Physics 4810 / 7810
Teaching and Learning Physics
Fall 2008
Finkelstein

A course on how people learn and understand key concepts in physics. Readings in physics, physics education research, education, psychology and cognitive science, plus opportunities for teaching and evaluating college and K-12 students. Useful for all students, especially for those interested in physics, teaching and education research.

> *Nobody thinks clearly, no matter what they pretend. Thinking's a dizzy business, a matter of catching as many of those foggy glimpses as you can and fitting them together the best you can. That's why people hang on so tight to their opinions; because, compared to the haphazard way in which they're arrived at, even the goofiest opinion seems wonderfully clear, sane, and self-evident. And if you let it get away from you, then you've got to dive back into that foggy muddle to wrangle yourself out another to take its place.* ---
> Dashiell Hammett

As we muddle along, this class is designed to be engaging, provocative, and enjoyable. The class will largely depend upon your input. You will help create and direct the class.

Student responsibilities:

- active participation
- weekly homeworks (readings, reflections, physics problems, and fieldnotes
- final project (project of your own design)

My role, as instructor will be to facilitate your engagement with the material, provide resources for you, and give you feedback and direction. Please make use of my office hours

Official Office Hours
F1023 Gamow: Tu / Thurs 3p – 4pm
303 735 6082
noah.finkelstein@colorado.edu

Texts: E.F. Redish, *Teaching and Learning Physics*
Also available online for free: http://www2.physics.umd.edu/~redish/Book/
[I don't promise the pages match up]
Introductory Physics Text, preferably Knight (1st ed) or Giancoli (6th)
Weekly readings handed out or on e-reserve

Course Website:
http://www.colorado.edu/physics/phys4810

Class Schedule:
Week 1: 8/26 Introduction
Week 1: 8/28 Identify preliminary fieldsite(s)
Week 3: 9/9 Identify area of interest for project - Turn in 1 paragraph description
Week 7: 10/7 Outline of project due
Week 13: 11/18 Rough cut of final project due
Finals week: project due.

Student Work:

There will be 3 forms of regular work in this course: (1) readings/reflections, (2) physics content/homework analysis, (3) practicum in teaching or research & fieldnotes.

Readings: (Tuesday Classes) Each week we'll be discussing readings. The tentative schedule is on the following page. We'll be reading both from Redish's book *Teaching Physics with Physics Suite* and original sources that are on the course web page, electronic reserves or handed out a week in advance.
Each week you are expected to write a paragraph summary of each paper/ reading, and to list out 3 questions, or points of interest that the paper brought up. You are to post your summaries / discussion points online on CU Learn by ***Monday 5pm.*** You are to review your colleagues notes on the reading and respond to one of the questions / comments or queries by ***Tues noon***.

While, I will lead the first week or two of readings, it will quickly be handed over to you to lead the discussions for the class. We will have students sign up to lead the discussion once or twice over the course of the term. These weeks you should be prepared to present a 5-10 min summary of the paper, and bring in some points of discussion for the class.
Graduate Students: you will typically have an extra article each week and are expected to read and comment on these.

Physics content: (Thursdays). We'll be covering the introductory sequence of physics (mechanics) at the same time we are reading about student learning. Our class will roughly parallel the 1st semester of calc- based physics, 1110.
(http://www.colorado.edu/physics/phys1110/). Our tentative schedule of topics is listed below. Each week you are expected to review the relevant sections in an introductory textbook, preferably from Knight or Giancoli. Each week you are expected to pick 3 problems from the CAPA assignment for 1110 (you will be given CAPA access or hardcopy of the HWs).
For the homework,

a) write a 1 paragraph / short outline of the physics content covered for the week.
b) Select 3 of the homework problems from the CAPA set for phys 1110 and:
    i. Solve the problem
    ii. Describe the solution process you used
    iii. Describe what physics content was needed from this section / other sections
    iv. Evaluate the problem: was this a good problem, mediocre problem, or a bad problem. Consider this problem both for content and pedagogical value.

