Pedagogical Trends and Implications for Space Design

Introduction

The physical design of teaching spaces conveys unspoken messages for both the students and the instructor. A teaching space can inspire creative thinking and collaboration, or it can encourage passivity and disconnectedness. Research indicates pedagogies and learning spaces that encourage active learning and promote student engagement can better meet the needs of today's diverse students. This document briefly examines emerging pedagogical trends and their implications for teaching spaces. It then provides specific recommendations based on models that are being implemented at other higher education institutions.

How Learning Works

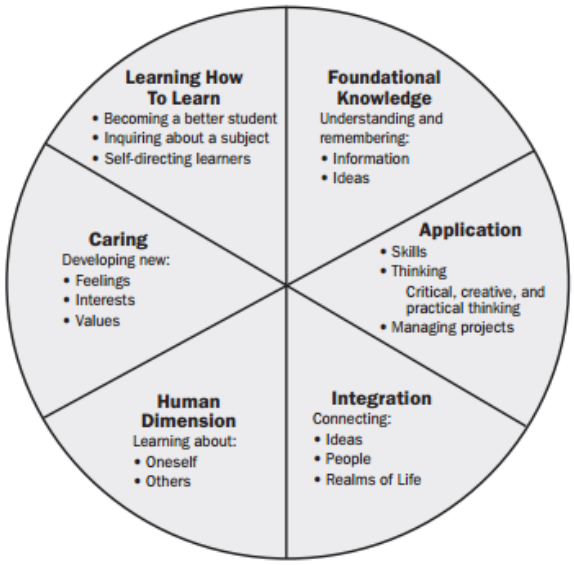

Figure 1: Fink's Taxonomy of Significant Learning

Recent research in education and cognitive psychology has identified several characteristics that can hinder or improve student learning. Fink (2003) devoted several years to surveying faculty members in order to identify what constitutes "significant learning" practices that help students develop practical, life-long skills (Figure 1). He found positive learning gains in classrooms with integrated course design that encourages active, problem-based learning where students engage inductive thinking while building their foundational knowledge. Fink showed that active learning classrooms increased students' knowledge retention, developed critical thinking and molded students into self-directed learners.

In line with Fink's taxonomy, Ambrose et al (2010) developed seven learning principles that influence student learning:

1. Engaging students' **pre-conceptions and prior knowledge** helps them grasp and process new information within a relevant context
2. **Organization of information** (e.g.: how that information is presented) influences how students learn and apply knowledge
3. **Motivation** determines and sustains what students do to learn
4. Students must acquire **component skills**, practice integrating them, and know when to apply what they have learned in order to master that skill
5. Students require **goal-directed practice** and **targeted feedback** to enhances the quality of learning

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6. The **social, emotional**, and **intellectual climate** of the course can impact student learning
7. Students must learn to **monitor and adjust their approaches** to learning if they are to become self-directed learners

These principles, along with today's rapidly changing student population, have significant implications for the future of teaching practices and pedagogy. Classes are becoming more socially and ethnically diverse, "digitally native" students expect their classroom experience to be more active, engaging and hands-on, and they expect their learning experience to be closely tailored to their individual needs and are not afraid to take responsibility for their own learning when given appropriate guidance and boundaries (Taylor, 2010). By critically examining and implementing new pedagogies in about out of the classroom, educators can better address the learning needs of today's students and prepare effective leaders of tomorrow.

New Approaches to Pedagogy

Advances in our understanding of cognitive learning processes and the changing demographics of the student population have led to several pedagogical changes. Massive Online Open Courses (MOOCs) that make free educational videos available online have opened up the opportunity to take teaching outside the classroom freeing up class time for other activities. In a report published by the Association of American Colleges and Universities (AAC&U), Kuh (2008) identifies ten specific high impact teaching and learning practices that have been widely tested and recognized as having strong positive impacts on student outcomes, retention rates and student engagement.

1. First year seminars
2. Common Intellectual Experiences: which evolved from the more traditional "core" curriculum ideas and consist of a set of required common courses
3. Learning Communities: where students take 2 or more linked courses as a group and work closely with each other and the professor. The goal is to encourage integration of learning across courses
4. Writing intensive courses
5. Collaborative assignments and projects
6. Undergraduate research
7. Diversity/ global learning: which range from exploring "difficult differences" to community learning and study abroad
8. Service learning, community based learning
9. Internships
10. Capstone courses and projects

In examining the transition to the emerging pedagogy paradigms in the field of engineering education, Felder (2012) identified similar pedagogical trends. Successful engineering programs shared the following characteristics:

1. Inductive teaching: where faculty present or students discover principles, formulas, and algorithms within the context of problems or projects. The projects can be easier during the students' first year, increasing in difficulty as they culminate in a capstone projected suggested by Kuh (2008).

