To: Paul Boynton, chair of General Education Committee
Cc: Tom Trainor, David Boulware
Re: PHYS 110 Win08 - report
5/27/08

Appendices:
1. Sample mid-term exam (machine graded)
2. Pop quizzes (using "clickers")
3. Internal evaluation quiz questions (given using clickers)
4. Prior goals vs achievements

Phys 110 for Winter 2008 was used as a test bench for the new general education course we want to develop, Phys 201. In general the course was successful:

a) enrollment to capacity, with very few dropouts (initial enrollment 195, final192)

b) good student evaluations (3.8 to 4.6 on general questions, median 4.1)

c) generally very positive response from students, on evaluation quizzes (see appended summary) and in person. Guest lecturers commented on the evidently high level of interest and engagement.

d) good regular attendance, indicating success of the quizzes and exams as motivators for keeping up and paying attention to lecture content.

This version of the course was a hybrid between previous 110 offerings (from which lecture materials had to be drawn in large part, due to the lack of relief time to prepare in advance), and the new approach we wanted to try out for 201. While I dropped several topics entirely, it was clear that the syllabus was still too broad for the time available, and I still apparently could not let go of the physicist's habit of needing to lay groundwork for succeeding topics in a systematic way.

The course mechanism worked rather well. The grade was based on 3 components:

1) mid-term exams: best 1 of 2 grades. (20% of grade; see Appendix 1)

2) pop quizzes: best 7 of 10 grades. (40% of grade; see Appendix 2)

3) term papers: 2 papers of about 5 pp, or websites with equivalent content, equally weighted. The first was on a specified range of topics (Einstein's contributions), the second was on any relevant topic of the student's choice. (40% of grade).

The exams consisted of multiple-choice, qualitative questions. The students were told in advance that the exam questions would be easy IF they were paying attention in class. Exam results showed the usual 2 bump distribution of those who got it, at least in part, and the 10% of the class who really could not really comprehend the readings and lectures. About 25% of the class got 90 or 100% on the exams, and another 25% missed several very simple questions. Also, as typical, mostly the same students were in each category for both exams.

Students were also told that the pop quizzes very easy if you pay attention, and to cover a topic that had recently discussed in class. They were intended to insure regular attendance,

and reward it (students got 3 points for a correct answer, 1 point for a wrong answer and zero if not present). Each quiz was a single multiple-choice question, based on something that had been discussed, and usually emphasized, that day, or at most the day before. In several cases the quiz question was related to a point emphasized in a video the students had just watched. One quiz was given per week, at the end of the hour, often on Thursdays but on other days frequently enough to keep the students guessing when the next would be.

The quizzes were successful in the sense that attendance was excellent. On the other hand, the high rate of problems with the IR clickers caused a great deal of wasted time and a lot of hand-editing effort by me to enter answers from students who could not manage to successfully operate their clickers or register their serial numbers.

The term papers were successful in that only about 25% of the students produced routine humdrum papers. The quality of writing (and thinking) in papers and websites was also much higher than observed in 110 the previous year, which I had found personally discouraging. However, this component was an extremely taxing one, and was only possible due to an exceptionally patient and skillful TA (Mike Dziomba). More TA help is needed! In addition to Mike, Jong-wan Lee was assigned part-time. He was very capable, but due to the limited time he was assigned, I chose to give him tasks that could be done in small chunks, such as answering students' questions on the Go-Post page, proctoring exams and getting them machine-graded, etc.

The course was structured as meeting 4 days a week (with no TA-led discussion sections on Fridays, as we had in 110 previously) for 5 credits. The general scheme was that i delivered a lecture on M-T-W, and used Thursday for "other things". A few times, i just did an extra lecture, or had a guest lecturer (Trainor) giving a talk in a completely different style and topic. On six of the Thursdays, I showed 30 minute segments of several videos (James Burke's BBC series, Brian Greene's "Elegant Universe", and "The best mind since einstein", with clips of Feynman speaking on various topics). Two Thursday sessions were used for the exams.