Physics homework is due ***Thursday in class***.

Teaching / Fieldwork (your choice): You are expected to spend a minimum of 2-3 hrs per week teaching in, working in, or studying educational environments. Possible environments are listed later. Each week you will be expected to send in ethnographic fieldnotes describing your experience. These should be no shorter than a page or a page and a half (and no more than a few pages). The format for these notes is described below. These are ***due within 24 hrs of fieldwork***

Final Project: a final project of your choosing will be due at the end of term. The format of the final project is described below. Again, Graduate students are expected to conduct a more in-depth (lengthy) project and writeup.

Grading: This class will not emphasize grades, but rather learning, and formative feedback. Nonetheless I am obliged to provide you with grades in addition to credit. I anticipate everyone will be able to do well. In general, I emphasize effort and learning.
30% - readings / participation 30% physics content / participation 40% final project.

Field sites:

Below are a few options where you might consider doing your fieldwork. Of course, since you are designing this course you are encouraged to work in any environment suited for your examining educational practices in physics. See me about arranging for other placements of your design.

Formal Settings:

College / University:

** CU: 1110- Work with TA's / LA's in the Tutorials

* CU: 2010: Study student learning / help organize & run study of simulation use or laboratories

** CU 2170: Modern Physics for Engineers. Support clicker questions in lecture and help-room

** CU 3310: E/M (Jr. Level) work Tutorial Sessions in restructured E/M course.

High School:

* Boulder High - work with high school teacher on projects of interest

* Evergreen High – work with high school teacher on projects of interest

Informal:

**Partners in Informal Science Education in the Community (PISEC).

Opportunities for work with Middle School Students (Longmont); High School (BVCP), and elementary schools.

Also distance learning support of K- 8 project in San Diego.

Science Discovery – CU outreach –

Help organize/ run afterschool classes at 30th St. campus

Whittier Schools partnership – help revise Physics for Fun series

Science from CU – revise / implement 1 hour traveling programs

Saturday Wizards Program – design / run outreach activities (particularly for Spring)

Fiske Planetarium programs

There is now a binder of precollege fieldsites / instructions / directions and demographics. Please make use of this to find a site that is NOT at CU…

** - encouraged

* - existing partnerships

Fieldnotes:

Fieldnotes will serve as a key source of data for you for your final projects. In general, you will be acting as participant-observers, documenting educational environments you are engaged in. However, depending upon your projects you may simply observe environments. Both forms of observation are valid; though, it should be clear which role you are in. Your fieldnotes should be written within 24 hrs of your observation and turned in to me on a similar time-scale. Your fieldnotes should not be less than most of a page & should not be more than 3 pp (single spaced).

Heading:
Your name: J. Smith
Field Site: e.g. Problem Solving Session or Lecture
Instructor(s): who ever is lecturing or who ever is at the prob. solving session
Date: Tuesday, mm/dd/yy
Times of observations: 1pm – 2pm
Number of Students present: 25
Topics Covered: Homework #2

