necessary to equip students with 21st-century skills, planners and decision makers at education institutions continue to design classrooms and campuses that reflect outdated modes of teaching. The right design will create a community of learning in every square foot and leverage space for "socially catalytic" interactions, areas where students and faculty can meet informally or where students can work together on projects: Commons areas historically have served as a place for students to gather for conversation and social activities.

- Learning can be extended beyond the classroom if a "learning per square foot" metric is used to evaluate space across campus. This new metric replaces the traditional "students per square foot" method for tracking and evaluating classroom space.

- The expectation that good education is dynamic education leads to classrooms designed for constant change and adaptation.

   To truly shift the educational paradigm, learning spaces also must reflect a network of connected places outside the classroom. Where learning can flow from one space to the next, and a sense of community is fostered.

   –Amy Kiefer, Vice President of Education Marker, KI

- Environments that allow for "socially catalytic" interactions connect classrooms to common spaces where students and faculty can meet informally.
  o Commons where students can gather to do group work should include reconfigurable furniture and access to power and wireless internet for use of laptops and other electronic devices.
  o Corridors with chairs, tables, whiteboards, and pin-up space allow students and faculty to continue classroom discussion and explore ideas spontaneously.
  o Informal gathering spaces adjacent to faculty offices promote accidental interactions and continued engagement.
  o Potential learning spaces include informal nooks, monumental stairwells, landings, and off-elevator spaces.

- The tradition of space planning focuses on a students per square foot mindset that does disservice to the academic aspirations of 21st-century teaching institutions. Recommendations for new ways to measure success include:
  o Non-classroom spaces should be measured and tracked as learning environments; recording data about every square foot and the amenities that support learning will help planners understand the physical assets of the institution as a whole.
  o Integrate technology support throughout learning spaces.
  o Evaluate flexibility, mobility, and versatility of space.

- o Advance environmental objectives by selecting interior products made from sustainable and healthy materials.
- o Evaluate student success based on formal (quantitative) as well as informal (qualitative) metrics.

17. Kinetwork. "KI Personalizes the Learning Experience with Learn2™ Seating." Online Video Clip. *YouTube.* YouTube, 13 Oct 2011. Web. 21 June 2013. **<http://www.youtube.com/watch?v=EIYUA7VtDys&feature=youtube_gdata_player>**.

- Learn2 Seating allows teachers to engage students through lecture, group discussion, collaborative projects, and brainstorming. The work surface can rotate 220 degrees and the seat is available in multiple colors and seat profiles. Learn2 comes with wheels or without.

18. Kittredge, Neil P. *Princeton Campus Plan: The Next Ten Years and Beyond.* Princeton: Princeton University, 2008. Print.

> *The most difficult planning problem for an institution is to decide what its visible architectural and natural universe should "look like."*
>
> *–Neil Rudenstine, Former Provost and Former Chair of the Trustee Committee on Grounds and Buildings, Princeton University*

19. Kuang, Cliff. "IDEO and Steelcase Unveil a School Desk for the Future of Teaching [UPDATED]." *Fast Company.* Fast Company, n.d. Web. 6 June 2013. **<http://www.fastcompany.com/1660576/ideo-and-steelcase-unveil-school-desk-future-teaching-updated>**.

- IDEO teamed with Steelcase to design a new classroom chair. The Node (**Figure 24**) is designed to replace the traditional tablet-arm chair pervasive at colleges throughout the country. Key features of the Node include:
  - o Large bucket seat allows movement and shifting of posture as needed
  - o Swivels allow rapid change of orientation
  - o Rolling base allows the chair to be repositioned in the room without disturbing the class
  - o A generously sized attached tabletop moves to accommodate a wide range of uses

FIGURE 24. THE NODE BY STEELCASE

- Kuang concludes with an editorial about the economics of this classroom chair; "Of course, it's unlikely that the chair will be appearing in your local public school anytime soon—the market seems to be the glizty new secondary schools and new university classrooms popping into existence. And you wonder whether the economics will work out, since a plastic chair probably can't last as long as bomb-proof metal job like you find in public schools. Meaning this design, for now, will be one more reason to envy a private-school education."

