Dr. Shawn P. Gross is an Associate Professor in the Department of Civil & Environmental Engineering at Villanova University, where he joined the faculty in 1999. He teaches undergraduate and graduate courses in engineering mechanics and structural design of reinforced concrete, structural steel, masonry, and wood. His research interests include the design and behavior of concrete structures reinforced with internal FRP reinforcement, serviceability and time-dependent deformations in reinforced concrete, composite steel-concrete floor systems, and open-web steel joists. He is a voting member of ACI Committees 440, Fiber Reinforced Polymers; 435, Deflections; 423, Prestressed Concrete; and 363, High-Strength Concrete.

The Inverted Classroom

In an inverted classroom, typical in-class lecture time is replaced with laboratory and in-class activities. Outside class time, lectures are delivered over some other medium such as video on-demand.1


Alternative Definition & Motivations

Make the best use of (faculty-student) “face time” in fostering student learning.

• Value of in-class time
• Student attention span
• Reflects today’s technologies
• Perceived Efficiencies

Bloom’s Taxonomy

Main Emphasis of CEE 2105 & CEE 3412
Courses Where Inverted Classroom Has Been Implemented at Villanova

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Main (Broad) Learning Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2012</td>
<td>CEE 3412</td>
<td>Structural Design (Steel &amp; R/C) Design/compute capacity of structural members</td>
</tr>
<tr>
<td>Spring 2013</td>
<td>CEE 3412</td>
<td>Structural Design (Steel &amp; R/C) Design/compute capacity of structural members</td>
</tr>
<tr>
<td>Fall 2013</td>
<td>CEE 2105</td>
<td>Mechanics I (Statics/Mech Mat) Solve basic mechanics problems</td>
</tr>
<tr>
<td>Spring 2014</td>
<td>CEE 3402</td>
<td>Structural Steel Design Design/compute capacity of structural steel members</td>
</tr>
</tbody>
</table>

Conventional Classroom (Basic Approach)

- 50- or 75-minute lectures delivered in class
  - Mostly theoretical content
- Quickly executed example problems
  - PowerPoint or quick review of pre-solved handout
- Homework primary introduction of “application” or higher level cognitive learning

Inverted Classroom (Basic Approach)

- Pre-recorded lectures viewed outside of class
- Example problems solved in class
  (real time by students, faculty, or some combination thereof)
- Homework primary introduction of “application” or higher level cognitive learning

Time Estimates (in-class)

<table>
<thead>
<tr>
<th></th>
<th>PRE-INVERSION</th>
<th>POST-INVERSION</th>
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</thead>
<tbody>
<tr>
<td>Theory-Based Lecture</td>
<td>60%</td>
<td>10%</td>
</tr>
<tr>
<td>Problem Sets</td>
<td>25%</td>
<td>70%</td>
</tr>
<tr>
<td>Assessment (Quizzes/Exams)</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>Administrative</td>
<td>5%</td>
<td>5%</td>
</tr>
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</table>

Online Recorded Lectures

- Entirely theoretical in nature
  - No solved problems
  - Intended to provide background and base for solving problems in problem sets
- Recorded using College of Engineering Distance Education facilities or simple screen capture software
- Available for viewing via computer or mobile device
- Lecture notes distributed in advance

Student Feedback

- Students given survey at end of course soliciting feedback on inverted classroom model and course structure
- Separate from standard course evaluations (CATS)
- Mandatory
- Anonymous
- Excellent feedback
  - 140 of 140 surveys returned over two years
  - 82 of 140 students provided written comments
Sampling of Student Comments

- The fact that more time can be spent with the professors physically working on the problems is more effective than if it were a lecture instead.
- Helped me see the thought process behind each problem.
- The setup was a great way to focus on problems. Problems are what we are tested on so that should be done in class. Really prepared for tests.
- The lectures were not burdensome to watch outside of class & I don’t think I would have been able to complete/understand the homework assignment or be successful on the tests & quizzes.

Sampling of Student Comments

- I learned a lot in this course from the in-class problems and the take-home problem sets but the lectures were not at all helpful to my learning in this course.
- I watched all the videos in the beginning of the semester but then one day I forgot and class went fine...and then I started “forgetting” more often.
- Out of class lectures were hard to pay attention after 30 min.
- The video lectures were helpful, but it was difficult to stay focused on the video outside of the classroom.

Survey Responses

The format of this course improved my overall learning over a classical in-class lecture format.

<table>
<thead>
<tr>
<th>Year</th>
<th>Strongly Disagree</th>
<th>Mildly Disagree</th>
<th>Neutral</th>
<th>Mildly Agree</th>
<th>Strongly Agree</th>
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<tbody>
<tr>
<td>2012 (CEE 3412)</td>
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<td>4</td>
<td>11</td>
<td>32</td>
</tr>
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</table>

Survey Responses

I feel that the format of this course improved my ability to apply knowledge in solving basic problems over a classical in-class lecture format.

<table>
<thead>
<tr>
<th>Year</th>
<th>Strongly Disagree</th>
<th>Mildly Disagree</th>
<th>Neutral</th>
<th>Mildly Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012 (CEE 3412)</td>
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<td>13</td>
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<td>2013 (CEE 2105)</td>
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<td>0</td>
<td>1</td>
<td>16</td>
<td>31</td>
</tr>
</tbody>
</table>
Survey Responses
I feel that the format of this course improved my conceptual understanding over a classical in-class lecture format.

<table>
<thead>
<tr>
<th>Year</th>
<th>Strongly Disagree</th>
<th>Mildly Disagree</th>
<th>Neutral</th>
<th>MILDLY Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012 (CEE 3412)</td>
<td>5</td>
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<td>7</td>
<td>10</td>
<td>15</td>
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<tr>
<td>2013 (CEE 3412)</td>
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<td>5</td>
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<td>17</td>
<td>15</td>
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<tr>
<td>2013 (CEE 2105)</td>
<td>0</td>
<td>3</td>
<td>7</td>
<td>14</td>
<td>24</td>
</tr>
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</table>

Impact on Student Performance (Grades)

Thoughts Based on My Experiences
- Accentuates good teaching, exposes poor teaching
  - Not just “lecture delivery”
- Puts a premium on organization of course
  - Effectively twice the class meetings, but only half of them involve face-to-face interaction
  - Need a good course calendar to keep things clear
- Format well suited to a pre-packaged course binder/course pack
Thoughts Based on My Experiences

- Does not require more student time, but that will be the perception
  - Does require more student responsibility
- Day 1 sales pitch is very important
  - Set expectations
  - Provide clarity on organization

Thoughts Based on My Experiences

- Promote “circular” path of learning, as needed by each individual student
  - Ability to rewatch lectures (and problems) as needed
- Format is easy to mesh with short labs, demonstrations, overarching problems, etc.
- Different ways to keep theory important, since it really is important
  - Quiz/exam problems
  - Embed theory into examples
- Higher level cognitive learning can be fostered in the same way

Thoughts Based on My Experiences

- Faculty time commitment
  - Can be very extensive first time through
  - Much more prep time that just recording lectures
  - Will probably never be totally steady-state in structural design courses (e.g. ACI 318-14)
  - Design best as numerous small pieces that can be replaced/edited/resequenced
  - Actually easier to prep “for class meetings”

QUESTIONS?

shawn.gross@villanova.edu