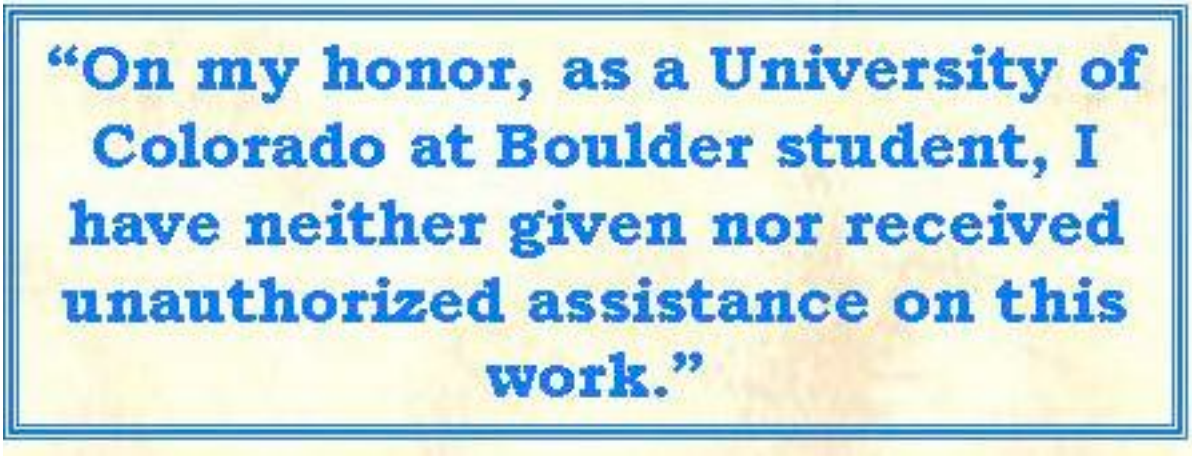
General Observation:
Here you are setting the scene for those who will read your notes. Describe the things you notice when you come in. Describe the general atmosphere, your state of mind (did you get stopped for speeding trying to get to site on time?), feelings expressed by others. This section describes the view from a wide angle. It should contain lots of observations about the site you enter and how you find your way in to the day's interactions. Your early notes should describe the people and physical spaces you encounter. In later notes, you should mark changes, things that are unusual. This section is usually about one paragraph long.

Narrative Description:
Here you are zooming in to your interactions with and observations of the students and other instructors at the site. Try to describe your interactions or observation of others as accurately as you can. Be careful to report behaviors rather than imputing your interpretation of the students thought process or mental state. In this sense you are capturing information (like a video camera would) without interpreting it. For example, "The students formed in 4 groups. Two of 5 and two of 6 students. Group 1 had 5 students. Two of the students are discussing the graph in problem 3, three are quiet. One student X, sat in the corner and refused to participate with his arms crossed" This is the longest section of the field note and contains several paragraphs. It should be as long as it takes you to describe your time at site. Each week we will focus your observations on a topic or question to make this manageable to describe.

Reflection:
Here you state your thoughts and opinions about what happened in the learning environment. This is where you would add your interpretation of key points in the narrative. It will be in this section that you might start thinking about the observed activities in terms of your project scope… What data support your project hypotheses etc? What have you learned about your own understanding and others'? You can bring in your background experiences or any information that helps frame your thoughts about the interactions at site.

Sundry Information / Thoughts:

Ethics: You should not cheat in this class. Frankly it will be easier if you do not and you'll learn more. If you cheat you'll fail. Collaborative work is encouraged. Citing your partner's work and sources that you draw from is necessary. Do not palagarize. If you are concerned about what this means, speak to me. More information is at:
http://www.colorado.edu/academics/honorcode/Code.html



Accommodations for disability:
If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner so that your needs be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, and www.Colorado.EDU/disabilityservices

Disability Services' letters for students with disabilities indicate legally mandated reasonable accommodations. The syllabus statements and answers to Frequently Asked Questions can be found at
www.colorado.edu/disabilityservices

More Ethics: Go Vote. Really. Vote.

From Steve Pollock's 2004 website yet impressively relevant (and I wholly concur):
"I firmly believe that we can take individual actions that will make the world we live in a better place. One obvious thing YOU can do is vote. Here is a link to some information if you haven't registered (http://www.colorado.edu/physics/phys1120/phys1120_fa04/vote.html). I know it's so easy to blow this off, and yet almost equally simple to register and vote. The number of young people voting has gone down over time, but it's YOUR life and YOUR future that are impacted. Take a stand! Convince your friends to participate! I would never consider suggesting which way you should vote - but WOULD ask that you use the powers of critical thinking, reasoned argument, inference by evidence, and basic logic you learn in physics and apply them to issues of political significance. (Which means, among other things, don't just listen to your parents, or one TV channel) Dig a little, think about what matters, make rational and ethically sound decisions. Argue and discuss, groupwork helps everywhere in life, not just in physics class. And then vote, it's empowering!"