20. Lim, V. F., L. K. O'Halloran, and A. Podlasov. "Spatial Pedagogy: Mapping Meanings in the Use of Classroom Space." *Cambridge Journal of Education* 42, no. 2 (2012): 235–251. Web. 5 June 2013. **<http://www.tandfonline.com.ezproxy.princeton.edu/doi/full/10.1080/0305764X.2012.676629#.UgK-65I9g6k>.**

- **Abstract:** The positioning and movement of the teacher in the classroom are fundamental to the pedagogical process. Specific spaces in the classroom take on certain meanings because of the nature of pedagogic discourse that occurs on the site and the positioning and distance of the site relative to the students and the teaching resources. Spatial pedagogy is realized through the patterns of positioning and the directionality of movement, as well as the intersemiotic correspondences in the use of space with other semiotic resources (e.g. language, gesture and teaching materials). This paper investigates the different types of space in the classroom and their associated meanings. It also discusses an approach for annotating the teacher's use of space, and the usefulness of visualizing this annotation through digital graphical methods. The notion of "structured informality" in the classroom is proposed

through data analysis of two teachers conducting similar lessons, but with apparently different pedagogical styles. (Contains 9 figures.)

- Spatial pedagogy emerges in the classroom as a result of the teacher's position in the room and the movement and pacing of the teacher.

- Space in classrooms can be understood within the Social-Consultative Space distance set.
  - **Authoritative Space**: space in the front center of the classroom near the lectern or teacher's desk.
  - **Personal Space**: space behind the teacher's desk or under student's chairs where personal items can be kept. This area provides a refuge for temporary disengagement from the class experience.
  - **Supervisory Space**: space alongside rows of desks where the teacher can observe without engaging directly with students. Surveillance space is a subset of Supervisory space in which the teacher can monitor without being seen. This occurs most often from the "back" of the classroom and can create a temporary Panopticon (Foucault, 1977).
  - **Interactional Space**: though often physically overlapping with Supervisory space, Interactional space occurs when the teacher stands alongside a student's desk and engages directly with the students.

21. Lim, Adrian. "A Day in a VEF Flexible Furniture Classroom." Online video clip. *YouTube.* YouTube, 31 July 2011. Web. 21 June 2013.
    <http://www.youtube.com/watch?v=F7mZDY3sI9U&feature=youtube_gdata_player>.

    - Video by Victorian Educational Furniture

    - Animation showing how flexible classroom furniture can increase the ways in which space can be arranged throughout a typical school day.

    - Products include the Kinetic Table, the PODZ Table, the PODZ Ottomans

22. Malone, Alanna. "Forest Getaway: Bagley Classroom, Duluth, Minnesota—a Classroom Building Brings an Artistic Touch to Stringent Efficiency Standards." *GreenSource: The Magazine of Sustainable Design* 6, no. 1 (2011): 48–51. Web. 5 June 2013.

    - **Abstract:** A passive classroom building in the woods for the University of Minnesota, Duluth. Includes green roof. Completed in June 2010. Designed by Salmela.

    - As is often the case when universities and colleges own large tracts of preserved wilderness, the University of Minnesota Duluth's Bagley Classroom is an award-winning showcase of sustainable design.

    - Having achieved LEED Platinum certification and on track for Passive House recognition, this net-zero classroom is a successful blend of engineering and architectural design.

- This building minimizes its environmental impact by siting on an existing volleyball court, generating on-site renewable energy, and minimizing energy needs by employing a super-insulated building envelope.

23. Matteson, Donna. "Learner Perceptions of Biophilia and the Learning Environment: A Phenomenological Study." Ed.D., Walden University, 2013. Print. http://search.proquest.com.ezproxy.princeton.edu/pqdtft/docview/1313752838/abstract/13EA8DF6C9E2CBFF35C/1?accountid=13314.

- **Abstract:** The purpose of this study was to address a local university's need to promote learner-centered instruction and collaboration through classroom design. Learner-centered collaborative experiences were proposed by the local university to enhance student satisfaction and build social connections and appreciation of diversity. This study builds on the theory of biophilia, which is human's innate attraction to nature. Although biophilia has been linked to health, healing, job performance, and attendance in the workplace, little has been written to link biophilia to the classroom. The study incorporated a phenomenological design to examine students' perceptions of the impact of nature-based sensory stimulus in the learning environment on social comfort and collaboration. Interviews were the primary data collection strategy. Data were analyzed by reading transcripts and then identifying meaning units to form essential categories. Findings indicated that participants perceived a positive impact of biophilia on social comfort and collaboration. These findings enhanced the understanding of the biophilia phenomenon and were used to identify a project to address the problem of outdated classrooms. One possible implication for social change is an improved learner-centered environment that fosters social comfort and collaboration through awareness of commonality to nature. In addition, these findings may be used to inform a new classroom design. Implications of the findings may inspire future research of other biophilia connections to learning.

