

INCREASING STUDENT SUCCESS IN MATHEMATICS





- **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**

TRADITIONAL INSTRUCTION



Seminars



Lectures

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

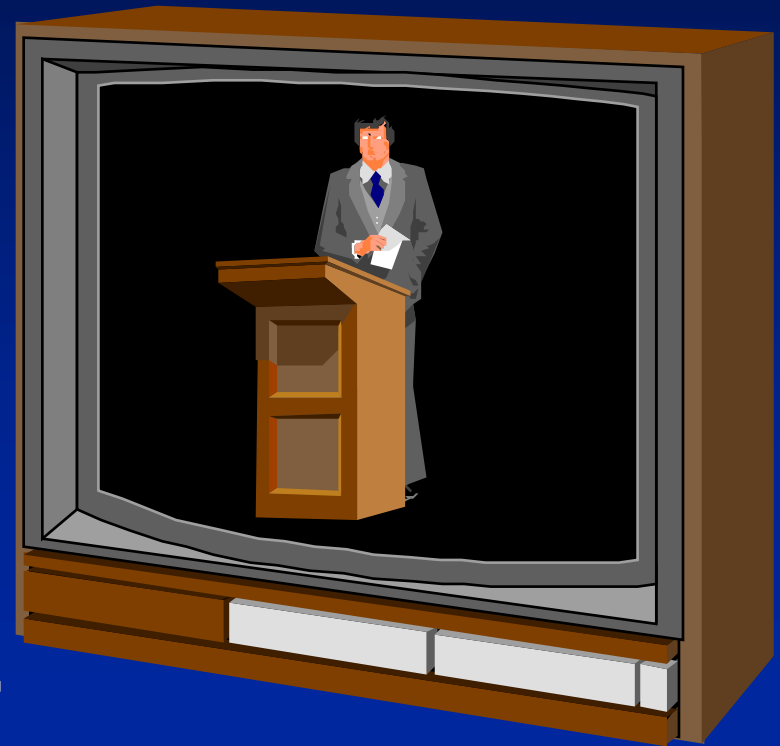


WHAT'S WRONG WITH MULTIPLE SECTIONS?

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



“BOLT-ON” INSTRUCTION



WHAT DOES NCAT MEAN BY COURSE REDESIGN?

Course redesign is the process of redesigning whole courses (rather than individual classes or sections) to achieve better learning outcomes at a lower cost by taking advantage of the capabilities of information technology.



The **National Center** for
Academic Transformation

WHY REDESIGN?

Look for courses where redesign will have a high impact – let's make a difference:

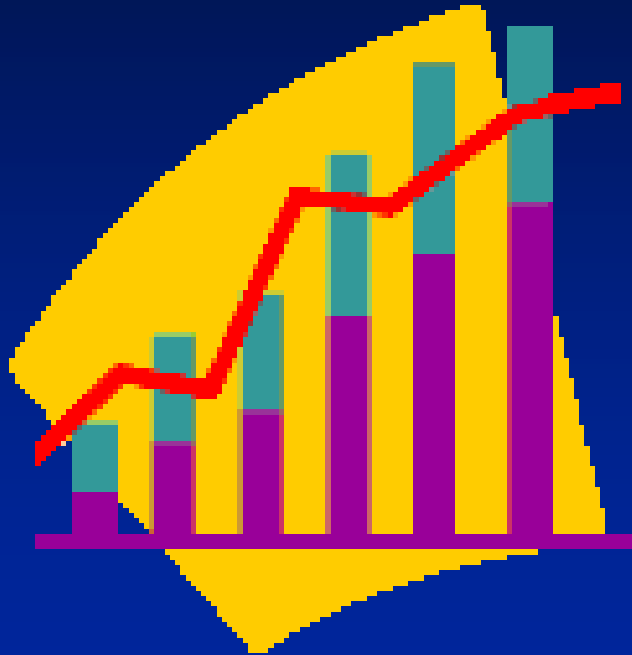
- **High withdrawal/failure rates**
- **Students on waiting lists**
- **Students turned away – graduation bottleneck**
- **Over enrollment of courses leading to multiple majors**
- **Inconsistency of preparation**
- **Difficulty getting qualified adjuncts**
- **Difficulty in subsequent courses**

TEAM EFFORT IS KEY

Each team included

- Administrator**
- Faculty experts**
- Technology expertise**
- Assessment assistance**

TAKING COURSE REDESIGN TO SCALE



- **The Roadmap to Redesign (R2R)**
2003 – 2006 (20 institutions)
- **Colleagues Committed to Redesign (C2R)**
2006 - 2009 (60 institutions)
- **Programs with Systems and States**
2006 – present (~80 institutions)
- **The Redesign Alliance**
2006 – present (70+ institutions)
- **Changing the Equation**
2009 – 2012 (34 institutions)

QUANTITATIVE

- **Mathematics**

- Developmental Math
- Pre-calculus Math
- College Algebra
- Discrete Math
- Introductory Algebra
- Elementary Algebra
- Beginning Algebra
- Intermediate Algebra
- Linear Algebra

- **Statistics**

- Business Statistics
- Introductory Statistics
- Elementary Statistics
- Economic Statistics