Instead of a textbook, i assigned readings in 4 mass-market books:

1) Hawking's BriefER history of time
2) Larry Krauss's Fear of Physics
3) Brian Greene's Elegant Universe
4) Alan Lightman's Concepts in Physics

The total cost of these was about $80, equivalent to the price of a standard 'conceptual physics' textbook.

The course website, http://courses.washington.edu/phys110, was set up by me three years ago, when I first started teaching 110, with the goal of passing it on to the next incumbent. In addition to the usual course information and syllabus, I posted pdfs of all slides shown in class. As a change from previous years, this time I made a point of posting slides only after a full week's delay, so that students could not rely on the postings to deal with pop quiz questions. The website also has links to the associated Catalyst tools, Go-Post (a

bulletin board/chat board) and U-mail (anonymous e-mail). The Go-post site received very little usage. This may have been due to technical changes by Catalyst (I have heard complaints from faculty in other departments about the transition from the previous E-post to Go-post). The U-mail facility was useful – again, not heavily used, but it did provide a way for students to complain about other students' rude behavior. None of the U-mails berated me – perhaps they are convinced there must be SOME way I can find out who sent the mail.

As indicated in the appended evaluation-quiz results (Appendix 3), students answered several of our questions for us:

1) Nearly half took the course because they were 'just curious'.
2) Of all the topics covered, the one they liked least was 'statistics', which i considered one of the most important components! i must be doing something wrong in teaching this subject.
3) nearly half thought the term paper assignments were least valuable.
4) They definitely want 5 credits, not 4 or 3.
5) They did not find the assigned readings particularly valuable; about half would have preferred a conventional textbook. i blame myself for this since i did not make the page assignments particularly coherent. I also felt the Lightman book was not particularly good.
6) The videos and films seemed successful, especially since i keyed several quizzes to their contents.
7) What the really want is dedicated TA time. The help center TA's are not prepared to handle the vague questions of these students.
8) The nicest result was that 90% would recommend the course to a friend!

Appendix 1: sample exam (exam 1, p.1)

PHYS 110B, Winter 2008, R. J. Wilkes
First Midterm Exam / p. 1 of 3

Use a standard mark-sense sheet. DON'T FORGET TO WRITE YOUR NAME ON IT! Do not turn in these pages, just turn in your mark-sense sheet.

Total 100 points, there are 10 questions, each worth 10 points. Of course, partial credit is not possible on a multiple-choice exam. 50 minutes allowed; you must leave when the bell rings.

There are no trick questions, and each question has *one* correct answer. If you think that more than one answer might be correct, choose the one that seems *most* correct to you.

1. Is it ever possible to prove, for certain, that a particular scientific theory is <u>false</u>?

   (a) Yes, by means of any confirmed experiment or observation that contradicts the theory.
   (b) Yes, by taking a vote among all of the scientists who are experts concerning that theory.
   (c) Yes, if the world's most respected authority disagrees with the theory.
   (d) No, because scientists can never agree on anything.
   (e) none of the above.

2. How is the sun situated in the universe?

   (a) The sun is at the center of the universe.
   (b) Earth is at the center of the universe, and the sun orbits around the earth.
   (c) The sun is just one of a large number of stars, and is located on the outskirts of the Milky Way galaxy, which itself is just one galaxy among many galaxies.
   (d) The sun is an isolated star that is far outside of all the galaxies in the universe, and is thus not part of any galaxy.
   (e) The Sun is located in the chariot of Apollo, which is driven across the sky daily.

3. The distance to the sun is about 93 million miles. Expressed in scientific notation, this is

   (a) 9.3×10^{6} mi.
   (b) 9.3×10^{-6} mi.
   (c) 9.3×10^{7} mi.
   (d) 9.3×10^{8} mi.
   (e) none of the above.

THERE ARE 3 PAGES IN THIS EXAM – MAKE SURE YOUR COPY HAS ALL 3.

