Active-Engagement Classroom Practices: Joyful Experiences and Hard-Learned Lessons

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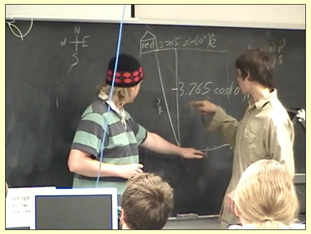
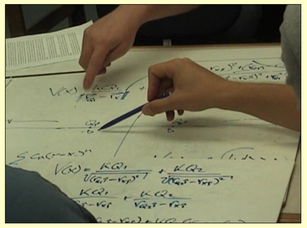
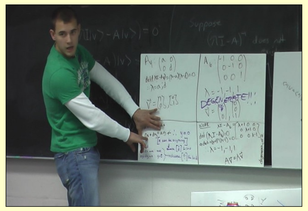
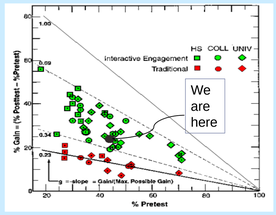




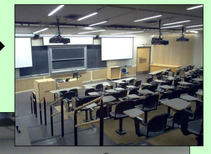


Courses which include active-engagement are more effective.



FCI scores from **N = 6542** students from **60 introductory physics courses** (from Hake, AJP 1992). Our recent scores are also shown.

Modified Space for Lecture



- Two rows of seats on each tier.
- Swivel chairs.
- Aisles for instructors.
- Three projectors.
- Tiered blackboards.
- Document camera.
- Demo prep area.

Use an appropriate mix of lecture AND active-engagement.

- The Instructor:
  - Paints big picture.
  - Inspires.
  - Covers lots fast.
  - Models speaking.
  - Models problem-solving.
  - Controls questions.
  - Makes connections.
- The Students:
  - Focus on subtleties.
  - Experience delight.
  - Slow, but in depth.
  - Practice speaking.
  - Practice problem-solving.
  - Control questions.
  - Make connections.

Team Approach to Curriculum Development

- Every faculty member is on 2 of 3 teams: lower division, upper division, and graduate.
  Teams meet every 3 weeks.
  Teams include tenure-line faculty, instructor's, TA's, teaching postdocs.
  The support of the Department Chair is crucial to the functioning of teams.
- Teams coordinate to discuss:
  - what content is important for the bigger picture (full curriculum),
  - over-arching goals to emphasize in the courses,
  - curricular assessment and change,
  - what students struggled with,
  - what students can be expected to know when moving from one course to the next.

New Department Culture

- Curricular improvements are not lost as heroes burn out.
- Traditional faculty, contingent faculty and TA's have support for continual improvements in their teaching.
- Large-enrollment, lower-division courses are no longer a burden to be shunned.
- Assessment happens naturally.

New Space for Active Large-Enrollment Active Engagement.

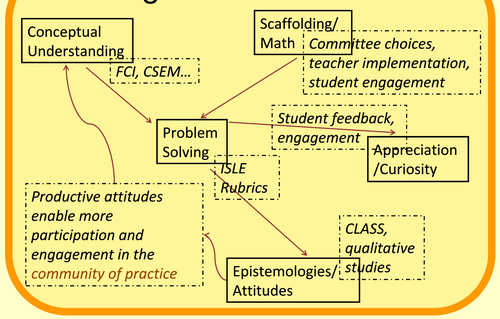
- Tables seat 3 groups of 3.
- One laptop for each group.
- Starboards project student work.
- Frictionless surface

Non-Content Goals

You might also want to consider these non-content goals:

- Metacognition
  - How do you know when you know something?
  - How do you organize content in your head?
  - What are the facets of problem-solving?
- Epistemology
  - What is the purpose of your education?
  - What is your job as a physicist?
- Professional Development
  - Writing and speaking like a physicist.
  - Problem-solving confidence.
  - Moving away from templates.

Setting Goals/Assessment

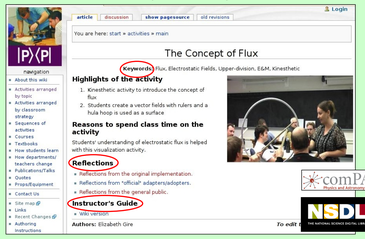


Collaborations Outside the Department

- with a college-wide education research group can:
  - allow for more specialized research expertise,
  - share assessment responsibilities,
  - support TA development and peer-evaluation of teaching.
- with a College of Education can:
  - support TA development,
  - support programs for future teachers.
- with local community colleges can:
  - provide a larger development group,
  - bring increased support from funding agencies,
  - facilitate transferability of courses.
- with other physics education research groups can:
  - provide a larger development group with specialized expertise,
  - provide larger student numbers to assess reform in small enrollment classes
  - allow for testing at diverse institutions.

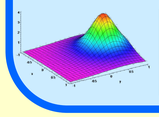
Documentation

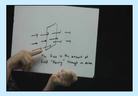
A wiki documents our reforms for ourselves and others through links on the National Science Digital library. Information includes instructor's guides for individual activities, rational and tips for different strategies, links to classroom video, and detailed narratives of specific examples.



Pedagogical Strategies

- Kinesthetic activities
- Small-group problem-solving
- Computer visualization
- Integrated laboratories
- Writing assignments
- Small whiteboard questions
- Lecture
- Demonstrations





Flexibility

- Many short upper-division courses rather than year-long sequences allow us to tailor the major for students with diverse career goals.
- Teaching content courses with modern pedagogical strategies allow us to address the needs of pre-service teachers within our major.
- Several active-engagement intro sections will allow us to have separate versions, e.g. for at-risk or honors students.

Curriculum Development Projects in Physics at OSU

OSUPER: OSU PHYSICS EDUCATION RESEARCH GROUP: Involves a complete overhaul of our large-enrollment introductory sequence for pre-engineers. Interactive-engagement is facilitated via incorporation of physics-education-research-based curriculum, a remodeled lecture hall, and a new SCALE-UP classroom.

PARADIGMS IN PHYSICS: Restructures the upper-division curriculum to be more modern, flexible, and inclusive. The content is reordered to present physics the way professional physicists organize their own expert knowledge. Pedagogical approaches include interactive small-group learning, project-based classes, and technology-based visualization activities.

VECTOR CALCULUS BRIDGE PROJECT: Uses geometric reasoning to bridge the gap between the way vector calculus is usually taught by mathematicians and the way it is used by other scientists, especially physicists.

Modified Space for Upper-Division Active Engagement.

- Instructor's computer & projector.
- Lecture & activity orientations.
- Tables seat groups of 3.
- One laptop for each group.
- Whiteboards on most walls.