24. Mayer, Richard E. *Multimedia Learning*. Cambridge; New York: Cambridge University Press, 2001. Print.

- Mayer's 12 principles of multimedia learning are often cited as the foundation for successful lecture presentations and web-based learning experiences.
    1. Coherence Principle – People learn better when extraneous words, pictures and sounds are excluded rather than included.
    2. Signaling Principle – People learn better when cues that highlight the organization of the essential material are added.
    3. Redundancy Principle – People learn better from graphics and narration than from graphics, narration and on-screen text.
    4. Spatial Contiguity Principle – People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.
    5. Temporal Contiguity Principle – People learn better when corresponding words and pictures are presented simultaneously rather than successively.
    6. Segmenting Principle – People learn better from a multimedia lesson when it is presented in user-paced segments rather than as a continuous unit.

7. Pre-training Principle – People learn better from a multimedia lesson when they know the names and characteristics of the main concepts.
8. Modality Principle – People learn better from graphics and narrations than from animation and on-screen text.
9. Multimedia Principle – People learn better from words and pictures than from words alone.
10. Personalization Principle – People learn better from multimedia lessons when words are in conversational style rather than formal style.
11. Voice Principle – People learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice.
12. Image Principle – People do not necessarily learn better from a multimedia lesson when the speaker's image is added to the screen.

25. Miller, Jennifer. "Flipped Out." *Spirit* Aug. 2013: 72-81. Print.

- "Flipping Classrooms" involves using class time as work sessions with teacher guidance and time at home for watching lectures on-line.

  The goal of flipping a classroom is not to bend education to the digital proclivities of kids, but to maximize student-teacher interaction during the most demanding lessons. It's about how we use our time *more than how we use our technology.*

  –Justin Reich, Fellow, Berkman Center for Internet and Society, Harvard University

26. Monahan, Torin. "Flexible Space & Built Pedagogy: Emerging IT Embodiments." *Inventio* 4, 2002 (1): 1-19. Web. 5 July 2013. **<http://www.torinmonahan.com/papers/Inventio.html>.**

- Monahan identifies five properties of space within the "Flexible" construct:
  o **Fluidity** represents the design of space for flows of individuals, sight, sound, and air.
  o **Versatility** indicates the property of space that allows for multiple uses.
  o **Convertibility** designates the ease of adapting educational space for new uses.
  o **Scaleability** describes a property of space for expansion or contraction.
  o **Modifiability** is the spatial property which invites active manipulation and appropriation.

- Though constructivist teaching pedagogy emphasizes fluidity and versatility in classrooms, technology often undermines those goals. Classrooms wired for distance learning often limit mobility because teachers and students must remain within the camera's view. Similarly, projectors, laptops, and microphones that are hard-wired prevent rapid reconfiguration of the space.

- **Abstract:** This paper analyzes the convergence of information technology infrastructures and traditional educational spaces and proposes flexible criteria for material-virtual, hybrid learning environments. I develop the concept of *built pedagogy* to account for the ways that built environments teach values through their constraints upon social action and interaction and suggest ways that the built pedagogies of hybrid spaces can facilitate learning by inviting students and teachers to participate in the continual re-design of learning structures.

27. Monahan, Torin. "Just Another Tool? IT Pedagogy and the Commodification of Education." *The Urban Review.* No. 4, December 2004. 271–292. Web. 5 July 2013. **<http://cursa.ihmc.us/rid=1129290566765_1946352641_1833/Monahan_just_another_tool_2005.pdf>.**

- **Abstract:** This article investigates the social relations being produced through the incorporation of information technology (IT) into educational practices. Drawing upon field research with the Los Angeles public school system, the article analyzes social relations in three technology classrooms, discusses gender and ethnic inequalities with technology, and documents the kinds of educational technology programs that teachers and administrators find valuable. Rather than IT being an apolitical tool, these examples illustrate how technologies operate within larger ideological systems, linking students and public institutions intimately with globalization processes of privatization and commodification. In conclusion, an alternative framework for technology pedagogy is introduced, one that confronts the politics of technology by perceiving information technologies as social media rather than simple tools.

