Back to the Future: 21st Century Instruction Innovations in Higher Education

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Reasons for rethinking college instruction

Expectations

- Knowledge-based economy
- Technology-enhanced manufacturing
- Credential for professional success
- Energy sector leading US job growth
  - 75% of top new jobs in sector in engineering (USA Today, 10/1/12)

Opportunity…?

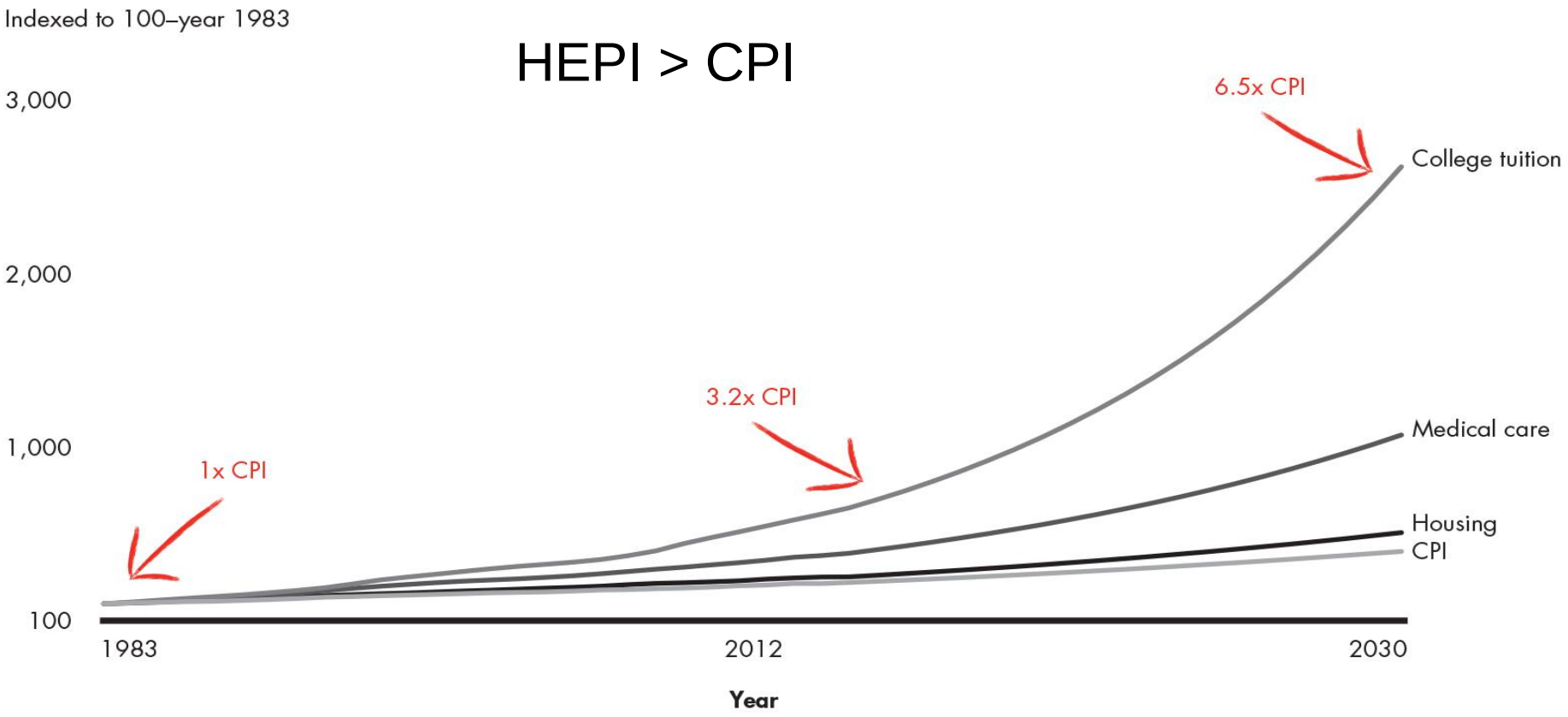
Higher Education Inflation

Figure 2: Higher education inflation (2001–2010)

Sources: US Bureau of Labor statistics (BLS); IPEDS; Bain & Company and Sterling Partners analysis

Higher Education Inflation

Figure 4: Projected tuition levels based on historical trends



Note: Housing costs—owner's equivalent rent; all metrics based on US city averages and are seasonally adjusted; forecast based on compounded annual growth 1983–2010
Sources: BLS; Bain & Company and Sterling Partners analysis