2. Faculty teaching addresses a broad spectrum of learning styles including visual/verbal, concrete/abstract, active/reflective, and sequential/global.
3. Lectures are combined with activities that ask students to discuss, explain, brainstorm, question, reflect and compute, to develop strong foundational knowledge and critical thinking skills
4. Some lectures are "flipped" with students watching lectures outside of class using interactive multimedia tutorials and other technology-based tools, while class time is dedicated to more active learning.
5. Assignments balance individual work with collaborative group work.

Like Kuh's (2008) high-impact practices, the pedagogical trends identified by Felder have had significant positive impact on student learning. Prince (2011), found that such active and problem-based learning improve students' attitudes about their educational experience (reducing drop out rates), increase long-term retention of information, promote teamwork skills and are an effective way of transitioning novice students to more complex projects.

Implications for Teaching Space Design

Emerging pedagogical trends have important implications on teaching space design. Scott-Webber (2004) reviewed literature on the emotional and cognitive effects of space to conclude that space configurations exert strong influences on individual activities that can either promote or discourage creativity, knowledge creation, communication and application. Bennett (2011) highlighted five specific characteristics that learning and teaching spaces should ideally be equipped with, in order to facilitate the pedagogical trends described above and to ensure positive learning gains.

1. Multiple focal points (instead of one focal point at the front) in classrooms so that student movement and mobility is not limited during classroom activities.
2. Grouping or clustering of students instead of immobile row sitting
3. Establishing informal group work spaces
4. Providing movable furniture to facilitate quick reconfiguration of the classroom for engaging activities
5. Building reconfigurable space for multiple purposes

Recommendations

This section provides practical, tiered recommendations for pedagogy and learning spaces based on models from other universities, taking into account budget and time limitations.

Phase 1: Immediate Fixes

There are several simple and low-budget design solutions that Cornell can implement immediately to re-tool existing spaces to facilitate high-impact pedagogical practice. These changes can then be enhanced or further modified as resources become available.

1. Think-Pair-Share: a student turns to a neighbor to discuss a question posed in class and then shares their response with the whole class. This allows students to reflect on and organize the material presented, helping them develop what Ambrose (2010) calls component skills. It also provides the opportunity for targeted feedback from the instructor and develops common intellectual experiences recommended by Kuh (2008).

Swivel chairs in auditorium used for Think-Pair-Share, Iowa State University

2. Group/Pair-work: like the Think-Pair-Share method, this goal directed collaborative practice allows students to better integrate information and engages them in inductive thinking.
3. iClickers (or mobile devices): the instructor posts a question on the board/ powerpoint slide and asks students to answer it by choosing an option on the iclicker. The instant targeted feedback that students receive through this method helps them monitor and adjust their approaches to learning, promoting self-directed learning practices.

Phase 1: Some Examples of Physical Learning Space Ideas That Facilitate Phase 1 Pedagogical Practices

- White/black boards that are not blocked by a projector screen
- Multiple display screens
- Multiple mobile whiteboards or walls painted with whiteboard paint for collaboration and brainstorming activities
- Mobile furniture – chairs and tables on wheels.
- Chairs with a storage compartment for students' bags and coats (e.g.: the Node Chair).
- Power outlets to allow student use of technology for class activities.
- Mobile microphones to facilitate student-student and student-faculty communication in the classroom.

Figure 1: Node chair from UMich

Phase 2: Future Teaching Spaces

MIT's Technology Enhanced Active Learning (TEAL) project and North Carolina State University's SCALE-UP projects are good examples of where teaching space redesign is headed. Based on Ambrose's (2010) research on how learning works and on the high-impact practices outlined by Kuh (2008) and Felder (2012), Cornell should consider adopting the following practices:

1. Group work: students engage the course material through collaborative group projects, in groups of varying sizes. This helps students solidify and apply foundational knowledge, develops the "integration" and "human dimension" skills necessary for Fink's (2003) significant learning, enhances the social and intellectual climate of the classroom and encourages students' global learning by giving them the opportunity to interact with and learn from their diverse peers.
2. Discussion break-out sessions: lectures are interspersed with break-out sessions where students analyze and evaluate the material presented, developing higher order thinking skills. The break-out sessions are also crucial in maintaining student attention. Research shows that student attention

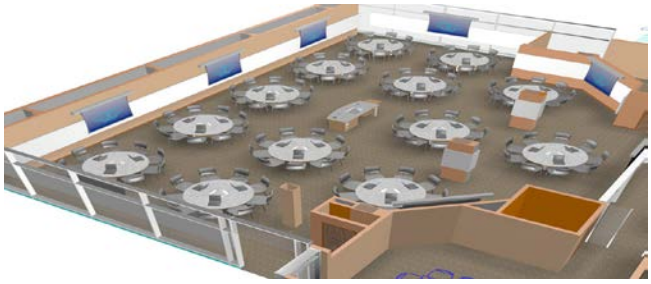
peaks after 15 minutes from the beginning of class, levels off and then decreases (Bunce, et al. 2010). Break-outs are a useful tool to retain student attention.