  For IT is not only a means of global expansion, it also represents a system for linking students and public institutions intimately to globalization processes, thereby reproducing and reinforcing rationalities of global competition and interconnection. Given this encompassing political orientation, the question posed here is not so much "Do computers work?" but "What social relations do they produce?"

  –Torin Monahan (2004), Assistant Professor of Justice & Social Inquiry, Arizona State University

- Computers are not merely tools like paper and pencil, they are media that can be used for creation of new rules and structures for learning. They are "part of complex systems of interdependencies and as contexts for creative expression and knowledge production, catalyzes empowering learning activities because constraints and interconnections become the explicit terrain for practices."

28. Neill, Stern, and Rebecca Etheridge. "Flexible Learning Spaces: The Integration of Pedagogy, Physical Design, and Instructional Technology." *Marketing Education Review* 18.1 (2008): 47–53. Web. 5 July 2013. **<http://digitalcommons.calpoly.edu/mkt_fac/22/>**

  Pedagogical innovation demands a space that enables exploration by both teacher and student.

  In developing a flexible learning space, attention was given to pedagogical, physical design, and information technology issues.

- Learning space configuration includes:
  - Linear: Lecture, Presentation, and Video
  - Horizontal: Class Discussion

- o Cluster: Small Group Discussion and Activities
- o Network: Decentralized Instruction

29. OWP/P Architects + VS Furniture + Bruce Mau Design. *The Third Teacher: 79 Ways You Can Use Design to Transform Teaching*. New York: Abrams, 2010. Print.

- Written by a group of designers, this book uses the Reggio Emilia approach to childhood education as the basis for a comprehensive set of 79 design recommendations. Highlights particularly applicable to higher education include:
  - o #1. Everyone can be a designer: Look to many sources for design inspiration. Teachers and students, as well as architects and designers, have ideas about their ideal learning environment.
  - o #8. Design for speech and hearing: Acoustics isn't just for concert halls. Using sound absorbent materials in classrooms is a simple and effective way to ensure that teachers can focus on teaching, not repeating.
  - o #9. Let the sunshine in: And the gray skies too. Increasing daylight in classrooms has been shown to cut down on absenteeism and improve test scores.
  - o #11. Make it new: Look at your learning space with 21st-century eyes. Does it work for what we know about learning today, or just for what we knew about learning in the past.
  - o #12. Support great teaching: Free teachers from the traditional desk at the front of the classroom and encourage new settings for teaching and learning.
  - o #15. Display learning: Posting student work, both current and past, up on the walls tracks progress in a visible way.
  - o #16. Emulate museums: An environment rich in evocative objects – whether it's a classroom or a museum – triggers active learning by letting students pick what to engage with.
  - o #18. Unite the disciplines: Art and science need each other. Discoveries – great and small – happen when the two come together; so give students places for cross-disciplinary work, and who knows what creative genius will flourish.
  - o #19. Bring the outside in: Transport the community, the landscape, and faraway places into the classroom with visuals and objects that call them to mind.
  - o #22. Swivel to attention: Give students furniture that lets them twist and lean safely. The movement will increase their ability to concentrate.
  - o #23. Make classrooms agile: A learning space that can be reconfigured on a dime will engage different kinds of learners and teachers.
  - o #41. Leapfrog LEED: Think of today's top rating for environmental school design as tomorrow's last-place rating, and design to be better than the current best practices.
  - o #44. Highlight the site: Every school is located in a particular place with its own unique geological features and natural history. Call attention to a school's site with design, construction, and signage.
  - o #50. Slow the pace: Alcoves and furniture in hallways discourage high-speed traffic and create places of pause.
  - o #55. Trigger the sense: Sound, smell, taste, touch, and movement power memory. An environment rich in sensory experiences helps students retain and retrieve what they learn.
  - o #56. Design in multiple dimensions: Evaluate ideas, features, and materials for the learning environment on their sensitivity to color, light, and texture.

- o #60. Open the doors: Give students places to exhibit their work as if it were in a public gallery, then invite the public to come and have a look.
- o #78. Dream big and be brave: The rate of technological advancement is increasing exponentially. When designing schools, don't let today's reality limit tomorrow's possibilities.