Source: The financially sustainable university, Bain & Company, July 6, 2012

Reasons for rethinking college instruction

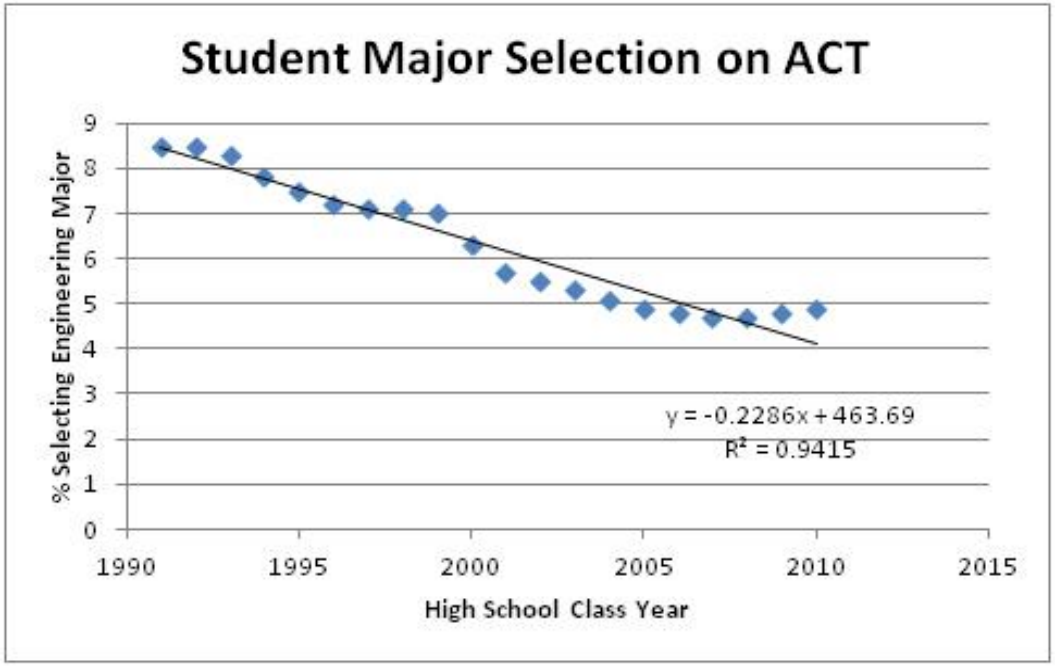
Competition, in-comes and out-goes

Competition

- Commercial Publishers
  - Wiley, Pearson, McGraw-Hill, etc
  - Instructional content, learning practice, assessment
    - On-line, interactive ebooks (underlines, tutorials, quizzes)
    - Practice, HW, and exam problem banks
    - Multi-media lecturettes
- MOOCs
  - edX (www.edx.org)
  - Coursera (www.coursera.org)
  - Udacity (www.udacity.com)
  - Udemy (www.udemy.com)
  - Khan Academy (www.khanacademy.org)

In-coming

- "[student achievement] is not accelerating fast enough for our nation's children to compete in the knowledge economy of the 21st century." [SoE A. Duncan, 2012, Referencing US DoE NAEP* measurement of weak growth in math/science]
- Only 45% US high school grads in 2011 ready for college level math, 30% in science [ACT scores] = growth in college remedial instruction
- Pipeline interest gap (especially women and minorities)



*--National Assessment of Educational Progress (8th graders) measurement of weak growth in math/science "Student achievement

Out-going

- Increased need for STEM graduates
- Increased need for STEM literacy in college grads as US citizens (infrastructure investment decisions, economics, science, technology)

