Structured Active In-Class Learning at Penn:

Challenges and Opportunities

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American Mathematical Society
Committee on Education
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Undergraduate STEM Education Initiative

Association of American Universities

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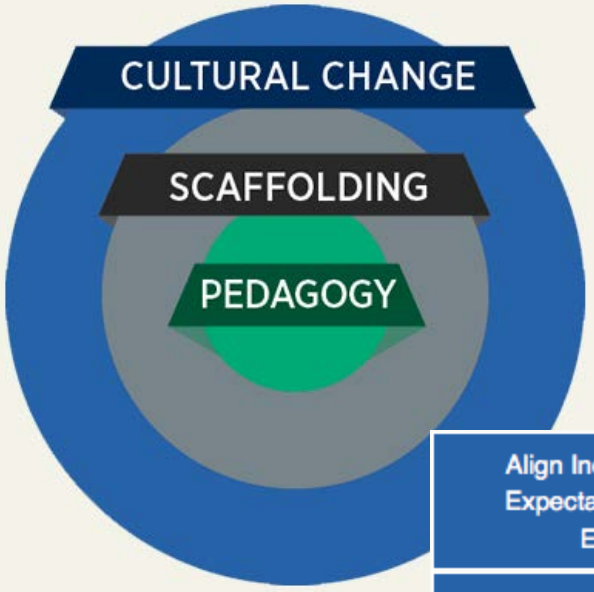

AAU Framework for STEM Education Reform

Align Incentives with the Expectation of Teaching Excellence

Establishing Strong Measures of Teaching Excellence

Access

Articulated Learning Goals

Leadership Commitment

Assessments

Facilities

Faculty Professional Development

Data

Educational Practices

Technology

Penn's AAU/STEM Initiative

Improves introductory courses in mathematics, chemistry, physics, and bioengineering through teaching practices that foster active learning.

- Support faculty in developing Structured Active In-class Learning (SAIL)
- Evaluate the impact of that teaching
- Disseminate SAIL practices across campus
- Develop appropriate classroom spaces
- Provide support for video creation.

A Faculty Board helps departments understand how students apply materials from introductory courses as they take courses in other departments, and provides information sharing and coordination between departments.

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STRUCTURED ACTIVE IN-CLASS LEARNING (SAIL)

SAIL promotes active learning during class time, taking advantage of the opportunities afforded by face-to-face meetings, providing environments where:

- **Students interact with instructors and peers during the learning process**
- **Students discuss and receive feedback on their understanding in real time**
- **Highly structured activities ensure engagement and provide support and direction for students**

Elements of a SAIL course:

- **Students participate in authentic practices in class, such as analyzing data, solving problems and applying concepts**
- **Out of class assignments, such as readings and videos, are designed to prepare students for the in-class learning.**

FACULTY MOTIVATION TO EXPERIMENT

FACULTY COUNCIL on ACCESS and ACHIEVEMENT

- Review of data on persistence in science
  - How many who took General Chemistry graduated with a science major?
  - Nationally ~ 25%
  - At Penn ~75%, but less than 60% among URMs

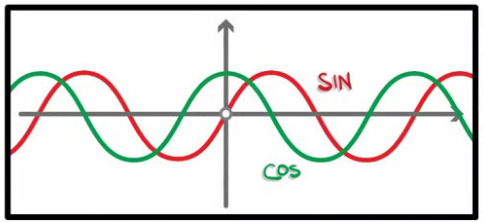
- Review of data on achievement in science and other gateway courses
  - URM students earn grades ~0.3 lower than their counterparts with similar testing data

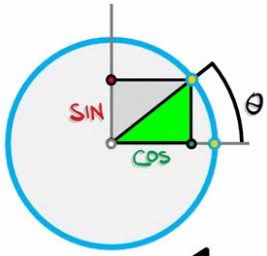
RECORDED MATERIAL

In order to participate effectively in in-class learning activities, students often need to arrive for class prepared with background knowledge and exposure to the new ideas they will tackle in the class session. With both professional teams and support for do-it-yourself faculty recordings, Penn supports the development of videos as one way to introduce students to material out of class.

Image still-clips from Physics Fine Cuts 2 demo of static electricity.

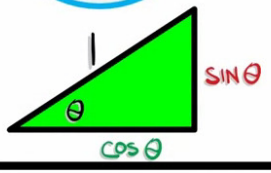
TRIGS





$$\cos^2\theta + \sin^2\theta = 1$$

$$x^2 + y^2 = 1$$



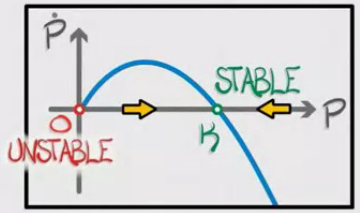
Calculus: Single Variable, © 2012-13 Robert Ghrist

