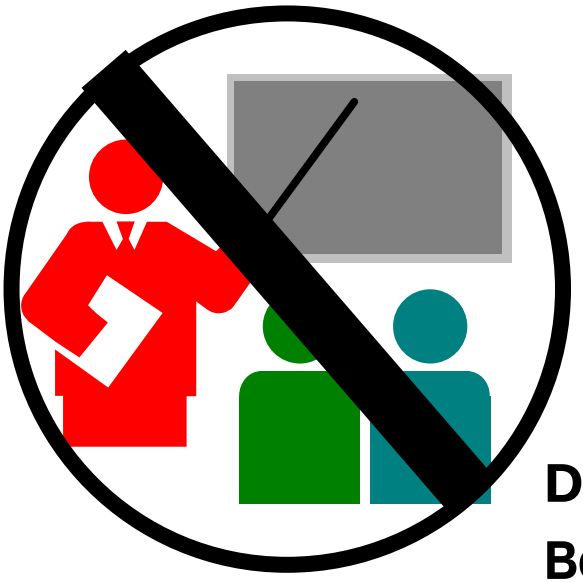
Educating in Bulk: The Introductory Physics Course Revisions at Illinois

http://www.physics.uiuc.edu/Research/PER/Course-Revisions.html



Academic-Industrial Workshop
October 24, 2004

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Coll. Of Engineering

Outline of Talk
(shamelessly pilfered from Gary Gladding, UIUC)

- A Bit of Pre-history
- The OLD
  - "Misery loves company"
- The NEW
  - The Plan
  - Glimpse of Details: Lectures, Discussion Sections, Labs, Homework, Exams
  - Student Satisfaction: one measure of success
- What can we conclude?
  - Why is it working?
  - What does it take to have it work elsewhere?
  - Lessons not "too late for the learnin' "

A Bit of Pre-History

- **Urbana, ~ May 1995**
  - **Rebellion brewing. Several engineering departments threatening to drop one (of three) semesters of introductory physics to 1) make room for additional courses thought needed for ABET and 2) teach the material (eg, E-M theory) "their way."**
- **Saturday Morning "Soccer match"**
  - **Meeting of Chairs and UG Assoc. Chairs of all engineering departments (Physics is in CoE at UIUC). Hassan Aref (then Chair of TAM) appears with whistle and soccer refereeing outfit (including cleats!!).**
- **Internal Physics dis-satisfaction**
  - **Faculty burn-out; student "assessment"**

The OLD

- **Introductory Physics at Illinois prior to Fall 1996**
  - **We do "Educate in Bulk"**
    - » **Calculus-based sequence**

	FALL	SPRING
• Physics 106 (Mechanics)	500	1000
• Physics 107 (E&M)	800	450
• Physics 108 (Waves)	400	750
» Algebra-based sequence		
• Physics 101 (Mechanics, thermo)	300	200
• Physics 102 (E&M, modern)	200	300
	2200	2700

  - **Tradition, Tradition, Tradition**
    - » **Large (200-300) Lectures with Small (24) Sections for Discussions and Labs (6-7 hrs/week)**
    - » **Lecturers free to "reinvent the wheel, starting from a square", Discussion TAs pretty much on their own, Labs intellectually disconnected from rest of course.**
    - » **Exams: Quantitative Problems**
    - » **RESULTS: NOBODY WAS HAPPY—MISERY REIGNED !!**

The PLAN

- **ONE COURSE !!**
  - All pieces of the course (lectures, discussion, labs, homework) must be made of the same cloth.
  - The student should see a coherent plan at work.
- **Emphasize Concepts !**
  - Traditionally, there is a large gap between what we think we are teaching (physics) and what is being learned (equation manipulation)
  - Introduce explicit instruction on concepts (and test for it !)
- **Use Active Learning Methods**
  - The learning of physics is NOT a spectator sport
  - Engage the student in all aspects of the course (including lecture)
  - Make use of the products of Physics Education Research (materials and knowledge). There is a research base here and faculty (especially at a research university) should use it!

Glimpse of Details

- **Lectures:**
  - Team taught, prepared powerpoint based: Active learning segments (Mazur, "Peer Instruction").
- **Labs:**
  - Totally integrated/coordinated with lectures (Thorton and Sokoloff, "Predict, Observe, Explain")
- **Discussion Sections:**
  - Collaborative learning; Socratic dialogue with TA (McDermott, Tutorials in Physics)
- **Homework:**
  - Web-based, interactive examples. "Tycho" (Kane)
- **Exams:**
  - Multiple choice, 1/3 conceptual, 2/3 calculational

The NEW

- Introductory Physics at Illinois as of Spring 2000

ALL COURSES TOTALLY REVISED !