NAE Grand Challenges
http://www.engineeringchallenges.org/


Make solar energy economical


Provide energy from fusion


Provide access to clean water


Reverse-engineer the brain


Advance personalized learning


Restore and improve urban infrastructure


Engineer the tools of scientific discovery


Develop carbon sequestration methods


Engineer better medicines


Advance health informatics

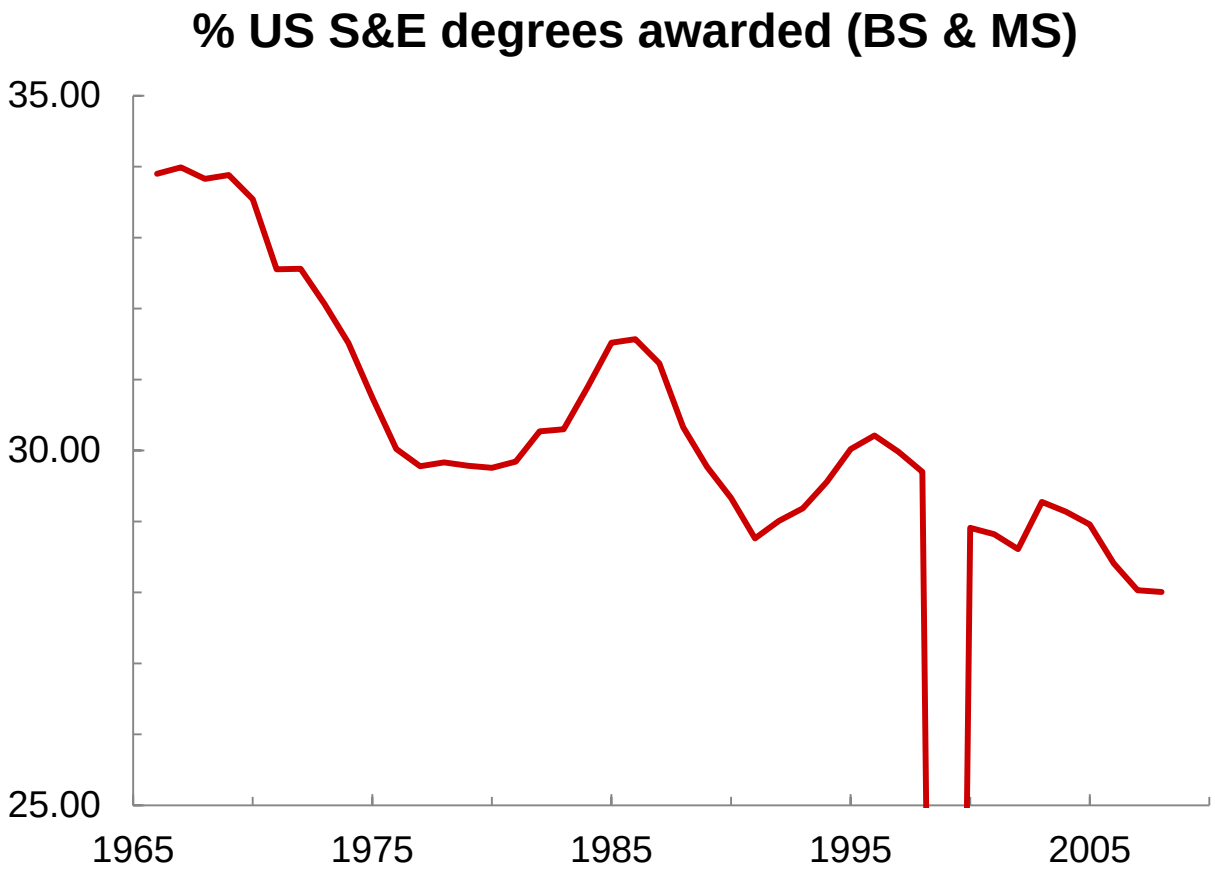

Prevent (nuclear) terror


Secure cyberspace


Enhance virtual reality


Manage the nitrogen cycle

Out-going



http://www.nsf.gov/statistics/nsf11316/pdf/nsf11316.pdf

Why change college instruction?

- IF it improves student learning
- IF it reduces costs
- IF it increases retention and graduation of STEM students
- IF it increases instructor enjoyment

Why *not* change college instruction?

- IF it diminishes student learning
- IF it increases costs
- IF it reduces retention and graduation of STEM students
- IF it decreases instructor enjoyment

- Base decisions on data and research-verified best practices

Some Critical Reflections on College Instruction

The Amazing Kreskin

- Word Association: *Classroom*



- Evolution of the classroom:

UW-Madison Lecture Hall, 1949

UW-Madison Lecture Hall, 2011

Origins of this choice?

- When was this choice made for universities?
- Answer: first universities (11th century)
  - Pope Gregory VII, 1079, cathedral schools, educate clergy, secular topics
    - Literacy (Latin), literature, rhetoric, logic, arithmetic, geometry, astronomy, music
    - Managing church property, calculating calendars, leading worship
- Based on learning in Catholic monasteries
- Books rare (Guttenberg ~ 1440)
- Leader reads verbatim, students copy = “text-books”
- Auditorium/sanctuary design + many students = many copies

<u>Pedagogy</u>

“*I* talk and demonstrate.”

“*You* listen, record, and respond if prompted”

Features of 11th Century Universitas

- Campus, tuition, classes, courses, lectures, notes, margin(alia), footnote
- Faculty, students, administration, chancellor, provost, dean, professor, associate professor, assistant (professor), sophomore, junior, senior, instructors
- Fees, assignments, laboratory, dormitory, requirements, prerequisities, examinations, texts, grades
- Convocation, graduation, commencement, procession, diploma, alumni association, donations
- *University*
- All Latin derivatives, little change from medieval origins
- All 11th-12th century origin

Traditional Classroom Learning

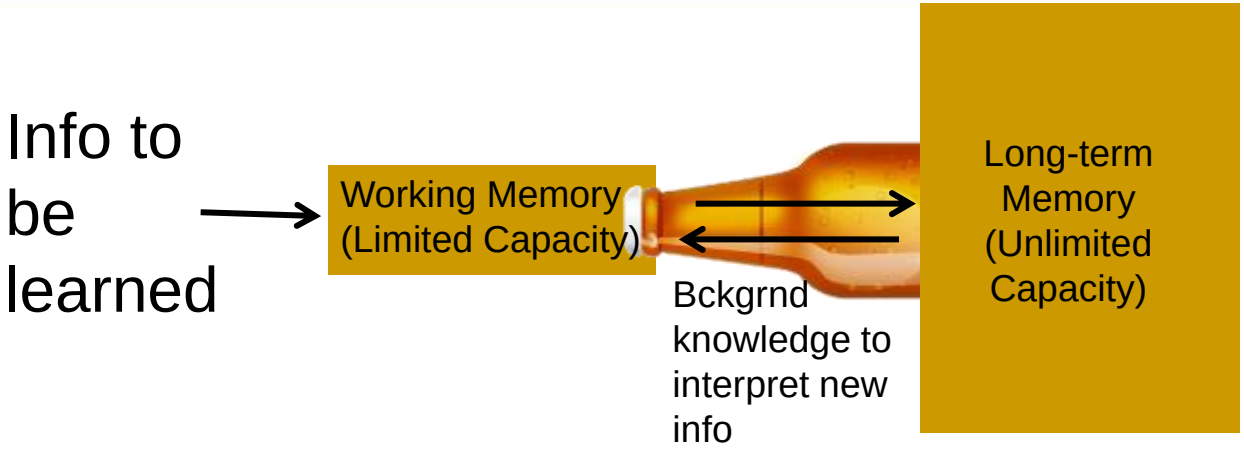
- Lecture + HW + testing
- Pros
  - Scalable
  - Efficient (low expert-to-novice ratios)
  - Works
- Cons
  - One size and pace for all
  - Long, continuous lectures inefficient for learning
    (Small “chunks” of content with frequent “testing” better)
  - Limited feedback (personnel budgets)
  - Learning occurs outside lecture w/o expert coaches
    - Less efficient (delayed feedback)
    - Misconceptions ingrained rather than immediately corrected

Underlying theory of learning

- Deliver identical content, HW, exams to all
- Learners sort themselves by their capacity and effort into a “natural bell curve” of capable learners and incapable or unwilling learners
- Analogy: health-care (goal: everyone as healthy as possible) with same medicines and treatments prescribed to all…blame “natural order or patient laziness” for poor outcomes even if patient needed a different treatment or medicine.