POPULATION DYNAMICS

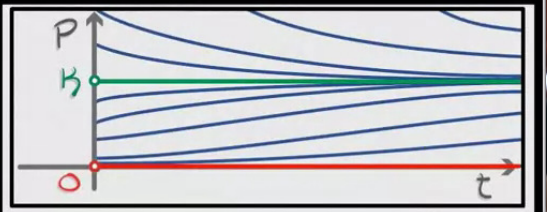
LOGISTIC MODEL

$$\frac{dP}{dt} = rP - cP^2 = cP(K-P) = 0$$

$$\lim_{t\to\infty} P = ?$$



A STABLE EQUILIBRIUM AT K
AN UNSTABLE EQUILIBRIUM AT 0

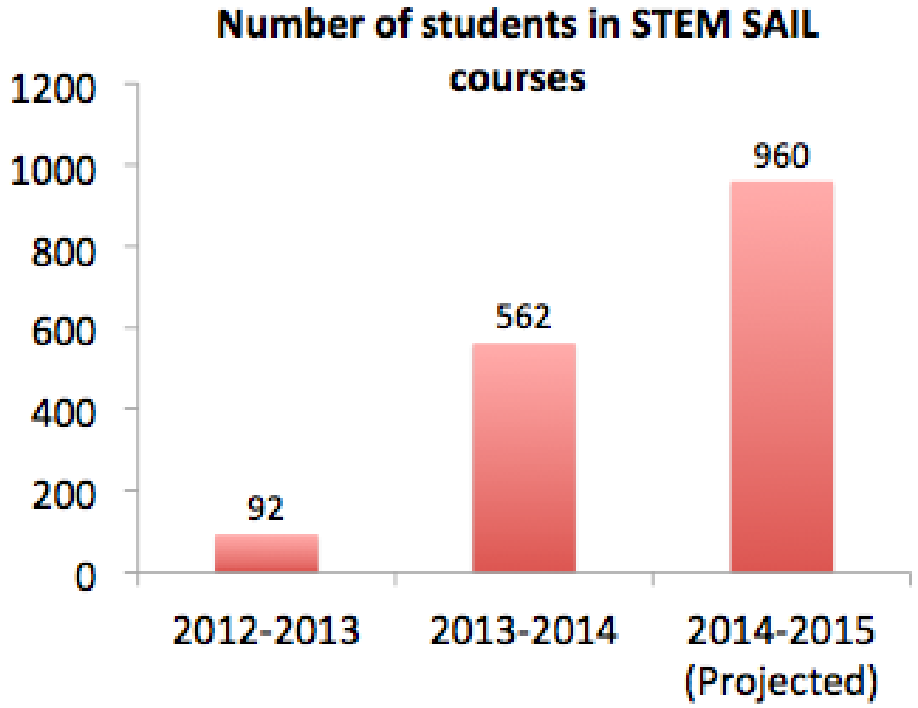


$$P = \frac{KP_0}{(K-P_0)e^{-rt} + P_0}$$

Calculus: Single Variable, © 2012-13 Robert Ghrist

STUDENTS REACHED

2012-2013	2013-2014	2014-2015 (Planned)
Intro Chemistry	Intro Chemistry	Intro Chemistry
Non-major Physics I	Non-major Physics I	Non-major Physics I and II
	Intro Physics I and II	Intro Physics I and II (2 sections)
	Intro Calculus (2 sections)	Intro Calculus (2 sections)
	Calculus I (4 sections)	Calculus I (5 sections)
	Genomics	Calculus I for Business Students
	Oceanography	Oceanography
	Elemental Cycling	Elemental Cycling
		Intro to Biomechanics



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ASSESSING SAIL: MEASURING SUCCESS

	Student Experience	Dissemination	Challenges
Course Level **One-on-one support from Center for Teaching and Learning staff for course development and assessment**	• Student surveys: i. Engagement and interest ii. Perceived learning iii. Perceived use of active learning • Pre- and post-assessment of content understanding • Performance on assignments	• Instructor surveys i. Use of active learning ii. Perceived student learning gains iii. Satisfaction with SAIL experience • Informal classroom observations	• What is the definition of "success"? • Lack of appropriate validated assessments • Lack of comparison groups for single courses • Survey fatigue: need to prioritize assessments
Departmental /Institutional Level **Department and institution level educational research team**	• Tracking student progress: i. Performance in upper level courses ii. Retention within major and STEM • Student surveys: i. Attitudes towards active learning ii. Perceived use of active learning	• Instructor surveys i. Awareness of SAIL and active learning ii. Use of active learning strategies • Informal classroom observations • Conversations with other instructors about teaching	• Lack of validated assessments that apply to all courses • Need for consistent definition of "success" • Getting diverse faculty on board to track students across courses • Coordinating data collection

DISSEMINATION: SUPPORTING INSTITUTIONAL CHANGE

Support for SAIL instructors:

- SAIL faculty workshops bring faculty together to discuss best practices.
- Training for TAs in SAIL courses to prepare for teaching in active courses.
- Course development grants ($5,000) to support instructor innovation in SAIL.
- Instructional technology support.
- Open Learning provides support for generating online videos.
- Best practices in SAIL website[6]

Support beyond SAIL:

- Faculty workshops and seminars facilitate discussion about teaching across departments. Here, faculty consider new teaching strategies.
- Support for instructional technology and video production.
- TA and mentor training.
- Graduate-level mini-courses on teaching and active learning support a culture of teaching at Penn.

