Teaching using a hybrid course model: Crafting and using effective out-of-class activities that engage and prepare students

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“Getting students engaged and guiding their thinking in the classroom is just the beginning of true learning, however. This classroom experience has to be followed up with extended "effortful study," where the student spends considerably more time than is possible in the classroom developing expert-like thinking and skills.”

-- Carl Wieman

Students struggle to prepare for class

Students are unsuccessful at preparing for class because
  ▪ they "read", but like it's a story
  ▪ "do problems" if we make them, don’t connect to course material
  ▪ poor metacognitive sense - gauge for what is expected of them
  ▪ afraid to seek help – they are afraid to make mistakes
  ▪ have (major) deficiencies in their pre-requisite skills

Students are most able to succeed when
  ▪ they prepare for class
  ▪ they are given context for their work
  ▪ they are given explicit expectations (low or high)
  ▪ they are supported and given guidance
  ▪ they are challenged to find answers for themselves
Our students crave the passive

- Students accustomed to working hard, but ineffectively
  - Highlighter
  - Flash cards
  - Rewriting notes
  - Looking at problem solutions
- They interpret a lack of specific assigned work as an invitation to do little or no active work
- Courses that penalize group success de-incentivize many important forms of active learning

Why not completely “flip” the classroom?

What’s good about flipping:
- Get students “working” outside of class (that’s what we want!)
- Give support to students during problem-solving in-class

Why completely flipped classrooms aren’t the solution:
- Students do not get as excited for the material (infectious instructors are necessary here)
- Students often miss the contextual parts (self-motivation)
- Students tend to learn material as “isolated fact nuggets” rather than developing understanding
- Overburdening students (“what is a credit?”)

Goals for a hybrid model

- Remediate for missing pre-requisite knowledge /skills
- Engage students in active preparation for class meetings
- Increase student excitement about subject material by providing context to the material
- Free-up lecture time for preconceptions, misconceptions, deeper investigations, and other active learning devices (clickers, group work)

Hybrid model

1. Prime students in class:
   - Give context and guidance
   - Set explicit expectations for learning outcomes (make sure to …)
Hybrid model

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2. Students explore at home
   - Guided activities
   - Online tutoring with ALEKS
   - Pair with Piazza or discussion board for great results

3. Quiz students on their learning from explorations at home

4. Develop and extend during next class meeting
   - Use class time to address confusion
   - Extended concepts and discuss applications
JUST model for effective out-of-class activities

JUST Activities

Just-in-time
- Learned the hard way with atoms-first approach
- Eliminates the need for refreshers
- Helps students appreciate the fruit of their learning more quickly
- Enables students to focus on the material that is immediately relevant

JUST Activities

Unburden
- Carrying a load of bricks
- Early versions of activities were less effective because students got lost too early

Confusion

Intro
- Idea 1
- Idea 2
- Idea 3
- Idea 4

Intro
- Idea 1
- Lead to Idea 2
- New activity
- Idea 2
- Lead to Idea 3

Unburden
- Carrying a load of bricks
- Early versions of activities were less effective because students got lost too early
- One activity = one concept
- Confusion (a good thing) occurs just when student is ready to go back to class/office hours
- Students arrive at class having prepared exactly the material we intend to investigate
JUST Activities

Try
- Approach requires students to explore / research
- Students struggled to figure out what they were supposed to do

Show, Try
- Showing the students an example of what we're looking for substantially increases willingness to 'jump in'
- Some students stayed on 'auto-pilot'

Show, Try, Think
- Final questions asking to apply and/or extend what they learned
- Students arrive in class meeting curious / interested

Transfer
- Learning is slow; Spiral approach to teaching general chemistry
- Transfer of skills and learning critical in course
- Later activities draw on and reference earlier activities
- Early activities foreshadow later learning to come
Teaching using a hybrid course model

Different goals for activities
- Remediation of pre-requisite skills (ALEKS)
- Skill / confidence building (Textbook, blended HW solution)
- Investigating basic concepts (JUST Activities)
- Exploring relationships and making connections (JUST Activities)

Different types of activities
- Answer questions by doing research
  - Sketching, drawing, making analogies
  - Play with widget (Mathematica CDF) to learn relationships
- Watch a video to get answers
- Engage in a student debate in groups

Pilot course using JUST activities
- Summer CH101 course (<50 students; small by BU standards)
- Workbook of 20 activities used to help the students work between classes to tackle the quantum aspects
- Pre- and post-instruction concept surveys given to the class
- Content Knowledge Gains and student attitudes were assessed after the course

Results of JUST activities on quantum concept instruction
- Positive correlation between completion of activities and
  - Content Knowledge Gains (pre- / post-surveys)
  - Course grade
- Students with lowest content gains showed least amount of out-of-class engagement with the activities
- Note: not accuracy, just completion (did they make an effort at it)
Results of JUST activities on quantum concept instruction

- “The activities were super helpful for preparing me for class.”
- “[Quantum] was way more challenging material and not very intuitive, so I think the activities were kind of harder. They took time, but when I got to lecture I was like: ‘oh, ok, this is way easier than I thought.”
- “Even if it wasn’t intuitive, I could understand why. When I was just thinking about how the electrons would be in orbitals, I wasn’t really getting it. But having to play with the simulations visually, and also having to force yourself to ask why, that helped a lot.”

Acknowledgments

- Emily Allen, Peter Garik (BU SED)

http://quantum.bu.edu/CDF/101/01-TravelingWaves.cdf
http://quantum.bu.edu/CDF/101/IRFrequency.cdf

“Do not let the math define the chemistry. I have seen myself and friends alike get wrapped up in equations, math, and rote calculations. The Chemistry defines the math, not the other way around. If one spends the time to fundamentally understand what is happening at a microscopic chemical level, then the math will explain itself.”