30. "Pedagogy, Classroom Design, Evaluation: The Recent History at Harvard." Harvard Magazine. *Harvard Magazine,* 18 Oct 2011. Web. 18 June 2013. **<http://harvardmagazine.com/2011/10/analysis-pedagogy-practice-and-teaching-innovation-at-harvard>.**

- Former Harvard President Derek Bok identifies three priorities for transforming undergraduate education.
  - o Professors should substitute new, learner-centered teaching for traditional lecturing.
  - o Faculty should develop new methods for measuring student success as a result of various teaching modalities.
  - o Departments across the university should prepare graduate students, who are tomorrow's faculty, to be experts in new methods of teaching.

- Top-tier universities have not been leaders in the reform of undergraduate education because applications continue to far outpace enrollment. Given these universities effect on the pedagogy and culture of higher education as a whole, however, it is crucial that they engage more fully with the urgent task of restructuring the teaching and learning environment.

- The focus on faculty performance as researchers has often lead to an undervaluation of professors' role as undergraduate teacher.

- Harvard Business School has furnished new teaching spaces called "hives" to allow students to sit in working groups at the newly renovated 125 Western Avenue building.

- Gu-Yeon Wei, associate dean for academic programs, is promoting a new kind of teaching space in Pierce Hall's third-floor library where small groups of students work together while focusing on a teacher only when needed.

31. Salmen, John P. "Universal Design for Academic Facilities." *New Directions for Student Services* no. 134 (2011): 13–20. *ProQuest.* Web. 5 June 2013.

- **Abstract:** Universal design (UD) can play a role in many aspects of academic life and is often thought of in the context of learning. However, this chapter focuses on the impact of UD on the design of facilities in a university or campus setting. Universal design has the potential for transforming universities into truly egalitarian institutions that accommodate all users regardless of their size, age, or physical capabilities, allowing them to flourish, learn, and unleash their true potential. Universities are especially good facilities for the application of UD because they accommodate a wide range of transient users. Since one size does not necessarily fit all, the application of UD needs to be appropriate to the institution's scale,

facility type, and program for it to be completely effective. Universal design accommodates not only people who use wheelchairs or are blind, but also older learners, parents with children, and nontraditional learners of all sorts. The effort to provide UD can also help institutions comply with the Americans with Disabilities Act (ADA), section 504 of the Rehabilitation Act of 1973, and other state and local accessibility regulations. This chapter explains the differences between accessibility and UD and discusses methods of accommodation and areas of opportunity for UD on campuses.

- The principles of universal design are: Equitable use; Flexibility in use; Simple and intuitive; Perceptible information; Tolerance for error; Low physical effort; Size and space for approach and use.

- Strategies for integrating universal design into classrooms include:
  o Modifying tables to offer accessible seating
  o Assuring that aisles in the bookstore and library are wide enough for wheelchairs.

32. Skill, Thomas D., and Brian A. Young. "Embracing the Hybrid Model: Working at the Intersections of Virtual and Physical Learning Spaces." *New Directions for Teaching and Learning* 2002, no. 92 (2002): 23–32. *Wiley Online Library.* Web. 14 June 2013.

- Envisioning the ideal learning environment, Roger Schank, then director of the Institute for Learning Sciences at Northwestern University, stated that students should spend one-third of their day at the computer, one-third talking with others, and one-third making something.

- The most effective strategy for approaching the e-learning/instructor-led classroom learning dichotomy is a hybrid model in which learners move between modalities throughout the curriculum; learning environments should support both virtual and real spaces.

- Chickering and Gamson's (1987) "Seven Principles for Good Practice in Undergraduate Education" are as applicable to the hybrid model of teaching as they were when written exclusively about instructor-led classroom environments.
  o Good Practice Encourages Student-Faculty Contact
    ▪ Whether in a shared classroom, or through an online community, the relationship between learner and teacher is central to the successful educational experience. Promoting ways for students and faculty to interact directly before, during, and after class time is an effective strategy for building a trusting and respectful relationship.
    ▪ Building design should provide student-controlled spaces adjacent to faculty-controlled classrooms where students can continue course work in proximity to faculty.
  o Good Practice Encourages Cooperation Among Students
    ▪ Providing shared calendars for students to coordinate meeting times and schedule student-controlled gatherings is one tool administrators have that promotes student-to-student learning.
  o Good Practice Encourages Active Learning

