TRANSFORMING TEACHING AND LEARNING
The Case for Course Redesign
Established in 1999 as a university Center at RPI funded by the Pew Charitable Trusts

Became an independent non-profit organization in 2003

Mission: help colleges and universities learn how to use technology to improve student learning outcomes and reduce their instructional costs
The Context

- Barely 6 out of 10 degree-seeking freshmen graduate within 6 years
- Graduation rates are especially low for minority and low-income students
- Many institutions lose 1 out of 4 students in the first year
INSTITUTIONAL RESPONSIBILITY FOR STUDENT SUCCESS

- Learning communities
- Student engagement (NSSE and CSSE)
- First-year experience
- Campus climate
- Academic advising
- Student support
- Affective domain

Emphasis on the “Extracurricular”
OUR FOCUS: LARGE-ENROLLMENT INTRODUCTORY COURSES

- Successful course completion is critical for first-year students.
- Typical drop-failure-withdrawal rates contribute heavily to overall institutional drop-out rates between the first and second year.
  - Research Us = 15%
  - Comprehensives = 22% to 45%
  - Community colleges = 40% to 50% or higher
Drop-Failure-Withdrawal Rates
Mathematics

- Georgia State U 45%
- Louisiana State U 36%
- Rio CC 41%
- U of Alabama 60%
- U of Missouri-SL 50%
- UNC-Greensboro 77%
- UNC-Chapel Hill 19%
- Wayne State U 61%
## Drop-Failure-Withdrawal Rates
### Other Disciplines

<table>
<thead>
<tr>
<th>Institution</th>
<th>Discipline</th>
<th>Rate</th>
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</thead>
<tbody>
<tr>
<td>Calhoun CC</td>
<td>Statistics</td>
<td>35%</td>
</tr>
<tr>
<td>Chattanooga State</td>
<td>Psychology</td>
<td>37%</td>
</tr>
<tr>
<td>Drexel U</td>
<td>Computing</td>
<td>51%</td>
</tr>
<tr>
<td>IUPUI</td>
<td>Sociology</td>
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<td>SW MN State U</td>
<td>Biology</td>
<td>37%</td>
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<tr>
<td>Tallahassee CC</td>
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<tr>
<td>U of Iowa</td>
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</tr>
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<td></td>
<td></td>
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</tr>
<tr>
<td>U of New Mexico</td>
<td>Psychology</td>
<td>39%</td>
</tr>
<tr>
<td>U of S Maine</td>
<td>Psychology</td>
<td>28%</td>
</tr>
<tr>
<td>UNC-Greensboro</td>
<td>Statistics</td>
<td>70%</td>
</tr>
</tbody>
</table>
THAT’S THE GOOD NEWS!
What do the grades represent?

- Curving
- Lack of consistency
- Lack of coverage
- Inflation
- Lack of time on task = easier course
WHAT’S WRONG WITH THE LECTURE?

- Treats all students as if they are the same
- Ineffective in engaging students
- Inadequate individual assistance
- Poor attendance and success rates
- Students fail to retain learning
WHAT’S WRONG WITH MULTIPLE SECTIONS?

- In theory: greater interaction
- In practice: large class size
- In practice: dominated by the same presentation techniques
- Lack of coordination
- Inconsistent outcomes
PROGRAM IN COURSE REDESIGN

Challenge colleges and universities to redesign their approaches to instruction using technology to achieve quality enhancements as well as cost savings.

50,000 students
30 projects
ASSUMPTIONS THAT GET IN THE WAY

- Improving quality means increasing cost
- Adding IT increases cost
- Using IT may even threaten quality
TRADITIONAL INSTRUCTION

Seminars

Lectures
“BOLT-ON” INSTRUCTION
QUANTITATIVE (13)

- **Mathematics**
  - Iowa State University
  - Northern Arizona University
  - Rio Salado College
  - Riverside CC
  - University of Alabama
  - University of Idaho
  - Virginia Tech

- **Statistics**
  - Carnegie Mellon University
  - Ohio State University
  - Penn State
  - U of Illinois-Urbana Champaign

- **Computer Programming**
  - Drexel University
  - University at Buffalo
SCIENCE (5)  
SOCIAL SCIENCE (6)

- **Biology**  
  - Fairfield University  
  - University of Massachusetts

- **Chemistry**  
  - University of Iowa  
  - U of Wisconsin-Madison

- **Astronomy**  
  - U of Colorado-Boulder

- **Psychology**  
  - Cal Poly Pomona  
  - University of Dayton  
  - University of New Mexico  
  - U of Southern Maine