Research-based understanding of learning

Mechanics of human memory



- Understanding (vs rote memorization) requires *doing stuff* with knowledge
  - not just listening and recording.
  - *More* doing = *More* understanding
- Rudiments practiced = routine not conscious,
  - reduces cognitive load to learn new, higher level content

https://sites.google.com/a/uwlax.edu/exploring-how-students-learn/
http://brainconnection.positscience.com/topics/?main=fa/working-memory4
http://www.screencast.com/users/Teach-Learn_0/folders/Jing/media/cf63a16a-57f6-4963-9928-55a290ccb2bb
http://www.screencast.com/users/Teach-Learn_0/folders/Jing/media/20d6b535-225e-4a0d-86c5-7def169cf6af
http://en.wikipedia.org/wiki/Working_memory

21st century, research-based pedagogy

- "Doing" with content rather than passive absorption
  - Processing, analyzing, applying, linking to previous knowledge *in chunks*
- Frequent, immediate, individualized feedback and "unlimited" practice
  - Immediately graded (feedback) homeworks and assessments
  - Unlimited practice exercise banks
  - Instructors = personal-coaches-in-midst rather than sages-on-stage
- Peer-collaboration
- Personalized learning and instruction
  - Self-pacing
  - Students get their individual questions answered, not "one-size-fits-all"
  - Personalized and detailed data tracking of student engagement & "sticking" points

[1] Scott, G., Coates, H., & Anderson, M. (2008). "Learning leaders in times of change…" University of Western Sydney and Australian Council for Educational Research. Retrieved October 18, 2010 from http://www.acer.edu.au/documents/UWSACER_CarrickLeadershipReport.pdf

[2] Cabrera, A. F. & La Nasa, S. (2005). Classroom teaching practice: Ten lessons learned. In W. de Vries (Ed.). *Calidad, eficiencia y evaluación de la educación superior* (129-151). Spain, Madrid: Netbiblo; Seymour, E. & Hewitt, N.M. (2000). *Talking about Leaving: Why undergraduates leave the sciences, 2nd Ed*. Co: Westview Press; Treisman, P.U. & Surles, S.A. (2001). Systemic reform and minority student high achievement. In *The right thing to do, the smart thing to do: Enhancing diversity in the health professions in honor of Herbert W. Nickens, M.D.* (pp. 260-280). Washington, DC: Institute of Medicine, National Academy Press, National Academy of Sciences.

[3] http://www.educause.edu/LearningSpaces ; http://www.thencat.org

Challenge

Resources!

- Personnel “bandwidth”
  - Instructors, TAs
  - Grader hours
- Classroom Restrictions
  - Great for lecturing
  - Poor for anything else

Enablers

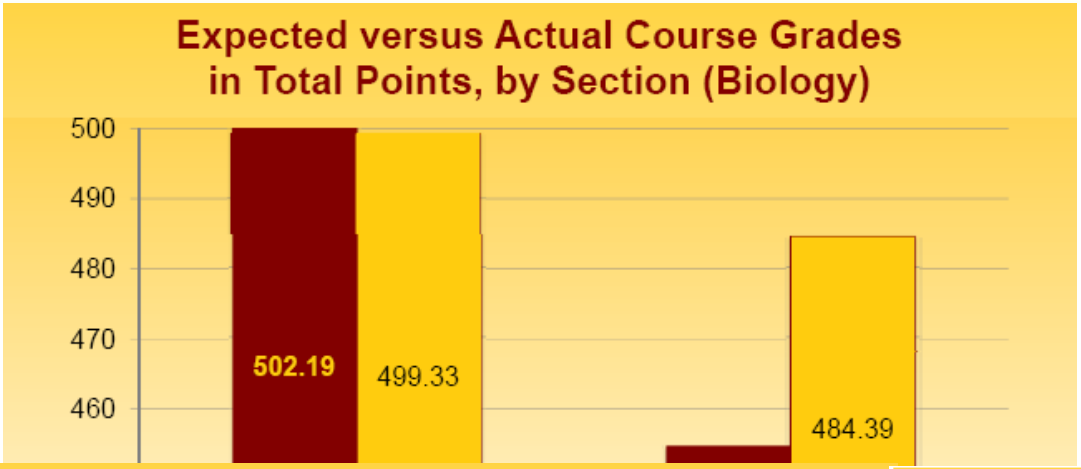
Pedagogy Research

Instructional Technologies (IT)