Phys 4810/7810: Final Project Overview

Purpose: to have you explore in depth a topic of your choosing, relating to teaching and learning in physics. The projects should be challenging, fun, and allow you to explore an area of your interest.

Topic: I encourage you to be creative. There is no set form to these final projects There are no set topics. Examples of reasonable final projects are: a traditional research paper, the design and write-up of some activities for your students, or a research study where you collect data on some area of physics education that interests you.
Some basic guidelines are below. However, as necessary, these too are flexible. Just be certain to check with me about your project.

Length: 10 pages (double spaced). Graduate Students are expected to be 20 pages. Your work must be **typed**. This may be the only inflexible rule. Don't forget a **spell checker** please.

Due date: No later than Noon, December 12, 2005. In my office.

Structure: Your projects will vary, but below I give some general guides for a research study, where you might collect data from the field:

Introduction:- states the problem or area of exploration
- list your research questions and hypothesis **
**(PURPOSE OF DATA COLLECTION)
- gives a summary of your paper

Background: - locates your topic in relevant literature
- gives a history of your field-site / working environment

Body: Data: - how were your data collected
- what difficulties were there in your data collection (why / when was is possible to collect data and why/when not) - were you able to prove your hypothesis?
- presentation of collected data -- e.g. fieldnote excerpts, taped conversation pre-post test data, etc. Make sure this is an orderly presentation.

For bulk data, include an appendix, rather than inserting volumes of data into the body. (e.g. if you developed sample homework problems it is okay to put one or two into the paper, but include the 50 or so used in an appendix)

Analysis/Results/Discussion:
- what results do your data suggest
- how does this prove/ disprove your hypothesis
- how does this support or refute alternative theories

Conclusion/ Summary:
- summarize your paper / work
- what future directions does this research point to --- if you were to continue the project what would you do next / recommend to others

As I mentioned in class there are many ways to approach the final project. If you have any questions feel free to contact me, I'm always eager to discuss your projects.

Tentative Schedule *Readings/ Content Coverage*

This schedule will be updated as we continue through the course. ***You have significant say in what happens when.*** NOTE this page will be updated on the WEB to reflect our current collective understanding. To begin, I propose something like the following:

Week	Tues Readings	Thurs Mechanics Content
1) 8/25	**Introduction: State of Affairs**	**Introduction** Introduction / preface to your physics text & Concepts of Motion, x,v,a: Knight: vii – xvii & Chapter 1
2) 9/1	**Survey of Field** TP: pp 5- 15 McDermott I Van Heuvelen	**Kinematics & 1-D Vectors:** Knight: Chap 2& beginning of 3
3) 9/8	**Content-based research:** TP: pp 115 – 123; 146 - 152 Tutorials: McDermott II Instructional strategies: Mazur Ch 2	**Vectors, & 2-D kinematics** Knight: 3 parts of Chap 6
4) 9/15	**Constructivism:** TP: Chap 2 (over the next 4 weeks) pp 30-36 and 40-42; 124 -141 Posner: (grads) Constructionism - Papert	**Forces:** Knight Chap 4
5) 9/22	**Knowledge in Pieces:** TP: Chap 2 18-29 and 42-43; 142-146 Changing Minds – diSessa; <or> Knowledge in pieces	**Dynamics & Forces & N3** Knight Chap 5, 6, 8.1-8.3
6) 9/29	**No Class – Rosh Hashannah**	**Situated Cognition & Context:** TP: cont ch 2 pp 29-30 and 36-40; pp 69-80; Brown, Collins, Duguid: Heller: Group problem solving; <or> Mestre: Problem Posing
7) 10/6	**Hidden Curriculum: Attitudes & beliefs:** TP: ch 2 43 – 50; chap 3 pp 51 – 68; Elby & Hammer (grads) Elby	**No class Yom Kippur**
8) 10/13	**Assessment**	**Conservation of Momentum**
9) 10/20	**Problem Solving:**	**Energy, Conservation of E and W**
10) 10/27	**Inclusion (gender / race)**	**Work and KE**
11) 11/3	**Context**	**Rigid Body Rotation**
12) 11/10	**Progressivism (history /politics); Society**	**Gravity**
13) 11/17	**Technology**	**Oscillations**
14) 11/24	**(gobble)**	**(gobble gobble – No Class)**
15) 12/1	**Representations/ Analogies etc…**	**Fluids**
16) 12/ 8	**presentations**	**presentations (party)**