- **Sociology**  
  - IUPUI

- **American Government**  
  - U of Central Florida
HUMANITIES (6)

- **English Composition**
  - Brigham Young University
  - Tallahassee CC

- **Spanish**
  - Portland State University
  - University of Tennessee

- **Fine Arts**
  - Florida Gulf Coast University

- **World Literature**
  - University of Southern Mississippi
IMPROVED LEARNING OUTCOMES

- Penn State - 68% on a content-knowledge test vs. 60%
- UB - 56% earned A- or higher vs. 37%
- CMU - scores on skill/concept tests increased by 22.8%
- Fairfield – 88% on concept retention vs. 79%
- U of Idaho – 30% earned A’s vs. 20%
- UMass – 73% on tougher exams vs. 61%
- FGCU - 85% on exams vs. 72%; 75% A’s and B’s vs. 31%
- USM - scored a full point higher on writing assessments
- IUPUI, RCC, UCF, U of S Maine, Drexel and U of Ala - significant improvements in understanding content

25 of 30 have shown improvement;
5 have shown equal learning.
REDUCTION IN DFW RATES

- U of Alabama – 60% to 40%
- Drexel – 51% to 38%
- Tallahassee CC – 46% to 25%
- Rio CC – 41% to 32%
- IUPUI – 39% to 25%
- UNM – 39% to 23%
- U of S Maine – 28% to 19%
- U of Iowa – 25% to 13%
- Penn State – 12% to 9.8%

24 measured; 18 showed improvement.
COST SAVINGS RESULTS

- Redesigned courses reduce costs by 37% on average, with a range of 15% to 77%.

- Collectively, the 30 courses saved about $3 million annually.
WHAT HAPPENS TO THE SAVINGS?

- Accommodate more students
- Offer more options at the second-year or upper-division level
- Develop distance learning courses and programs
- Decrease time to graduation for students by eliminating academic bottlenecks
- Free up expensive campus space
EXAMPLE
Math Department at Ole Miss

AY 2000-2001
- 45 math majors
- 40 BA students
- 5 BS students
- PhD program put on probation

- Fall 2000: 6 courses
- Spring 2001: 7 courses

AY 2006-2007
- 81 math majors
- 50 BA students
- 31 BS students
- 20 PhDs over the last 4 years

- Fall 2007: 13 courses
- Spring 2007: 15 courses
ROADMAP TO REDESIGN (R2R)

- Calhoun CC: Statistics
- Chattanooga STCC: Psychology
- Eastern Washington U: Psychology
- Georgia State U: Precalculus
- Louisiana State U: Precalculus
- Texas Tech: Spanish
- UNC-Greensboro: Precalculus
- U of Missouri-St. Louis: Precalculus
- U of Alabama: Spanish
- UNC-Chapel Hill: Precalculus
- UNC-Greensboro: Statistics
- Wayne State U: Precalculus
ROADMAP TO REDESIGN (R2R)

- 10 of 12 R2R projects improved learning; the other 2 showed equal learning.
- 9 of 12 improved course completion rates.
- All 12 reduced costs by 32% on average, with a range of 13% to 68%.
TAKING COURSE REDESIGN TO SCALE

- The Roadmap to Redesign (R2R)
- Lumina Study: Underserved Students
- Colleagues Committed to Redesign (C2R)
- Programs with Systems and States
- The Redesign Alliance
REDESIGN CHARACTERISTICS

- Redesign the whole course—not just a single class
- Emphasize active learning—greater student engagement with the material and with one another
- Rely heavily on readily available interactive software—used independently and in teams
- Increase on-demand, individualized assistance
- Automate only those course components that can benefit from automation—e.g., homework, quizzes, exams
- Replace single mode instruction with differentiated personnel strategies

Technology enables good pedagogy with large #s of students.
SIX REDESIGN MODELS

- **Supplemental**: Add to the current structure and/or change the content
- **Replacement**: Blend face-to-face with online activities
- **Emporium**: Move all classes to a lab setting
- **Fully Online**: Conduct all (most) learning activities online
- **Buffet**: Mix and match according to student preferences
- **Linked Workshop**: Replace developmental courses with just-in-time workshops
SIX REDESIGN MODELS AND MATH

- Supplemental 3
- Replacement 13
- Emporium 21
- Fully Online 2
- Buffet 0
- Linked Workshop 1
THE MATH EMPORIUM: ACADEMIC GOALS