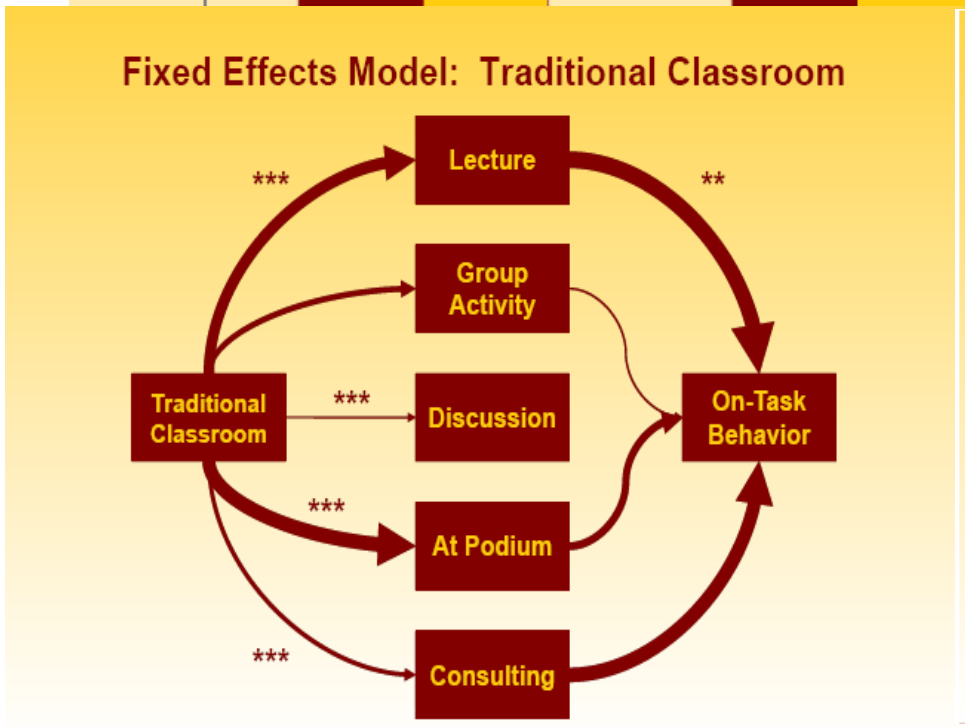
21st Century Classroom Design

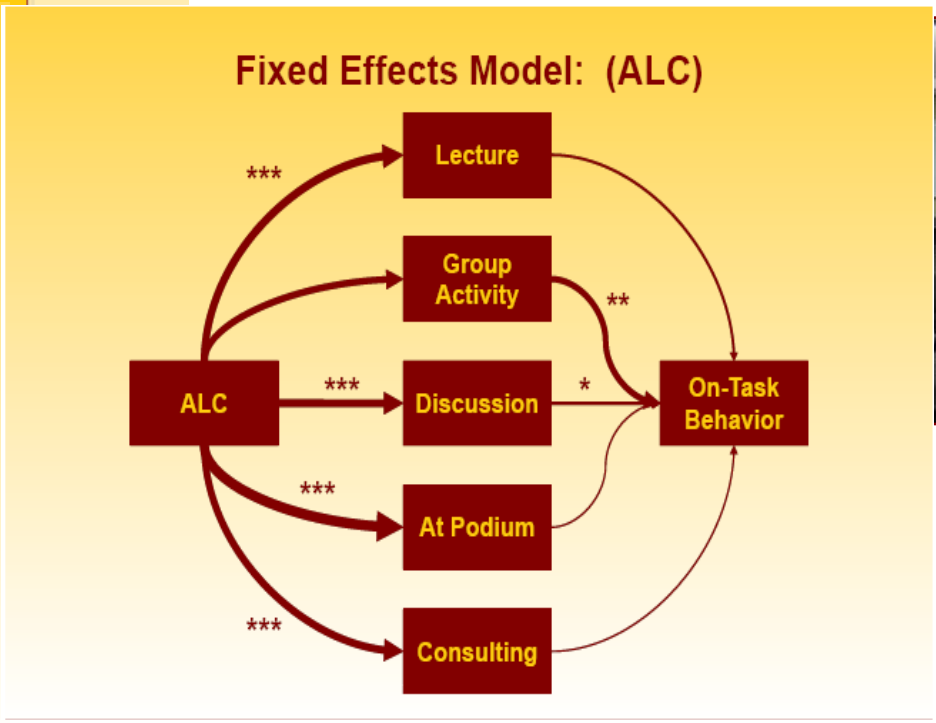
http://scaleup.ncsu.edu/
http://en.wikipedia.org/wiki/SCALE-UP
http://www.emporium.vt.edu/
http://www.educause.edu/LearningSpaces
http://www.thencat.org
http://www.wiscel.wisc.edu
http://www.studioteaching.org/
http://discovery.wisc.edu/home/discovery/recorded-lectures/carl-wieman-32012/

Does the *space* matter?



Yes!





Best Practices for Learning Spaces

- Large capacity room
- Extended hours access (up to 24/7)
- Furniture configuration supports P2P collaboration
- “Many-coaches-in-midst” vs. “sage-on-stage”
- Flexible usage hours
- Furniture
  - Easy mobility
  - Ample “surface space”
- IT hardware and software for unlimited practice problems with immediate feedback, assessment-when-ready
- Self-paced, unlimited practice opportunity

- Decouple course credit from rigid semester basis …?