- The physical classroom too often limits the range of active learning experiences. Space for group-driven activities, access to multimedia display and creation tools, and flexibility in room layout are all aspects of a well-designed learner-centered teaching space.
- Virtual spaces for collaboration as well as media production and consumption can often compensate for limitations in physical space.
  - o Good Practice Gives Prompt Feedback
    - Face-to-face conversations are a highly valuable tool for instant feedback; shifting away from the "sage on the stage" model of lecturing to a "guide on the side" model of facilitated discussion provides students with peer-to-peer feedback.
  - o Good Practice Emphasizes Time on Task
    - Virtual environments that allow students to extend the "time-on-task" beyond the classroom walls deepen and strengthen the educational experience.
    - Wireless networks and robust web-based learner portals that link students to videos, lectures, discussions, and each other can blend the lines between living and learning spaces or between public and private spaces across campus.
  - o Good Practice Communicates High Expectations
    - Flexible learning environments provide multiple paths for student achievement.
    - Blending diverse e-learning opportunities with a robust portfolio of active-learning experiences within the classroom creates a learning-objectives-driven curriculum.
  - o Good Practice Respects Diverse Talents and Ways of Learning
    - The responsibility of creating successful learning environments does not rest solely on the faculty in the classroom.
    - Implementation of good practices requires cooperation of everyone at the university: from students to deans, facilities staff to faculty.

- Trends relevant to educational facility designers:
  - o Ubiquitous computing
  - o Wireless networking & robust internet access
  - o Technology-intensive teaching and learning
  - o Emphasis on informal learning
  - o De-emphasis on the classroom
  - o Imaginative furniture design
  - o Emphasis on service learning
  - o Student-created products for business
  - o New learning partnerships

- Following the recommendation to design for flexibility requires these four strategies:
  - o Design larger spaces that are more flexible than smaller spaces.
  - o Partitions should be moveable and demountable to allow for reconfiguration.
  - o Quantity of space allows teachers and students to control the environment without conflicting with each other.
  - o Buildings should always be evolving and the result of constant manipulation and adaptation.

33. "University of Connecticut Social Sciences and Classroom Buildings / Leers Weinzapfel Associates Architects." *ArchDaily,* 20 March 2013. Web. 6 June 2013.

<http://www.archdaily.com/346767/university-of-connecticut-social-sciences-and-classroom-buildings-leers-weinzapfel-associates-architects/>.

- University of Connecticut Social Sciences and Classroom Buildings are two separate buildings that frame the intersection of two campus paths. The buildings house five departments and include 40 classrooms.

- The classrooms range in size from a 400-seat lecture hall to small seminar rooms and include twelve departmental teaching spaces. Every classroom is equipped with state-of-the-art technology.

- The project serves major campus planning goals by framing outdoor gathering spaces and defining paths and thoroughfare.

  A large day-lit lecture hall and ten classrooms occupy the ground level; students and faculty interact in the public galleries surrounding the courtyards. The three upper floors accommodate an additional ten smaller classrooms as well as the five departments and their several hundred offices and specialized teaching spaces.

34. Van Note Chism, Nancy. "A Tale of Two Classrooms." *New Directions for Teaching and Learning* 2002, no. 92 (2002): 5–12. *Wiley Online Library*. Web. 14 June 2013.

    We know too much about how learning occurs to continue to ignore the ways in which learning spaces are planned, constructed, and maintained.

    –Nancy Van Note Chism

- The design of classrooms affects the ways in which teachers and students interact. In a computer lab with fixed tables facing the front of the room, the teacher must move up and down the aisles to see students' faces otherwise blocked by computer monitors – looking sideways down the rows. In a room setup for group discussion, students turn their chairs to face the teacher and abandon their writing surface.

- The lack of awareness of how learning spaces affect learning outcomes combine with the complexities of planning academic programs to yield a dearth of knowledge around classroom design.

- Traditionally, space use and planning decisions have been the realm of campus architects, facilities staff, registrar, and recently, the technology officer. Noticeably left out of this conversation are the users: teachers and students.

- Traditional classrooms were designed to serve the transmission theory that frames teaching as telling; rooms are configured to focus students' attention solely on the teacher who stands in one place in the room.

- Classrooms for the 21st century should reflect the shift to constructivist teaching theory that addresses the ways social context influences learning.

