PHYS 5274
Physics Pedagogy
Fall 2014

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Schedule: F 12 -1:50pm

Office Hours: TBA

Prerequisites: none

Course Text: The text will consist of a series of readings that will be provided.

Course Coverage: Teaching methods for introductory courses and labs will be discussed, as well as teaching methods in general, including working with groups, student-centered pedagogy, discovery and inquiry-based methods, grading and other pedagogy. We will also read physics education research papers, in order to inform you of the science of teaching.

The Nature of the Course: Students will discuss the content and pedagogy of the laboratories and recitations they will be teaching, discussing teaching methods relevant to the materials, working through portions of laboratory and the recitation materials in order to illustrate instructional methods, pointing out areas of student difficulty, why the materials have been developed the way they are developed based on physics education research. Students will observe each other teaching, using the Reformed Teaching Observation Protocol (RTOP) and discuss the outcome of the observations. There will also be time allotted for discussion of issues of grading, course administration and other topics.

Expected Learning Outcomes:

1) Students will be able to teach research-based laboratories and recitations effectively.

2) Students will be able to demonstrate their understanding of the nature of the materials, including the use of research-based materials, modeling, effective pedagogy for teaching physics concepts and calculations, and interpretation of data, both in class and while teaching.

3) Students will understand various pedagogies, such as how to use interactive engagement, student-centered pedagogies and other teaching techniques.

4) Students will be able to develop and grade physics problems by a rubric, especially problems that require students to explain their reasoning and physics problems that require both conceptual and quantitative responses.

Methods for Assessing Expected Learning Outcomes:

1) Students will be observed teaching introductory physics laboratories or recitations.

2) Students will use a rubric to observe other students teaching.

3) Students will be evaluated on their discussion of the readings.

4) Students will be evaluated on their discussion of different teaching techniques in class.

5) Students' grading of undergraduate students' physics papers will be evaluated.

6) Students will be evaluated by examination and quizzes.

Partial List of Readings

1. Arnold B. Arons, "Student patterns of thinking and reasoning Part 1," Phys. Teach. 21, 576 (1983).
2. Arnold B. Arons, "Student patterns of thinking and reasoning Part 2," Phys. Teach. (1984).
3. Arnold B. Arons, "Student patterns of thinking and reasoning Part 3," Phys. Teach. 22, 88 (1984)
4. American Association of Physics Teachers, "The Goal of Introductory Physics Laboratories," http://www.aapt.org/Resources/policy/goaloflabs.cfm, viewed August, 2013.
5. Arnold B. Arons, Guiding insight and inquiry in the introductory physics laboratory, Phys. Teach. 31, 278 (1993).
6. L.C. McDermott, "Guest Comment: How we teach and how students learn—A mismatch?" *Am. J. Phys.* **61** , 4, 295 (1993).
7. R.R. Hake, "Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses," *Am. J. Phys.* **66** , 64-74 (1998).
8. 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).
9. 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).
10. L. C. McDermott and P. S. Shaffer, "Research as a guide for curriculum development: An example from introductory electricity. Part I: Investigation of

student understanding," *Am. J. Phys.* **60** , 994 (1992); Erratum: *Am. J. Phys.* **61** , 81 (1993)
11. P. S. Shaffer and L. C. McDermott, "Research as a guide for curriculum development: An example from introductory electricity. Part II: Design of instructional strategies," *Am. J. Phys.* **60** , 1003 (1992).
12. F. Reif, "Millikan Lecture 1994: Understanding and teaching important scientific thought processes," *Am. J. Phys.* **63** , 17-32 (1995).
13. A. van Heuvelen,"Learning to think like a physicist: A review of research-based instructional strategies," *Am. J. Phys.* **59** , 891-897 (1991).
14. Kathleen M. Koenig, "Effectiveness of different tutorial recitation teaching methods and its implications for TA training," Robert J. Endorf, and Gregory A. Braun, Phys. Rev. ST Physics Ed. Research 3, 010104 (2007).
15. Rachel E. Scherr, Rosemary S. Russ, Thomas J. Bing, and Raymond A. Hodges, "Initiation of student-TA interactions in tutorials," Phys. Rev. ST Physics Ed. Research 2, 020108 (2006).
16. D. Hammer, "More than misconceptions: Multiple perspectives on student knowledge and reasoning, and an appropriate role for education research," *Am. J. Phys.* **64** , 1316-1325 (1996).
17. David Hammer, "Student Resources for Learning introductory physics," *Am. J. Phys.* **68** No. SI, pp. S52-S59 (2000).
18. E.F. Redish, "Millikan Lecture 1998: Building a science of teaching physics," *Am. J. Phys.* **67** (7), 562-573 (1999).
19. D. Hammer and A. Elby, "Tapping epistemological resources for learning physics," *J. of Learning Sciences* **12** , 53-90 (2003).
20. P. Heller, R. Keith, and S. Anderson, "Teaching problem solving through cooperative grouping. Part 1: Group versus individual problem solving," *Am. J. Phys.* **60** , 637-644 (1992).
21. P. Heller, M. Hollabaugh, "Teaching problem solving through cooperative grouping. Part 2: Designing problems and structuring groups," *Am. J. Phys.* **60** , 627-636 (1992).
22. A. A. diSessa, "Toward an Epistemology of Physics," *Cognition and Instruction*, **10** (1993) 105-225.
23. A. A. diSessa, "Knowledge in Pieces," in *Constructivism in the Computer Age,* G. Foreman and P. B. Putall, eds. (Lawrence Earlbaum, 1988) 49-70.
24. Hunter G. Close, Paula R. L. Heron, "Research as a guide for improving student learning: An example from momentum conservation,' American Journal of Physics, Vol. 78, No. 9. (2010), pp. 961-969.
25. Frederick Reif, "Understanding and teaching important scientific thought processes," Journal of Science Education and Technology, Vol. 4, No. 4. (10 December 1995), pp. 261-282.
26. Schoenfeld, Alan H., "When good teaching leads to bad results: The disasters of 'well-taught' mathematics courses," *Educational Psychologist* 23:2 (1988) 145-166.
27. Michelene T. Chi, Paul J. Feltovich, Robert Glaser, "Categorization and representation of physics problems by experts and novices," Cognitive Science, Vol. 5, No. 2. (1981), pp. 121-152.

28. M. Chi , “From things to processes: A theory of conceptual change for learning science concepts,” Learning and Instruction, Vol. 4, No. 1. (1994), pp. 27-43.
29. Jill Larkin, John McDermott, Dorothea P. Simon, Herbert A. Simon, “Expert and Novice Performance in Solving Physics Problems,” Science, Vol. 208, No. 4450. (20 June 1980), pp. 1335-1342.
30. Edward F. Redish, J. M. Saul, R. N. Steinberg, “Student expectations in introductory physics,” American Journal of Physics, Vol. 66, No. 3. (1998), pp. 212-224.
31. Mestre, Jose, "Learning and instruction in pre-college physical science", *Phys. Today* 44:9 (1991) 56-62.
32. Arons, A. B., "Cultivating the capacity for formal reasoning", *Am. J. Phys.* 44 (1976) 834.

Grades: The grade will be weighted as follows:

Readings and class participation	25%
Quizzes	15%
Student Teaching Observations	15%
Evaluation of teaching	20%
Evaluation of grading	10%
Exams	15%

Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor’s office hours. Please note instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, you may contact the Student Disability Services office in 335 West Hall or 806-742-2405.