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

Binyomin Abrams, Natalya Bassina, Dan Dill, Alex Golger (CAS)
Emily Allen, Peter Garik (SED)
Boston University
abramsb@bu.edu

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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

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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

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Students struggle to prepare for class

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

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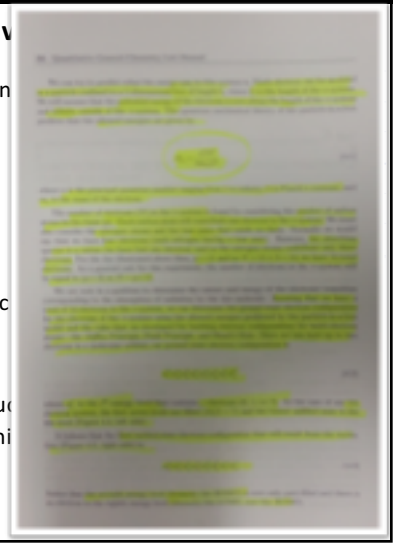
Our students crave the passiv

- Students accustomed to workin hard, but ineffectively
  - Highlighter
  - Flash cards
  - Rewriting notes
  - Looking at problem solutions
- They interpret a lack of specific do little or no active work
- Courses that penalize group suc important forms of active learni



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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?")

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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)

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Hybrid model

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

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   - Guided activities
   - Online tutoring with ALEKS
   - Pair with Piazza or discussion board for great results

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4. Develop and extend during next class meeting
   - Use class time to address confusion
   - Extended concepts and discuss applications

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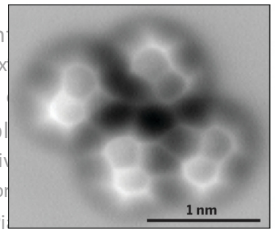

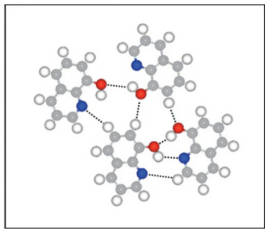

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JUST model for effective out-of-class activities

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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

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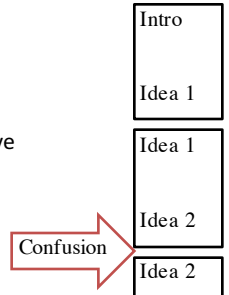
JUST Activities

Unburden

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



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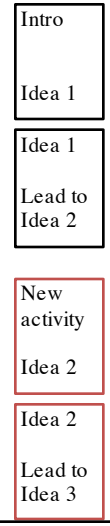
JUST Activities

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



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JUST Activities

Try

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

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JUST Activities

Try

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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'

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JUST Activities

Try

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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

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JUST Activities

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

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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

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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

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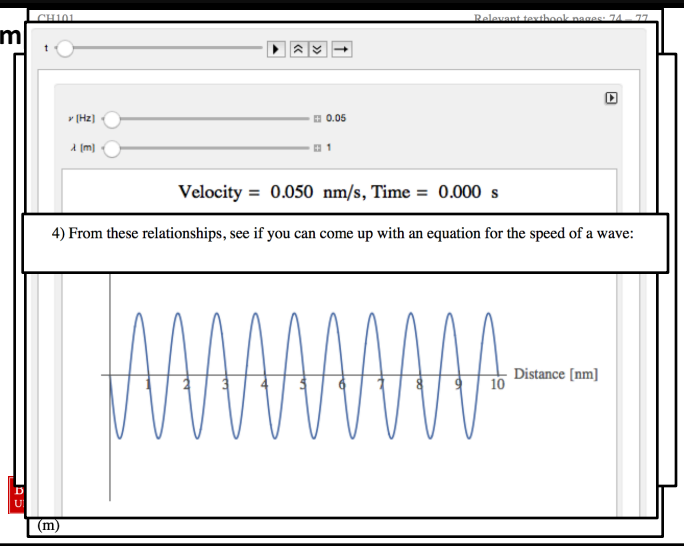
Sam



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)

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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."

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Acknowledgments

- Emily Allen, Peter Garik (BU SED)

abramsb@bu.edu

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http://quantum.bu.edu/CDF/101/01-TravelingWaves.cdf
http://quantum.bu.edu/CDF/101/23-ElectronWaveInterference-1.cdf
http://quantum.bu.edu/CDF/101/IRFrequency.cdf

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"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."

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