- Enhance quality by individualizing instruction
- Assess students’ knowledge in much smaller subject-matter chunks
- Provide feedback and direction to allow students to make up for specific deficiencies
- Provide help 75 - 80 hours per week
- Incorporate examples and information from other disciplines
- Make changes in the course as it proceeds; continuous improvement as a built-in feature
THE MATH EMPORIUM
at
Virginia Tech
THE MATH EMPORIUM at Virginia Tech

Traditional
- 38 sections (~40)
- 10 tenured faculty, 13 instructors, 15 GTAs
- 2 hours per week
- $91 cost-per-student

Redesign
- 1 section (~1520)
- 1 instructor, grad & undergrad TAs + 2 tech support staff
- 24*7 in open lab
- $21 cost-per-student

Replicated at U of Alabama, U of Idaho, LSU, Wayne State, U Missouri-St. Louis, Seton Hall
THE EMPORIUM MODEL
77% Cost Reduction (V1)
30% Cost Reduction (V2)
UNIVERSITY OF ALABAMA SUCCESS RATES

- Fall 1998: 47.1%
- Fall 1999: 40.6%
- Fall 2000: 50.2%
- Fall 2001: 60.5%
- Fall 2002: 63.0%
- Fall 2003: 78.9%
- Fall 2004: 76.2%
TENNESSEE BOARD OF REGENTS
Developmental Studies
Redesign Initiative

- Redesign remedial and developmental math and English
- 6 universities/13 community colleges
- 7 courses based on ACT scores
- Modularization: a key strategy
DEVELOPMENTAL MATH
Cleveland State Community College

- Basic Math (~200), Elementary Algebra (~500) and Intermediate Algebra (~500)
- 2 hours in lab + 1 hour in class each week
- Lab open ~54 hours per week staffed by instructors and peer tutors
- Mastery-based instructional software
- Course material is organized into 10 – 12 modules (1 per week)
- Can move quickly and begin next course during the same term
<table>
<thead>
<tr>
<th>Course</th>
<th>Before</th>
<th>After</th>
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<tbody>
<tr>
<td>Basic Algebra</td>
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<tr>
<td>Completion % (ABC)</td>
<td>52%</td>
<td>65%</td>
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<tr>
<td>Course GPA</td>
<td>1.92</td>
<td>2.53</td>
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<td>Elementary Algebra</td>
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<tr>
<td>Completion % (ABC)</td>
<td>52%</td>
<td>70%</td>
</tr>
<tr>
<td>Course GPA</td>
<td>1.95</td>
<td>2.88</td>
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<tr>
<td>Intermediate Algebra</td>
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<td></td>
</tr>
<tr>
<td>Completion % (ABC)</td>
<td>56%</td>
<td>79%</td>
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<td>Course GPA</td>
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<td>3.20</td>
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<tr>
<td>Course</td>
<td>Before</td>
<td>After</td>
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<tr>
<td>-----------------------------</td>
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</tr>
<tr>
<td>Basic Algebra</td>
<td>73.3%</td>
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<tr>
<td>Elementary Algebra</td>
<td>70.3%</td>
<td>86.2%</td>
</tr>
<tr>
<td>Intermediate Algebra</td>
<td>77.3%</td>
<td>90.1%</td>
</tr>
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</table>
Before
- An average of 182 of 327 students (56%) successfully exited the program.

After
- 268 of 340 students (79%) successfully exited the program.

This represents a 47% increase in moving students through developmental studies to college-level math courses.
PERFORMANCE IN COLLEGE-LEVEL MATH COURSES

Before
- Completion rate of developmental students = 71%
- Completion rate of other students = 70%

After
- Completion rate of developmental students = 81%
- Completion rate of other students = 70%

Redesign students also had higher average course grades (3.15 compared to 2.94)
MORE STUDENTS TAKING COLLEGE-LEVEL MATH COURSES

- The number of students enrolling in and passing a college-level math course during fall 2008 increased by 15% compared to the average of the past five years.
- The number of students enrolling in a college-level math course during spring 2009 have increased from an average of 320 students in previous spring semesters to 480+ in the current term, a 50% increase.
INCREASED MOBILITY WITHIN DEVELOPMENTAL MATH

- 37 students completed two or more developmental math courses in one semester.
- 33 students exited the developmental math program after one semester.
- 9 students completed Intermediate Algebra and a college-level math course in the same semester.
- 2 students completed three courses in one semester, each completing over 1800 exercises.
REDUCED COSTS
$50,000+ Annually