Institutional culture that supports innovation in teaching

- Increased interest in faculty discussions about teaching and learning
- More instructors transitioning to SAIL courses
- SAIL instructors continue participating in discussions on teaching and learning while continuously improving their SAIL courses
- SAIL beyond STEM - New SAIL courses offered in Economics, Political Science, and History

COLLABORATIVE CLASSROOM SPACES

Collaborative classrooms at Penn are designed to :

- Feature small-group work and to enable the entire class to explore concepts and provide feedback, making use of instructional technology.
- Promote student discussion, while facilitating instructor interaction with students and their work.

Collaborative classrooms at Penn:

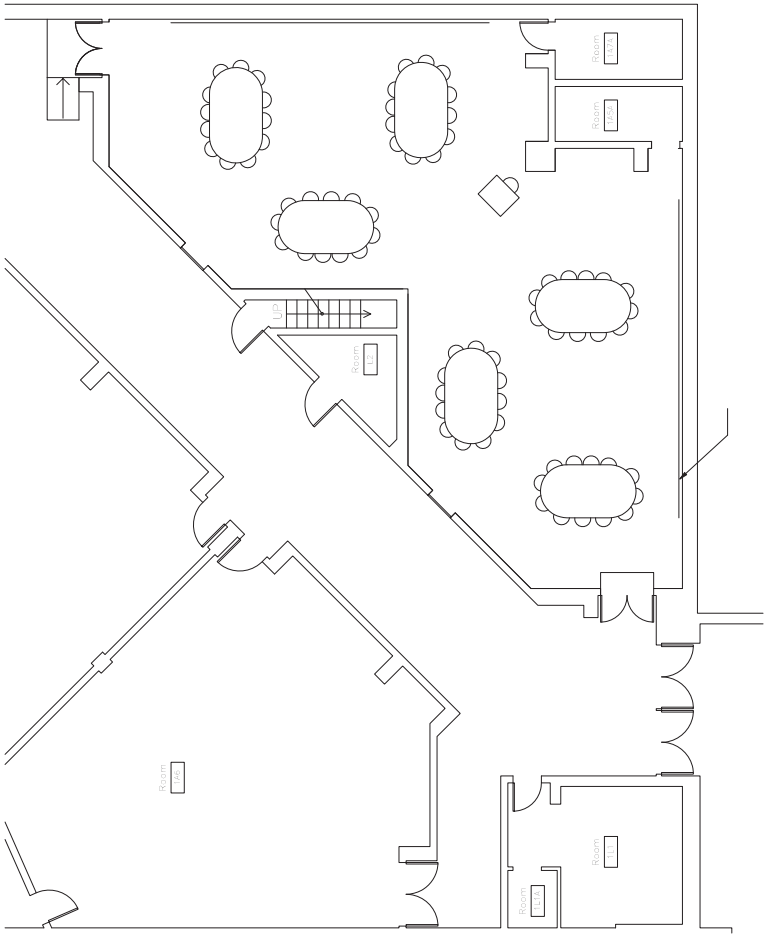
Spring 2012: None

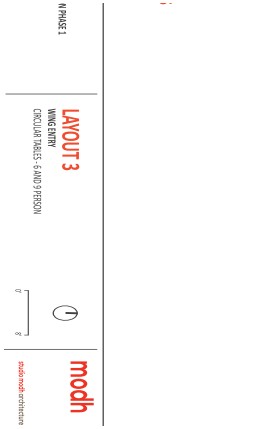
Fall 2014: Four, including one for up to 60 students and one for up to 90 students

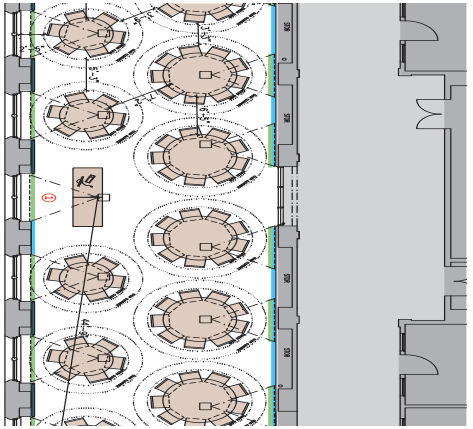
Spring 2016: Seven, including two for up to 70 students and two for up to 90 students

Two examples of Penn's Collaborative Classrooms: one in the Van Pelt–Dietrich Library Center (top) and the other in the ARCH building (right).

Reconfiguring space is not without its challenges







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MATH SAIL FEATURES

- Experiments with several different active-learning approaches
- Some examples: directed viewing of video modules, directed reading of textbook (or course-pack materials)
- Emphasis on “meta-curriculum” (focus on concepts and ideas rather than exclusively on performing computations)
- Consultation with partner departments and schools, e.g., development of new “Math 104E” for engineers and Math 110 for Wharton students