- **Computing**

- Computer Programming
- Information Technology Concepts
- Computer Literacy
- Information Literacy
- Tools for the Information Age

ALSO

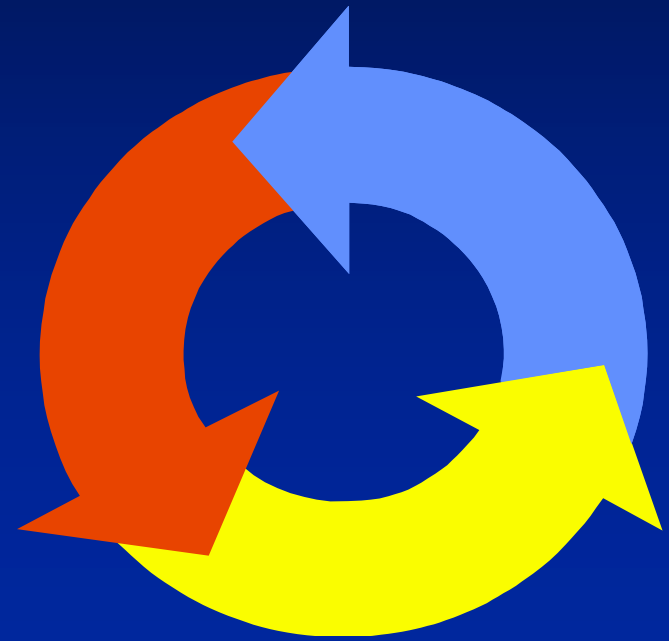
- **Courses in Humanities, Science, Social Science and Professional Fields such as engineering, education and business**

120 REDESIGNED COURSES

- 160,000 students nationwide
- Improved student learning: **72%**
Equivalent student learning: **28%**
- Cost reduction: **37%** (9% to 77%)
Annual savings: ~\$9.5 million
- Other outcomes
 - Increased course-completion rates
 - Improved retention
 - Better student attitudes toward the subject
 - Increased student satisfaction with the mode of instruction

NCAT METHODOLOGY: Relevance and Utility

- Discipline: math & literature
- Age: traditional & working adults
- Institution: small & large
- Location: on-campus & at a distance
- Redesign: current & new courses
- Level: introductory & advanced



WHY DO STUDENTS FAIL MATH?

“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.”

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
- Mastery learning—not self-paced
- 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.

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

Characteristics

- **Move classes to a lab setting**
- **Permit the use of multiple kinds of personnel**
- **Allow students to work as long as they need to master the content**
- **Can be adapted for the kinds of students at a particular institution**
- **Allow multiple courses the same time**
- **Include multiple examples in math**

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

UNIVERSITY OF ALABAMA Math Learning Center



UNIVERSITY OF ALABAMA

Success Rates

Semester Success Rate

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%
Fall 2005	66.7%
Fall 2006	73.8%
Fall 2007	75.2%
Fall 2008	78.1%

CLEVELAND STATE COMMUNITY COLLEGE

Developmental Math

- Success rate in dev math went from 54% to 72%

College Level Math

- Success rate in 3 courses inc from 72% to 75%
- College Algebra increased, Finite Math & Statistics unchanged
- More students passed a college level math course in Spring 2009 than were enrolled in a college level math course in Spring 2008

Developmental Students In College Level Math

- Before 71% success for developmental students
- After 76% success rate for developmental students

WHY DOES THE EMPORIUM INCREASE SUCCESS?

- Active learning: Students spend the bulk of their course time doing math problems.
- On-demand help: Students get assistance when they encounter problems in doing math.
- Modularization: Students spend more time on things they don't understand and less time on things they have already mastered.

LINKED WORKSHOP MODEL

- Retain basic structure of the college-level course, particularly the number of class meetings
- Replace remedial/developmental course with just-in-time (JIT) workshops
- Design workshops to remove deficiencies in core course competencies
- Workshops consist of computer-based instruction, small-group activities and test reviews to provide additional instruction on key concepts
- Students individually assigned software modules based on results of diagnostic assessments
- Workshops facilitated by students who have previously excelled in core course; students trained and supervised by core course faculty
- JIT workshop activities designed so students use concepts during next core course class session, which in turn helps them see the value of the workshops and motivates them to do workshop activities

WHOLE COURSE VS. COMPETENCIES NEEDED

- **Cleveland State: Whole developmental course**
- **Austin Peay: Competencies needed for two specific college-level courses**
- **Jackson State: Competencies needed for 40 programs of study requiring college level math courses**
 - 31 required 7 of 12 modules
 - 2 required 8 of 12 modules
 - 7 required all 12 modules
- **What impact do these different structures have on student success and cost?**

WHY MODULARIZATION?

- **“Currently, all students spend the same amount of class time working on course elements.**
- **The traditional model does not allow for variances in skills areas or learning differences.**
- **Modularization will target skills areas for each student, thus speeding up student learning.**
- **The learning environment should give more time to deficient skills and less time to those skills at which they are already competent.”**

"Students learn math by doing math, not by listening to someone talk about doing math."



WHAT HAVE WE LEARNED?

- The Emporium Model works and the Linked Workshop Model works.
- Modularization works.
- It's possible to improve quality while radically reducing costs in developmental and college-level math.
- Math students at all levels will flourish by using technology appropriately.

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