The Big Idea: Integrate all aspects of a course using active learning methods based on physics education research in a team teaching environment

Calculus-based:	PHYCS 111 (fall96)	112 (spring97)	113/114 (fall97)
Algebra-based:	PHYCS 101 (fall99)	102 (spring00)	

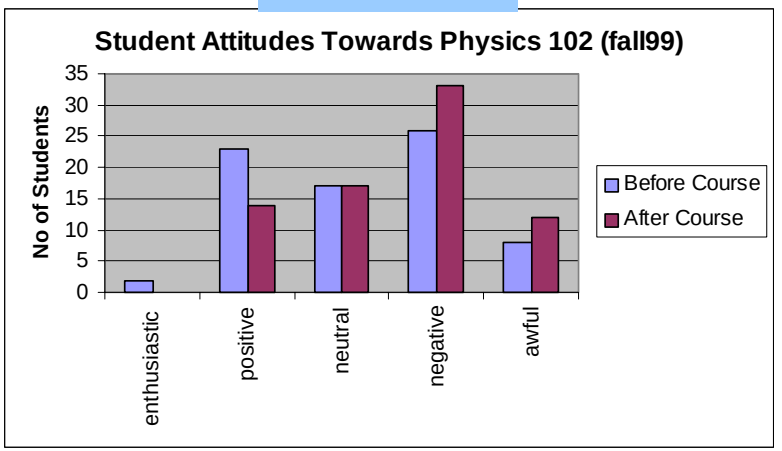
- Faculty Participation
  - 16-17 Faculty assigned for these courses (2500 students)
  - Responsibilities: Lecturer,Discussion Coordinator,Lab Coordinator
  - Faculty team meets weekly to keep course on track.
  - Faculty team creates exams
- The Good Things
  - Pain and gain are shared.. No burnout.. NO HEROES
  - Existing Infrastructure lowers the bar for participation.. This assignment is seen as an ordinary assignment!

Most of faculty have now taught in these courses!

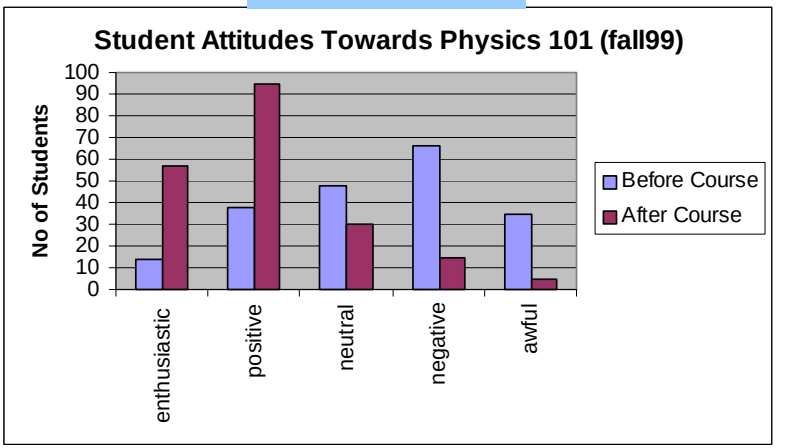
Student Satisfaction

- **What do students think of physics after taking our courses?**

THE OLD



THE NEW



- **How do students rate their TAs?**
  - **University-wide ranking of "excellent" ≡ top 30% of peers**

THE OLD
Spring 95
Total Physics TAs = 77
 # "Excellent" = 15
19 ± 5 %

THE NEW
Spring 00
Total Physics TAs = 72
 # "Excellent" = 48
67 ± 6 %

Why Is It Working?

- **Key 1: Design Process was a Collective Effort**
  - Committee of 8 met for a year to generate the design
  - These people became the core
- **Key 2: Infrastructure**
  - People (veteran faculty, computing help, lecture, lab & secretarial support)
  - Computing (all materials on NT server, faculty get NT machine for desk while teaching)
  - Welcome to 1XX, here's how we do things….
- **Key 3: Team-Teaching**
  - All faculty (3-4 per course) do faculty-type jobs
  - Pain and Gain are shared … no more burnout… NO HEROES
- **Key 4: Administrative Support**
  - Released time essential for initial creation of materials
  - Total support for systemic change… JUST DO IT!
  - Continuing support (e.g., new Assoc Head position) to maintain the system as the "newness" wears off.

What Does it Take to Work Elsewhere?

- **ORGANIZATIONAL CHANGE**
  - Probably more important than any of the substantive details presented earlier!
  - End by overstating (perhaps?) a couple of issues to provoke you to think about change in your own department.
- **MAJOR OBSTACLES (US !!)**
  - Character issue: The Arrogance of Physicists
    - » What makes effective instruction is largely an empirical question.
    - » Listen to students
    - » Learn from others
  - Cultural issue: "My" Course
    - » Course is NOT just lectures
    - » Department "owns" course—progress comes from many

BOTTOM LINE: Overcoming these obstacles is a liberating experience

Why Hasn't it Happened Yet at BU?

- **CAN'T BE TOP DOWN**
  - As Dean of Engineering, I have no "line" authority over the Physics Department, so I can't make it happen.
  - As a member of the Physics Department, I can remonstrate and cajole, but since I'm not teaching undergraduates, I can't start the necessary grass roots efforts.
- **BUT THERE IS HOPE!**
  - **Departmental Self-Assessment**
    - » In preparation for external review, BU Physics is undertaking a self-assessment—will include all aspects of the department.
    - » Several colleagues have approached me about UIUC reforms—may lead to concrete plans to alter methodology
  - **Cultural issue must be overcome:**
    - » BU prides itself on "small" courses—although intro physics courses are typically ~85 students.
    - » "Team teaching" has not been tested here.

BOTTOM LINE 2: Barriers to change are real.

Lessons not “too late for the learnin’ ”

- “The Few, The Proud, the Marines”: Identify a real first team.
- “Bet the Farm”: Prepare to spend $$ and time on planning and development.
- “Just do it”: Bungee jumping approach to change.
- “Abe Lincoln’s axe”: Structured course environment provides continuity while allowing change, flexibility and creativity
- “Equal opportunity thief”: Borrow adapt from excellent existing materials based on Physics Education Research.

BOTTOM LINE 3: Reform works and is worth it!

Any Questions?