Helping HS students succeed in college physics

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(channeling the thoughts of
Phil Sadler, Harvard University, and
Steve Tai, City College of New York)
Outline:

- How are High School (HS) and College/University (C/U) students related?
- Investigating student success in C/U physics
- How is C/U success in physics:
  - independent of HS teaching?
  - dependent on student choices?
  - Influenced by teacher choices in the classroom?
- Open discussion: The role of physics teaching at the HS level
Who takes physics?

College enrollment in introductory physics is roughly half that of high school physics.

» 45% of students who take HS physics take C/U physics.
» Only 3% who do not take HS physics take C/U physics.
» Most students who take honors or AP physics as their highest physics course in high school take physics again in college.
» Only 3% who take “non-science” physics courses take C/U physics.
» 25% of HS students take physics, 33% of C/U students
A survey to study student success in C/U physics

• ~2000 students at 19 schools in intro physics
• diverse background
• Compare responses to grades in the course
• Over 50 topics asked about, each correlated to grades
• Statistics carried out analyze the effect of EACH topic, independent of others (i.e. the others are “summed over” when looking at each individual topic)
Caveats

The survey was testing only how success at the college and university level related to (and was dependant on) high school instruction.

It did not ask questions about the other values of high school instruction.

It did not use independent methods to evaluate high school instruction.
Things that matter while being things we can’t change:

**Socio-economic status and gender**

- **Suburban vs. urban vs. rural**
  - something we can’t change at our schools

- **Racial background**
  - something we can’t change
  - Maine is kinda white (says a southern raised immigrant kid)

- **Gender**
  - something we can’t change much at our schools
  - one interesting point will come up later
Things that are interesting but hard to influence as a teacher:

Student choices in classes they take.

- Delaying C/U physics helps your grade
- Two years of physics in HS are better than one
  - Not as obvious as it seems
  - Remember, these students STILL take intro C/U physics!
- Calculus and physics are equally helpful at the college level!
  - Each alone is equal to the other…
- Taking college physics from a same-gendered C/U professor helps your grade…
Teacher choices within the classroom

Three factors to consider when looking at the influence that teachers have on students:

| Expected to improve student performance, but worsens it instead |
| Correctly NOT expected to improve student performance |
| Correctly expected to improve student performance |
Things that do help

Good, that’s just what we expected

• **Focusing on multiple explanations rather than flying through material**
  » Multi-faceted understanding
  » Spending time on a single topic

• **Doing mechanics in detail**
  » Much intro physics is mechanics (1st semester, typically)
  » Basic concepts are learned in kinematics/dynamics

+0.8 points

+0.1 points per week
Things that don’t affect students’ future success in C/U physics

- Teaching these topics had no effect on C/U success:
  - E&M
  - Optics and waves
  - Modern physics

- Questions worth discussing:
  - So why we would teach these topics?
  - Do students need to see what’s cool and interesting?

Hmm, so why do we do that?
Things that don’t affect students’ future success in C/U physics

Hmm, so why do we do that?

• **Assigning only end-of-chapter homework…**
  » Instead give mixed qualitative and quantitative problems
  » Problems should relate to students’ personal lives

• **Project and lab work**
  » Science fairs, major projects, and detailed labs have no measurable effect on students C/U performance
  » This sort of work may have other goals than C/U success!
Things that don’t affect students’ future success in C/U physics

- Hmm, so why do we do that?

Explicitly discussing student reasoning in terms of pre/misconceptions

- i.e. warning that “you shouldn’t think this” doesn’t work
- need explicit interaction to challenge and help students build more appropriate models
- Actions speak louder than words in creating effective classes
Things that don’t help that you think should help:

- **A friendly teacher**
  - but how do you interpret that?  
  -0.5 points

- **Covering too much material in HS**
  - Instead, focus on basic concepts, in multi-faceted detail
  -0.5 points

- **Doing too many labs (>4) a month, without time to process what’s learned**,  
  -0.3 points

- **Doing too many qualitative problems**  
  -0.4 points

Whoa! What’s going on here!?!
Things that don’t help that you think should help:

Whoa! What’s going on here!??

THE TEXTBOOK

Students taking a class with a text did much worse than those whose HS classes did not use a text

How do we interpret this?

• What else happens in such a class?
• How do students learn differently?
• How do instructors teach differently?
What do students think matters?

What part of HS physics matters most to students?

» successful prediction of demonstration outcomes
» extensive coverage of electricity and magnetism
» larger class sizes.
» more quantitative problems
» friendly high school teachers

Those who had not taken high school physics attributed significantly more value to taking a high school physics course than those who had actually taken one.
Summary of what Sadler suggests

- Explaining problems in several different ways
- Using no textbook at all or reading it less
- Courses characterized by students as covering a small number of topics in great depth (particularly concentrating on mechanics)
- Deemphasizing the solving of qualitative problems in class
- Carrying out four labs or fewer each month
- Teachers described as of average friendliness or less
- Avoiding extensive discussions following demonstrations