Addressing the resource bandwidth

- Leverage peer-peer teaching!
- ~~"Expert lecturers"~~ → tutors, coaches
  - Instructor
  - TA's → UG student assistants
  - *Peers!*
- IT
  - infinite practice exercise banks
  - immediate feedback
  - individualized diagnostic and intervention potential
  - Suppresses cheating, reduces proctor needs

THE UNIVERSITY of WISCONSIN MADISON

Wisconsin Collaboratory for Enhanced Learning

WisCEL

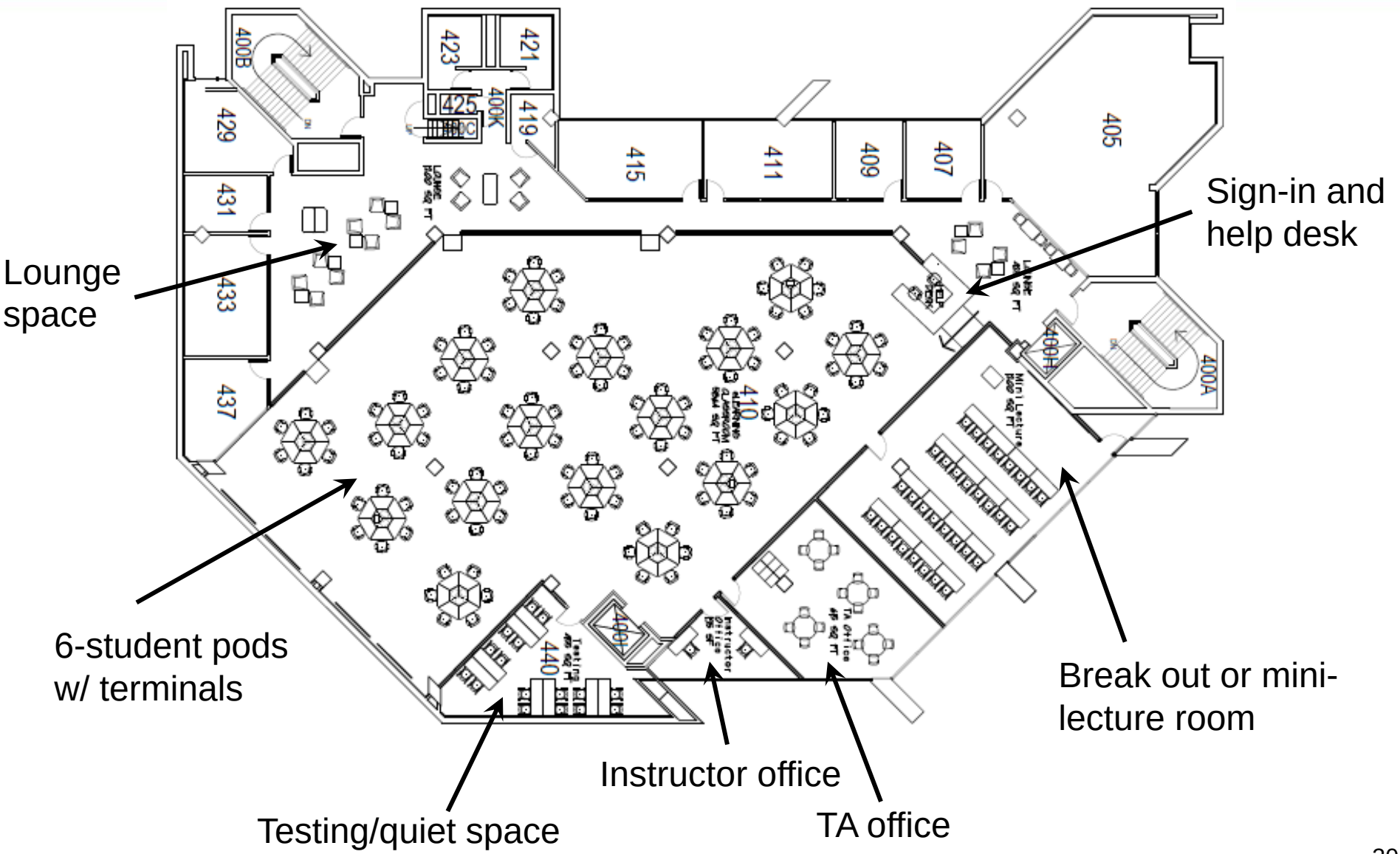
UNIVERSITY OF WISCONSIN–MADISON

John H. Booske, Director
Suzanne Smith, Associate Director

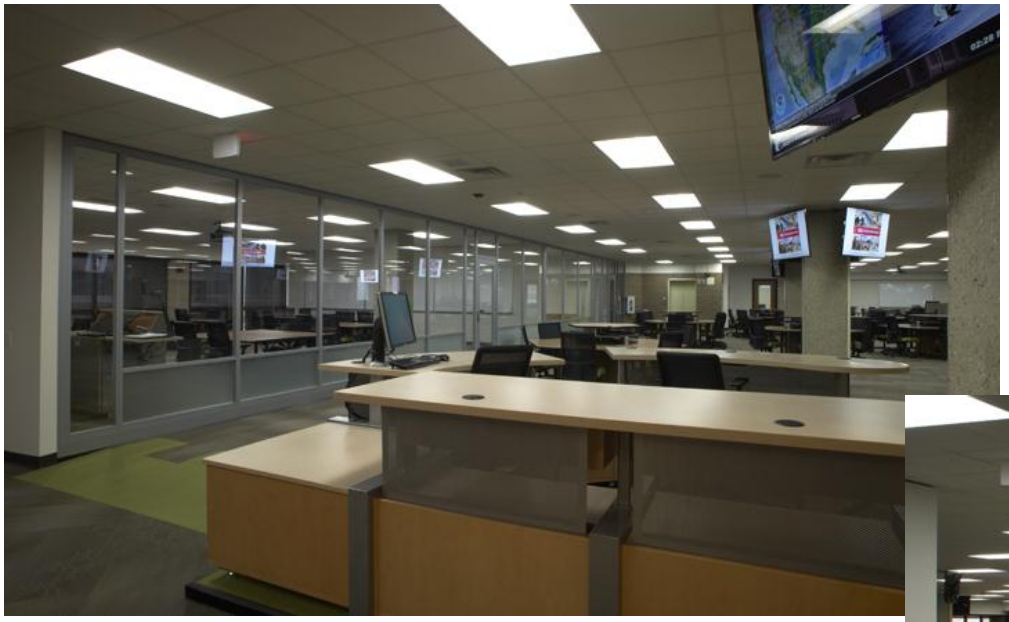
Timeline and Status

- Design effort started 2010 (conceptualization: 2009-10)
- Libraries: College (3rd floor, east) and Wendt (4th floor)
- Costs: space renovations & startup (one time), operations
- Pilot sections: Spring 2011, Fall 2011
- First full scale instruction: Spring 2012
- Fall-Spring 2012-13
  - 77 sections (24 distinct courses)
  - 61 instructors
  - 3 Colleges (L&S, Engr, Bus)
  - > 2700 enrolled students