- A new way of understanding learning was outlined in "Powerful Partnerships: A Shared Responsibility for Learning" (1998).
  - Is about making and maintaining connections
  - Takes place in the context of a compelling situation
  - Is an active search for meaning by the learner
  - Is developmental and involves the whole person
  - Is done by individuals within a social context
  - Is affected by the educational climate
  - Requires frequent feedback
  - Takes place informally and incidentally
  - Is grounded in particular contexts and individual experiences
  - Involves the ability of individuals to monitor their own learning

- Learning spaces designed for constructivist education will not be limited to the classroom, but will spill into corridors, across campus, and throughout the interconnected digital web. These spaces will include:
  - Small-group meeting spaces
  - Project spaces
  - Spaces for whole-class dialogue
  - Spaces where technology can be accessed easily
  - Spaces for display of ideas and working documents
  - Spaces that can accommodate movement and noise

35. Van Note Chism, Nancy. "Challenging Traditional Assumptions and Rethinking Learning Spaces." *Learning Spaces*. Ed. Diana G. Oblinger. Washington, DC: Educause, 2006. 2.1-2.12. Print. **<http://net.educause.edu/ir/library/pdf/pub7102b.pdf>**.

- Great article outlining the importance of space design in learning pedagogy.

  We can facilitate deeper and richer learning when we design spaces with learning in mind.

  Torin Monahan used the term "built pedagogy" to refer to "architectural embodiments of educational philosophies." In other words, the ways in which a space is designed shape the learning that happens in that space.

36. Van Note Chism, Nancy, and Deborah J. Bickford. "Editors' Notes." *New Directions for Teaching and Learning*. 2002, no. 92: 1–4. *Wiley Online Library*. Web. 14 June 2013.

- This introduction provides an overview of the chapters within *New Directions for Teaching and Learning*.

37. Walsh, Colleen. "In the Spirit of the Law." *Harvard Gazette*. Harvard Gazette, 19 April 2012. Web. 7 Aug 2013. **<http://news.harvard.edu/gazette/story/2012/04/in-the-spirit-of-the-law/>.**

- Designed by A.M. Stern, Wassertein Hall, Caspersen Student Center, and Clinical Wing at Harvard Law School includes generous lobby spaces (**Figure 25**) and wide hallways with seating that encourage casual interactions.

FIGURE 25. CASPERSEN STUDENT CENTER LOUNGE, HARVARD LAW SCHOOL

- Cluster Classrooms (**Figure 26**) include views to the outdoors, spaces for group work, and front-oriented seating. Projection screens and chalkboards provide multiple ways to display information. The wood trim serves as a subtle connection to the richness of natural texture and patterns.

FIGURE 26. WASSERTEIN HALL CLASSROOM, HARVARD LAW SCHOOL

38. Whiteside, Aimee L., Christopher D. Brooks, and D. J. Walker. "Making the Case for Space: Three Years of Empirical Research on Learning Environments." *EDUCAUSE Quarterly* 33, no. 3 (2010): 17. *ProQuest.* Web. 5 June 2013. **<http://www.educause.edu/ero/article/making-case-space-three-years-empirical-research-learning-environments>.**

- **Abstract:** An article in last year's *EDUCAUSE Quarterly* special issue on learning spaces reported on the results of the University of Minnesota's pilot evaluation of its high-tech, state-of-the art Active Learning Classrooms (ALCs). The next phase of research on learning environments at the University of Minnesota involved a unique partnership with undergraduate researchers, faculty members with considerable classroom experience, and several collegiate and unit associates. In this new project, funded by the Bush Foundation

(established in 1953 by Archibald G. and Edyth B. Bush), the authors conducted a more systematic investigation of the impact of formal and informal learning environments. They explored the effects of different types of formal learning environments on student learning outcomes and teaching and learning strategies, and they explored where, when, and how students completed their course assignments when they used informal study spaces. To answer their research questions about informal student study environments, the authors developed a study assignment log, asked students to complete a photo survey of their selected learning spaces, and conducted student focus groups. The authors present the results and key findings of the study in terms of formal and informal learning environments. Concluding implications and recommendations are also presented. (Contains 10 figures, 3 tables and 8 endnotes.)

- Active Learning Classrooms (ALC) provide round tables with nine seats each (which allows three small groups of three when needed).

- ACT scores in the ALC were 29.8 points higher than expected.

- A professor that was observed teaching the same class in a traditional classroom and an ALC spent much more time leading class discussion in the ALC than lecturing. While in the traditional classroom, he spent very little time leading discussion and more time lecturing from behind the podium.

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