Other topics: Order-of-magnitude physics; More on any area above; Labs; Homework; Content-specific topics (e.g. student reasoning about electric fields); areas of your interest.

Reading References:

The following readings are references to those listed above, **NOT** all of the readings for a week. Readings will be on the website.

Week 2:

McDermott I: McDermott, "How We Teach and How Students Learn - A mismatch?" AJP 61(4), (1993), p295,

Van Heuvelen, A., "Learning to think like a physicist: A review of research-based instructional strategies", Am. J. Phys. 59 (1991) 891-897.

Week 3:

McDermott II: [one of following]

D. E. Trowbridge and L. C. McDermott 'Investigation of student understanding of the concept of velocity in one dimension,'', Am. J. Phys. 48, 1020 – 1028 1980 .
D. E. Trowbridge and L. C. McDermott "Investigation of student understanding of the concept of acceleration in one dimension, , Am. J. Phys. 49, 242 – 253 1981.
L. C. McDermott, M. L. Rosenquist, and E. H. van Zee,
'Student difficulties in connecting graphs and physics: Examples from kinematics,'' Am. J. Phys. 55, 503 – 513 1987
McDermott, and Shaffer, "Research as a guide for curriculum development: an example from introductory electricity Parts I&II" AJP 60(11), (1992), 994-1013

Mazur, *Peer Instruction* Chapter 2

Week 4

Posner, G.J,Strike, Hewson and Gertzog, "Accommodation of a Scientific Conception: Toward a Theory of Conceptual Change," Science Education 66(2), 211-227 (1982).

Papert, S, "Situating Contructionism," in Harel and Papert, Constructionism, Ablex, (1991), 1
http://www.papert.org/articles/SituatingConstructionism.html

Week 5:

diSessa, A.A. *Changing Minds*, MIT Press pp 89 –99 ---- or -----
diSessa, A.A., "Knowledge in Pieces," in Forman and Puffall Constructivism in the Computer Age, Hillsdale NJ: Lawernce Erlbaum (1988).

Week 6:

Brown, Collins, Duguid, "Situated Cognition and the Culture of Learning," Educational Researcher, Jan - Feb 1989, 32-42

Patricia Heller, Ronald Keith, and Scott Anderson, Teaching problem solving through cooperative grouping. Part 1: Group versus individual problem solving, AJP 60(7), 627- 644

Mestre et al, Collaborative Group Techniques, http://umperg.physics.umass.edu/resources/cgt

Week 7:

Elby, A. & Hammer, D. (2001). On the substance of a sophisticated epistemology. Science Education, 85 (5), 554-56
http://www2.physics.umd.edu/~elby/papers/epist_substance/Substance.html

A. Elby (2001, to appear), Helping physics students learn about learning, American Journal of Physics (Physics Education Research Supplement), 69(7SUPP1)
http://www2.physics.umd.edu/~elby/papers/epist1/epist_curric.htm

Additional Reading Resources:

A host of papers are available on the web. The university of Maryland group strives to keep an somewhat up-to-date list of papers:
http://www.physics.umd.edu/perg/perow.htm

R.R. Hake, "Interactive-engagement vs traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses," Am. J. Phys. 66, 64-74 (1998)

L.C. McDermott and E.F. Redish, "Resource Letter PER-1: Physics Education Research," Am. J. Phys. 67, 755-767 (1999)