Appendix 2: Sample pop quiz

(The photoelectric effect had just been discussed and demonstrated in class. 90% of the students chose B.)

Pop Quiz #7 3/3/08

- According to Einstein, which of the following would be **most likely** to make an electron pop out of a metal surface (inside a vacuum tube, with negative voltage applied)?

A. Shine **red** light from a very intense light source for a long time

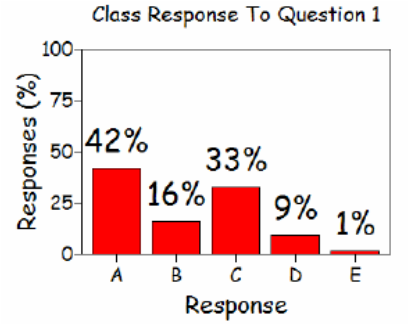
√ B. Shine **blue** light, even from a weak source for a short time

C. Keep the metal surface in the dark

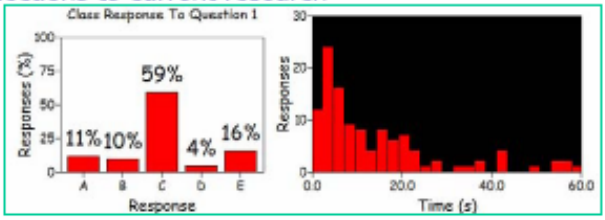
D. None of the above: you can't get electrons to jump out of atoms

Appendix 3: Evaluation quiz results

- Why are you taking this class ?
  A. Just curious about physics
  B. Heard it was an easy class
  C. Need it to fill a degree requirement
  D. Needed a class at 10:30 and this was all I could get into



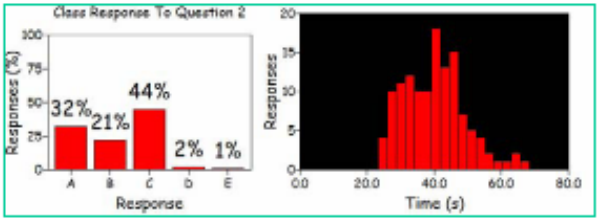
1. which topic did you find LEAST valuable as part of the course?
   A) ptolemy/kepler/newton development of mechanics
   B) electricity and magnetism
   C) probability and statistics
   D) relativity
   E) quantum theory
   F) connections to current research



2. which part of the course grade requirements did you find LEAST valuable
   A) exams

   B) pop quizzes (as a concept - imagine the clickers worked perfectly every time!)

   c) term papers

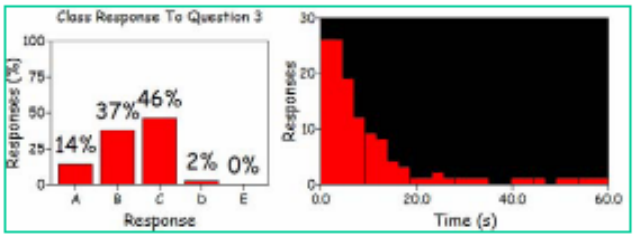


3. did you consider the readings to be a valuable addition to the course?

A) yes

B) partially

C) no

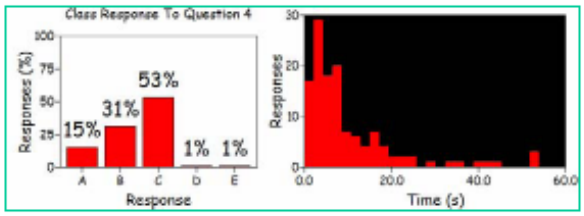


4. would you have preferred to have readings assigned in a conventional textbook, rather than read mass-market books by prominent scientists, as we did?