3. Problem-Based Learning/ Inquiry-Based Learning: students are led on a process of discovery by solving, researching or analyzing a challenging and stimulating real-life problem. This is a great opportunity to engage students' prior knowledge and uncover and address any misconceptions.

Phase 2: Some Examples of Physical Learning Space Ideas That Facilitate Phase 2 Pedagogical Practices

- Wider rather than deeper classrooms to allow for greater mobility and facilitate student-instructor communication. This is especially helpful when instructors want to give immediate targeted feedback.
- Row seating replaced by round tables that encourage collaborative group work and permit breakout sessions. (eg: MIT TEAL Project sits three groups of three students at each table)
- Mobile furniture and multiple display screens around the room's periphery to allow for flexible seating arrangements and diverse presentation techniques
- A laptop or other computers available to students as part of the classroom space to engage in research or technology enabled collaborations. (e.g.: MIT TEAL Project provides one laptop per group of three students)
- A "smart" teacher work station in the middle (instead of the front) of the room that increases instructor's accessibility to and interaction with students, enabling the instructor guide students in their work.

Faculty can guide students through inductive processes, motivating them to create novel solutions and preparing them for future research or capstone work.



A rendering of the MIT TEAL classroom for a large class

Phase 3: Teaching Spaces: Where Cornell Can Lead

The future trend in pedagogical practices and space design is seamless integration of teaching and learning spaces. Students are constantly seeking out informal learning spaces to discuss and reflect on class material outside the class time. An article on trends in learning spaces in medical science buildings notes that "the need for [informal study space] is so great that even formal instructional space is co-opted by students after class" (Wesel, 2012). Designing "smart" classrooms for integrated courses that use technology, pedagogy and spaces together to engage students and promote active learning is where Cornell can take the lead. A truly integrated learning environment will:

1. Provide deliberate practice space for hands-on learning to enhance students' component skills and help them become mature self-directed learners. This can take the shape of labs and studios, capstone projects, learning communities and spaces for collaborative projects as described by Kuh (2008).
2. Increase student-student, student-faculty and student-technology interactions to keep students motivated and to provide opportunities for goals-directed practices and targeted feedback. This can be achieved through opportunities for common intellectual experiences, learning communities, collaborative projects and global learning (Kuh, 2008).
3. Provide opportunities for simulations and experiential learning to engage students' prior knowledge, develop critical thinking practices, and provide a context to integrate the new material. Seminars, research projects, study abroad, service learning and internships are good examples of high-impact experiential learning that have been shown to have positive influences on student achievement (Kuh, 2008, Prince, 2011).
4. Be multi-purpose to enable cross-departmental collaboration and collaborative teaching, creating a positive social, emotional and intellectual climate, broadening students' global education, and motivating inductive reasoning.

Phase 3: Some Examples of Physical Learning Space Ideas That Facilitate Phase 3 Pedagogical Practices

- Integrating multi-media technology for blended "flipped" classrooms where students can prepare for class in a different way and apply this knowledge to hands-on activities during class.
- Integrating multi-media technology for massive online open courses (MOOCS) like the EdX model at Harvard and MIT and the open courses from Stanford. This not only facilitates the flipped classroom but also allows students to take a more active approach to their learning under expert guidance from faculty.
- Buildings with plenty of informal spaces to study and collaborate (eg: Virginia Tech's Math Emporium, Cornell's CHE building and Mann Library) in order to enable students to integrate class material outside the classroom
- Redesigned classrooms that can be used for group work and active learning when class is not in session.
- "Smart", technology-rich studio classrooms that allow students to collaborate, engage in problem-based inquiry, reflect on, build upon or modify prior knowledge and organize information to fit their learning style.

The Role of CTE

1. Keeping abreast with pedagogical trends: Pedagogical trends are constantly changing and space design needs to reflect and accommodate these changes. CTE can draw on its extensive experience with teaching and pedagogy in partnership with the design team to ensure that the Cornell's teaching spaces address the needs of today's students.
2. Faculty training: While active learning spaces encourage excellence in teaching and learning, these new environments can be intimidating and can pose new challenge to faculty members. In order to fully leverage the learning potential of the new classrooms, faculty members may benefit from

training and support in adapting active learning techniques, technology use and student engagement.

3. Assessment: While many institutions of higher education are redesigning their classrooms, impact assessment of the new teaching spaces are still relatively rare. The CTE can help Cornell take the lead by designing and implementing pre-and post studies. Such studies will not only help Cornell but will also contribute to the whole higher education field.

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