Structured Active In-Class Learning at Penn:
Challenges and Opportunities

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AAU Framework for STEM Education Reform
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.
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 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
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.
POPULATION DYNAMICS

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

A STABLE EQUILIBRIUM AT \( K \)

AN UNSTABLE EQUILIBRIUM AT \( 0 \)

A LOGISTIC MODEL

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

\[ \cos^2 \theta + \sin^2 \theta = 1 \]

\[ x^2 + y^2 = 1 \]
## Students Reached

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Intro Chemistry</td>
<td>Intro Chemistry</td>
<td>Intro Chemistry</td>
<td>Intro Chemistry</td>
</tr>
<tr>
<td>Non-major Physics I</td>
<td>Non-major Physics I</td>
<td>Non-major Physics I and II</td>
<td>Non-major Physics I and II</td>
</tr>
<tr>
<td>Intro Physics I and II</td>
<td>Intro Calculus (2 sections)</td>
<td>Intro Physics I and II (2 sections)</td>
<td>Intro Calculus (2 sections)</td>
</tr>
<tr>
<td>Intro Calculus (2 sections)</td>
<td>Calculus I (4 sections)</td>
<td>Calculus I (5 sections)</td>
<td>Calculus I for Business Students</td>
</tr>
<tr>
<td>Genomics</td>
<td>Oceanography</td>
<td>Oceanography</td>
<td>Oceanography</td>
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<tr>
<td>Oceanography</td>
<td>Elemental Cycling</td>
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<tr>
<td>Elemental Cycling</td>
<td></td>
<td></td>
<td>Intro to Biomechanics</td>
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</tbody>
</table>

### Number of students in STEM SAIL courses

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Students</th>
</tr>
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<tbody>
<tr>
<td>2012-2013</td>
<td>92</td>
</tr>
<tr>
<td>2013-2014</td>
<td>562</td>
</tr>
<tr>
<td>2014-2015 (Projected)</td>
<td>960</td>
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</tbody>
</table>
## Assessing SAIL: Measuring Success

<table>
<thead>
<tr>
<th>Course Level</th>
<th>Student Experience</th>
<th>Dissemination</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-on-one</td>
<td>Student surveys:</td>
<td>Instructor surveys</td>
<td>What is the definition of “success”?</td>
</tr>
<tr>
<td>support from Center for Teaching and Learning staff</td>
<td>i. Engagement and interest</td>
<td>i. Use of active learning</td>
<td>Lack of appropriate validated assessments</td>
</tr>
<tr>
<td>for course development and assessment</td>
<td>ii. Perceived learning</td>
<td>ii. Perceived student learning gains</td>
<td>Lack of comparison groups for single courses</td>
</tr>
<tr>
<td></td>
<td>iii. Perceived use of active learning</td>
<td>iii. Satisfaction with SAIL experience</td>
<td>Survey fatigue: need to prioritize assessments</td>
</tr>
<tr>
<td></td>
<td>Pre- and post-assessment of content understanding</td>
<td>Informal classroom observations</td>
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<tr>
<td></td>
<td>Performance on assignments</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Departmental /Institutional Level</th>
<th>Student Experience</th>
<th>Dissemination</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department and institution level educational research team</td>
<td>Tracking student progress:</td>
<td>Instructor surveys</td>
<td>Lack of validated assessments that apply to all courses</td>
</tr>
<tr>
<td></td>
<td>i. Performance in upper level courses</td>
<td>i. Awareness of SAIL and active learning</td>
<td>Need for consistent definition of “success”</td>
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<tr>
<td></td>
<td>ii. Retention within major and STEM</td>
<td>ii. Use of active learning strategies</td>
<td>Getting diverse faculty on board to track students across courses</td>
</tr>
<tr>
<td></td>
<td>Student surveys:</td>
<td>Informal classroom observations</td>
<td>Coordinating data collection</td>
</tr>
<tr>
<td></td>
<td>i. Attitudes towards active learning</td>
<td>Conversations with other instructors about teaching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii. Perceived use of active learning</td>
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</tr>
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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 website⁶

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
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