- Faculty productivity has risen by 23%.
- Average student load per instructor went from 106 to 130.
- FTE teaching load per instructor went from 21.2 to 26.0.
- Adjunct faculty (N = 10) eliminated.
- Lab staffing shifted from a full-time staff position to 5 part-time tutors (+ full-time instructors.)
- Low-enrollment sections: multiple courses will be offered in the same classroom simultaneously.
### COLLEGE-LEVEL MATH

Cleveland State Community College

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
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<tbody>
<tr>
<td><strong>College Algebra</strong></td>
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<td>Completion % (ABC)</td>
<td>65%</td>
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<td>Course GPA</td>
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<td>Common test items</td>
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<tr>
<td><strong>Finite Math</strong></td>
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<td>Completion % (ABC)</td>
<td>75%</td>
<td>91%</td>
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<td>Course GPA</td>
<td>2.53</td>
<td>3.63</td>
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<tr>
<td>Common test items</td>
<td>82%</td>
<td>88%</td>
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</table>
WHAT’S NEXT?

- The first pilot occurred in spring 2008.
- Cleveland State redesigned 3 developmental courses and 3 college-level courses in one year.
- 4 more redesigns are in progress: Introductory Statistics, Basic Calculus, Precalculus I and Precalculus II
- 95% of students will take math in the redesigned format.
- Cleveland State experienced the usual start-up problems (technology glitches, registration problems) yet produced outstanding results.
- This suggests that student achievement will increase as the redesign matures.
WHY DO STUDENTS FAIL?

“The primary reason many students do not succeed in traditional math courses is that they do not actually do the problems. They generally do not spend enough time with the material, and this is why they fail at a very high rate.”

Kingsborough Community College
WHY DOES THE EMPORIUM INCREASE SUCCESS?

- Students spend the bulk of their course time doing math problems.
- Students spend more time on things they don’t understand and less time on things they have already mastered.
- Students get assistance when they encounter problems in doing math.
"Students learn math by doing math, not by listening to someone talk about doing math."
LINKED WORKSHOP MODEL

- Retains basic structure of the college-level course
- Replaces developmental courses with just-in-time workshops
  - remove deficiencies in core course competencies
  - computer-based instruction, small-group activities and test reviews
  - facilitated by students who excelled in core course; trained and supervised by core course faculty
- Students are assigned software modules based on diagnostic assessments
- Students use concepts during next core course class session, which helps them see the value of the workshops and motivates them to do workshop activities
Fundamentals of Math

- 33% of students who previously took the developmental course and the college-level course sequentially were successful.
- 70% of students who would have otherwise been assigned to a developmental course were successful in the course linked to a supplemental workshop.

Elements of Statistics

- 23% of students who previously took the developmental course and the college-level course sequentially were successful.
- 52% of students who would have otherwise been assigned to a developmental course were successful in the course linked to a supplemental workshop.
REDUCED COST OF INSTRUCTION

• Instructional costs will decrease from $208,260 to $150,448, a 28% reduction.

• How
  – Eliminate Elementary Algebra and Intermediate Algebra, reducing the number of developmental sections from 52 to 0.
  – Add 13 enhanced sections of Fundamentals of Math and 21 enhanced sections of Elements of Statistics.

• In addition, 70 classrooms will become available each week.
IMPROVED LEARNING OUTCOMES

- Hagerstown CC – “walk-aways” (didn’t take final exam) declined from 32% to 17%
- Jackson State CC - success rates → 41% to 57%
- LSU - lowest ever drop rate (6%), A-B-C rate = 75%, highest ever final exam median (78%)
- U of Alabama - success rates → 40% to 78%
- U of Idaho – more A’s and B’s; fewer C’s, D’s and F’s
- UM-SL - success rates → 50% to 78.4%
- UNC Greensboro – success rates in College Algebra (38% vs. 51%), Precalculus I (23% vs. 62%), Precalculus II (40% vs. 59%)
- Wayne State – success rates → 35.5% to 42.8%; 1/2 vs. 2/3 passed the final exam
WHAT DO THE FACULTY SAY?

- “It’s the best experience I’ve ever had in a classroom.”
- “The quality of my worklife has changed immeasurably for the better.”
- “It’s a lot of work during the transition--but it’s worth it.”
CAROL to CAROL
at LSU in Spring 2005
FOR MORE INFORMATION

www.theNCAT.org

- Project descriptions
- Progress reports
- Project contacts
- Program descriptions
- Monographs
- Planning resources