Learning space features

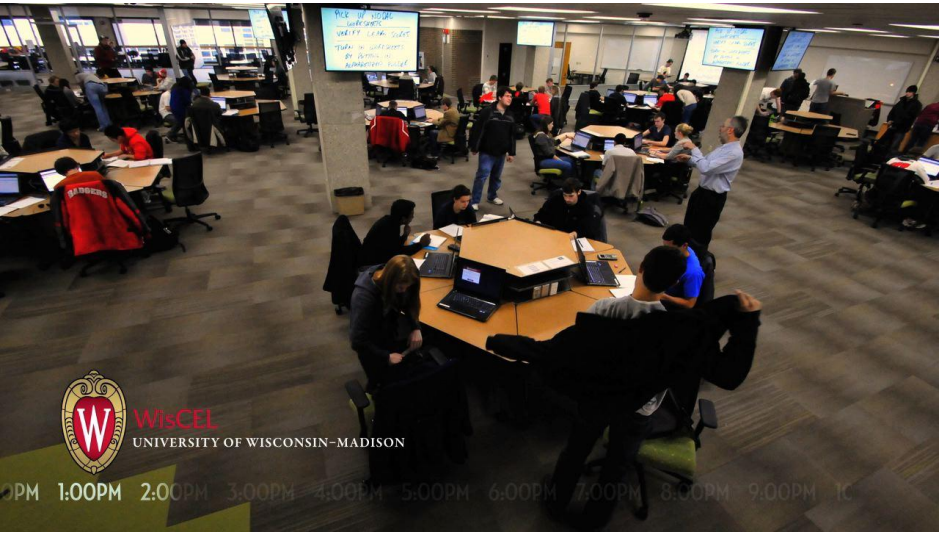


Bringing formal learning to informal spaces



Wendt Commons
WisCEL Center

Moving towards 24 x 7



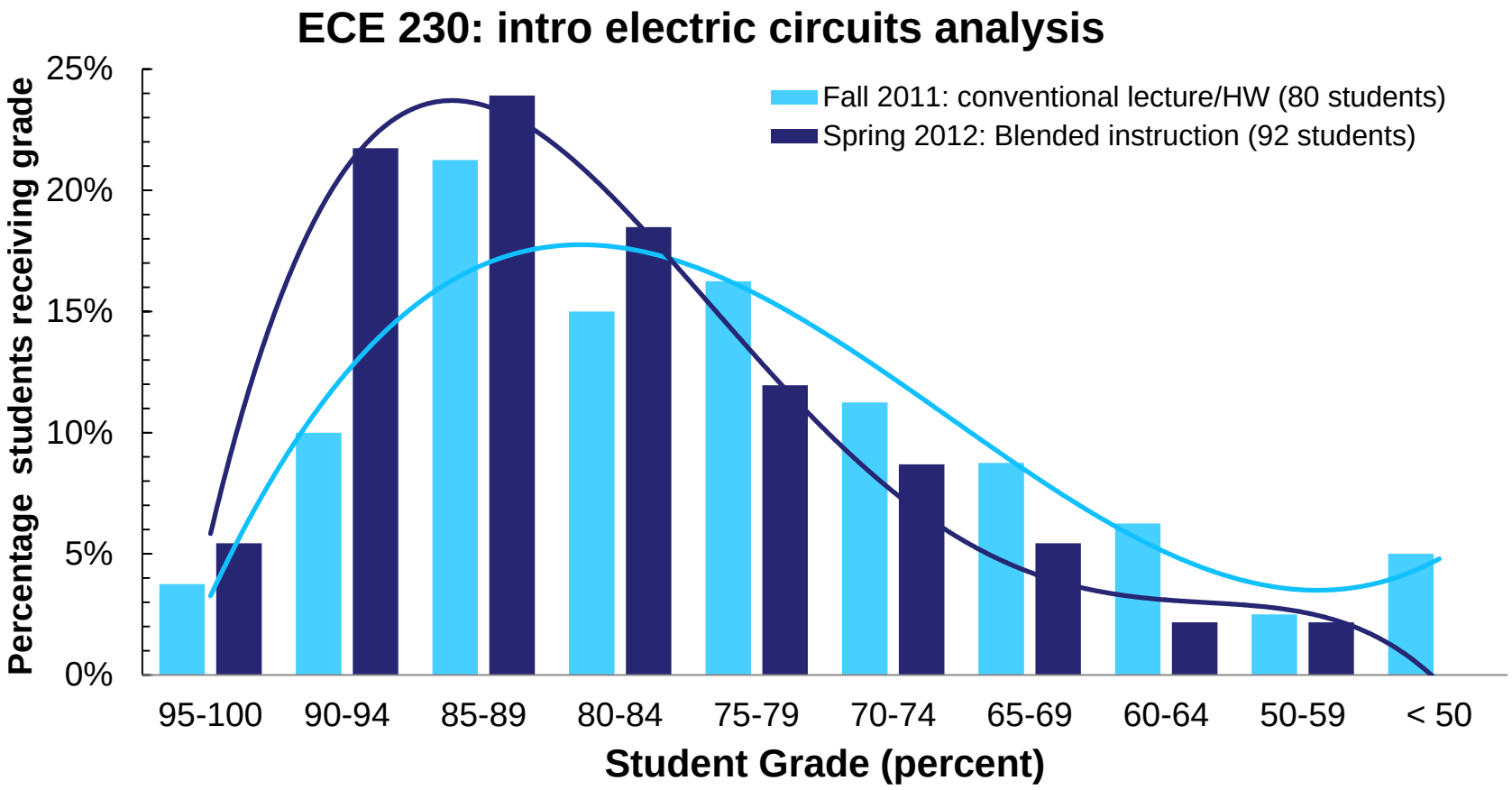
Supporting new instruction & learning approaches

- Peer collaboration
  - Spontaneous
  - orchestrated
- Instructor-as-coach models
- Flipped classroom
- Self-pacing opportunities
- Frequent and immediate learning progress feedback
- Increased instructor time with students
- International connectivity

Features of the experience

- Substantial up front cost, reduced operating costs/time
- Students fully engaged *100% of the class time* with learning
  - More time-on-task
  - Frequent & immediate feedback
  - *Prefer* 75 min over 50 min blocks of time!
- Talking to peers spontaneously, getting unstuck
- Agilely interacting with different peers depending on who can best answer the question (instructor/TA last resort, not first)
- Glass walls add value
  - Sound, activity barrier
  - Allow instructors to proctor exam taking in side room while coaching in active learning lab
- Instructor experience: *FUN!*
  - Finding out what students stuck on
  - Success for all (most)
  - Interactions richer, deeper
  - No office hours needed!
  - No lecture prep!
  - No homework set design, no HW grading

Promising Results



- *Class average score increased from 77 – 83.5% !*
- *20% of students moved from < 80% to > 80% !*
- *Increasing subject mastery = success for all!*

Much of this is not “new”

- Socratic model predates Gregorian universitas lecture model
- 1-to-1, 1-to-several, P2P, “doing” vs passive listening
  - Predate lecture-HW-exam model
  - Discipleships
  - Appreticeships