A) definitely

B) to some extent

C) no

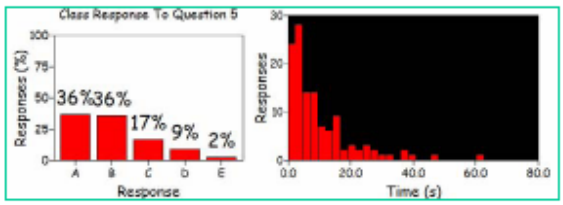


5. did you consider the films to be a useful part of the course? rate them A to F, with

A) really helpful

...to

F) useless



6. what additional resource would have been MOST valuable if added to the course?

A) Discussion sections (1 hr a week with a TA as a required part of the class)

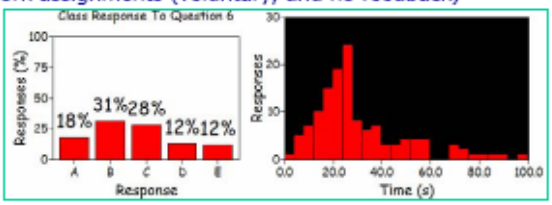
B) TA help specifically for this class available in the Physics Study Center (but would have to be at limited, specified hours)

C) Graded homework assignments (to provide incentive to actually do the work, and point out your mistakes)

D) Ungraded homework assignments (voluntary, and no feedback)

E) both A and C

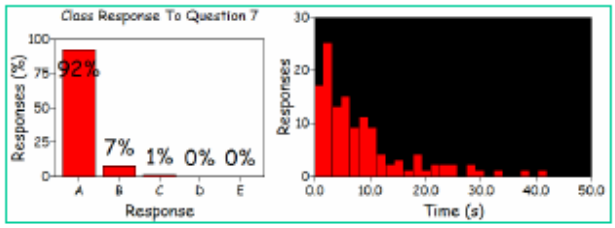
F) both B and C



7. Would you have preferred this course to be offered as:

A) this 5-credit version

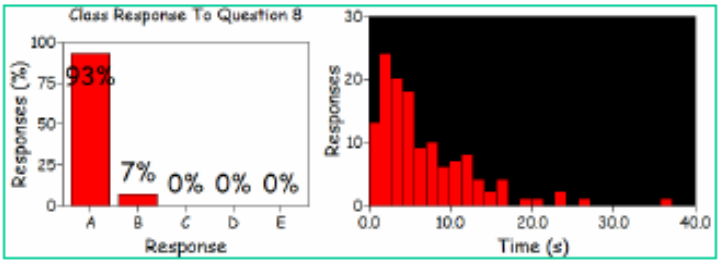
B) a 3-credit, slimmed-down version, meeting only 3-days per week?



8. would you recommend this course to friends?

A) yes

B) no



Appendix 4: Prior goals vs achievements

I. Here are my personal prior goals for the course, from the wiki page. How many did we achieve?

Must address cultural issues, in particular the anti-intellectualism which seems especially widespread and historically entrenched in USA. Give students answers to the question 'what good is this course?':

* can you read and comprehend material that may be complicated, abstract and not necessarily well-written?
* will you know how to self-educate after leaving the university?
* do you know how to distinguish reliable from biased or fraudulent sources of information, on TV, in newspapers and magazines, and on the web?

These are skills we want to develop in this class.

Differences between this and a conventional physics course:

* content is not focused on how-to (eg calculations or applications)
* course goal is to provide an intellectual framework to understand what physical science can and cannot provide, and allow students to follow future developments knowledgably.

II. Here are our committee's goals, again from the wiki. How many did we achieve?

What are OUR (faculty) goals for the course? We hope by the end of winter term you will

1. have an overview of the development of ideas (history of ideas in physics), to better understand motivations for current research directions.
2. have acquired a basic scientific vocabulary, to make the significance of future news items understandable.
3. learned to use rational thinking to separate facts from wishes, political positions, and frauds.
4. understand how scientists express the limitations of knowledge and learning to identify the current boundary between what-we-know and our-best-guesses.
5. learn about the concept of probability and the basic ideas of statistics, not only to interpret things you read about, but also to comprehend the fundamentally probabilistic way in which Nature works.