A Blended Introductory Physics Course
&
a MOOC
with a Lab

Michael F. Schatz
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Georgia Institute of Technology

Supported by the Gates Foundation & NSF (DUE-0942076)
MOOC Registration: coursera.org

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Search for physics
Georgia Institute of Technology
Introductory Physics I with Laboratory
with Michael F. Schatz
May 20th 2013
11 weeks long
Acknowledgements

Georgia Tech
Scott Douglas, Shih-Yin Lin,
Emily Alicia-Munoz, Ed Greco

Georgia State
John Aiken, Brian Thoms

NC State
Ruth Chabay
Bruce Sherwood

Colorado/Michigan State
Danny Caballero

St. Andrew’s School
John Burk

Highpoint University
Aaron Titus

Hamline University
Andy Rundquist

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NSF DUE-0942076
Hype can be good

+ Draws attention (Provosts, Deans, ....)
+ Frees resources
+ Provides opportunities for (potentially) transformative experiments
…on the Shoulders of Giants…

+ **Video-Analysis-Based Labs**
  
  *(P. Laws, R. Teese, others; Douglas Brown (Tracker))*

+ **Reform Curriculum**

  *(Matter & Interactions: R. Chabay & B. Sherwood ) (F. Reif)*

+ **Modeling**

  *(Modeling Instruction : D. Hestenes et al.)*

  *(NRC Framework for K-12 Science Education: H. Quinn et al.)*

+ **Science Communication & Peer Evaluation**

  *(Calibrated Peer Review: A. Russell et al.)*
Introductory Physics MOOC with a LAB
Video Capture & Analysis of Motion Observations
Modeling of Motion Observations

```python
# Define Physics Parameters
ball.position = vector(-61,1,0)  # ball position (x,y,z)
ball.mass = .145  # ball mass in kilograms
ball.velocity = vector(25,0,0)  # ball velocity (vx,vy,vz)
ball.netForce = vector(35,0,0)  # ball net force (Fx,Fy,Fz)

# Ball physics update
ball.velocity = ball.velocity + ball.netForce/ball.mass*time.deltat
ball.pos = ball.pos + ball.velocity*time.deltat
```

```python
# Ball physics update
ball.velocity = ball.velocity + ball.netForce/ball.mass*time.deltat
```
Video Lab Reports & Peer Evaluation
The Rest of the MOOC

+ Video Lectures (with embedded “Clickers”)
+ Online Textbook
  (Free limited time access)
+ Discussion Forum
+ Online Homework & Tests
Physics MOOC Tour
Discussion Question

Scenario: Your large lecture (200-student) on-campus mechanics course will use online (MOOC) content (lectures and, perhaps, labs).

How will you/your TAs interact, face-to-face, with on-campus students?
Discussion Question

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How will you/your TAs interact with on-campus students?

+ Live Practice Talks (with feedback) & Seminar-Style Physics (1-2 hrs/week)

+ Small Group Guided Problem Solving (2-3hrs/week)
Discussion Question

Scenario: Your large lecture (200 student) on-campus mechanics course will use online (MOOC) content (lectures and, perhaps, labs).

How will your course content change?
Other Discussion Topics

+ Producing Lectures w/ Animation
+ Large Lectures are Mini-MOOCs
+ Maturity of MOOC Platforms (Coursera)
  (LMS: Homework Delivery, Discussion Forum, Peer Evaluation)
+ Discussion Forum Differences:
  On-campus vs MOOC students
+ Commercial Textbook Access (MOOC)
Whiteboard Animation in Lectures

System & Surroundings

Model for Weight Force
\[ \vec{w} = \hat{m} \vec{w} = -mg\hat{j} \]

Are there other significant interactions for falling objects?

Skydivers sure hope so!
Is this doing any good?

+ Standard measures (pre/post concept inventory)
+ Attitudes, expectations (CLASS, E-CLASS)
+ Analysis of student work (Student videos)
+ Student interviews (Think-aloud)
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physics

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Clicker Question:

Setting: Introductory Physics (Mechanics) on your campus.

Are the labs well-coordinated with the lectures?

(1) Yes
(2) No
(3) Other (e.g., don’t know, no labs, studio, …)
Clicker Question:

Setting: Introductory Physics (Mechanics) with lecture and labs.

What’s more important, lecture or labs?

(1) Lecture
(2) Labs
(3) Equally important.
Clicker Question:

Setting: Introductory Physics (Mechanics) with lecture and labs.

What’s the main purpose of the lab?
Introductory Physics MOOC with a LAB
Hype can be good

+ Draws attention (Provosts, Deans, ....)
+ Frees resources
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...on the Shoulders of Giants...

+ Video-Analysis-Based Labs
  (P. Laws, R. Teese, others; Douglas Brown (Tracker))

+ Reform Curriculum
  (Matter & Interactions: R. Chabay & B. Sherwood) (F. Reif)

+ Modeling
  (Modeling Instruction: D. Hestenes et al.)
  (NRC Framework for K-12 Science Education: H. Quinn et al.)

+ Science Communication & Peer Evaluation
  (Calibrated Peer Review: A. Russell et al.)
Foundation for Standards
(from US National Academy of Sciences)

A FRAMEWORK FOR K-12 SCIENCE EDUCATION
Practices, Crosscutting Concepts, and Core Ideas
2012
Scientific and Engineering Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Developing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

NRC Framework for K-12 Science Education

H. Quinn, Stanford
Doing a Lab

- Record moving object(s) on video
- Analyze video in software (Tracker)
- Model motion on computer (VPython)
- Compare model to observations
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Lab Reports

- Each student creates a 5-minute video lab report, uploads to YouTube
The Labs

(1) Constant Velocity
(2) Free Fallin’ (1D force & motion)
(3) Black Holes (>1D force & motion)
(4) Rope Physics in Sport (Energy, Oscillations)
(5) Capstone: Choose Your Own Adventure
Peer Evaluation: Rubric

- Students grade 5 peers videos + self with 7-item rubric

1. Is the video presentation clear?
2. Does the author state the problem and show a result?
3. Does the author identify the relevant model(s)?
4. Was the model predictive of the observed motion?
5. Did the author explain the model/observation connection?
6. Does the video correctly explain the physics?
7. How does this video compare to mine?
Physics MOOC Tour
Training to Evaluate

• Beforehand….
  + View sample videos and apply rubric
  + Guided video critique
• Afterward….
  + guided self-reflection assignment
  + TA-moderated discussion in forums
Physics MOOC Tour
Peer Evaluation Implementation (Ideal)

Calibrated Peer Review (CPR) (Arlene Russell, UCLA)

+ Student performance in training used to weight evaluations
Peer Evaluation Implementation (Actual)

Coursera (circa Summer 2013)

+ No calibration---student score is item median.
Other Discussion Topics

+ Preliminary test—on-campus Spring 2013
  (Student Reactions, Perceptions)
+ How best to weigh labs in final grade?
+ How to extend beyond mechanics?
+ Can labs “in-silico” replace hands-on labs?
Is this doing any good?

- Standard measures (pre/post concept inventory)
- Attitudes, expectations (CLASS, E-CLASS)
- Analysis of student work (Student videos)
- Student interviews (Think-aloud)