- Learning commons spaces predate lecture classrooms
- Common K-5 model! Effective learning *can* be fun

- Individualized instruction
- Decentralized classroom designs

} = *Back to the Future*

- What’s changed?
  - Scalability via IT
  - Scientific basis for understanding learning process

Why change college instruction?

- IF it improves student learning
  - ✓ Short term gains
  - Longitudinal impact of learning gains?
- IF it reduces costs
  - Instructional personnel
    - ✓ Time commitment for instructors
    - ✓ SA's vs TA's
  - IT
    - Investment in IT, access to online regardless
    - Cost differentiated by where/how we deploy/configure/use it?
  - ✓ Space usage (24 x 7, leverage library spaces)
- IF it increases retention and graduation of STEM students
  - TBD
- ✓ IF it increases instructor enjoyment

Summary and conclusions

- Changing instruction
  - Strong driving forces
  - Train leaving (left) station
- Best learning is individualized just like healthcare
- IT
  - Game changer tool
  - Not replacement for expert personalized human coaching
- Physical spaces matter

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WisCEL

Combining pedagogies, learning space design and instructional technology deployment to personalize and humanize learning, improve learning outcomes and prepare students for the 21st century knowledge economy

- Preliminary results exciting and consistent with other research
- New challenges!
  - Computerized testing facilities
  - Capacity for demand (instructors, students)
  - Self-pacing challenges
    - Semester-based timetables
    - 3-credit bundling of learning
  - Student and instructor expectations for “always working IT”

Visit our Website: http://www.wiscel.wisc.edu/