Department of Physics Course Syllabus
Michigan State University

Spring 2015
I. PHY 905: Introduction to Physics Education Research

Tuesdays & Thursdays 5:10pm – 6:00pm
118 Farrall Ag Eng Hall

Instructor	**Office Hours**
Vashti Sawtelle	Wed, 10a-12pm (Holmes)
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COURSE DESCRIPTION

This course is designed to help you to learn just what physics education research is about. Through examination of physics content, pedagogy and problems, through teaching, and through research in physics education, we will explore the meaning and means of teaching physics. We will gain a deeper understanding of how education research is done and how people learn. We will also explore how people understand key concepts in physics. This course is designed to be useful for all students, especially for those interested in physics, teaching, and education research.

COURSE GOALS

This course aims to develop understanding of physics education research, its history, and its current objectives. To this end, we'll focus on five key areas:

- Understanding the early motivation for physics education, and the background current topics build upon.
- Becoming familiar with the teaching and assessment practices developed and used by physics educators.
- Finding the key questions addressed by theories of science learning and the theoretical constructs that are useful in formulating such theories.
- Understanding knowledge of prominent theories of learning relevant to study of science learning.
- Developing an appreciation for understanding of student thinking and learning, valuing and questioning evidence about validity of major theories, and becoming reflective about one's own learning.

The course will engage us in analysis of personal and community beliefs about science thinking and learning, reading of relevant literature, local discussions, study of science thinking of students at various levels of schooling, formulation of evidence-based theories about science thinking and learning, and formulation and implementation of research questions and strategies.

COURSE REQUIREMENTS AND ASSESSMENT

The following are brief descriptions of the responsibilities and assignments that will help you meet the goals of this course. Requirements with (*) are described in detail on assignment handouts available on D2L. Further details about all assignments will be provided during class. Depending on how the course unfolds, some details may change. We will inform you of any changes in advance of the assignment due dates.

Course Participation

We expect all students to be active participants in every class meeting. There will be reading, thinking ("knowledge worrying"), and writing assignments in preparation for each class meeting. Some of this preparation will involve your participation in the discussion board on the course D2L website. 20% of your final grade will be based on your participation. To access the website, login to D2L using your regular MSU username and password. Click on the link to PHY 905. Course information, documents and the discussion board are available through this website.

Session Leadership*

As you are preparing for careers in which you are likely to be instructors, team leaders, and/or project designers this assignment involves the preparation and leading of discussion/activities for two class sessions. You will be working with partner(s) to prepare and lead sessions. 15% of your grade will be based on this activity.

Physics Content/Homework Analysis

We will be thinking deeply about not only how students learn, but what we are asking them to do in the learning process. Several weeks, we will review a set of the homework for the introductory physics classes at MSU. You are expected to pick 3 problems from the class/topic selection (guidelines will be provided in that week) and complete the following (20% of your grade):

a) write a 1 paragraph / short outline of the physics content covered for the week.
b) Select 3 of the homework problems from the LON-CAPA set for phys 1120 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. Put yourself into the place of a student and discuss how a student taking the class would view the problem.
    v. Evaluate the problem: was this a good problem, mediocre problem, or a bad problem. Consider this problem both for content and pedagogical value.

Teaching / Fieldwork (your choice)*

You are expected to spend a minimum of 2 hrs a week teaching in, working in, or studying educational environments. Possible environments are those you already teach in, or are interested in knowing more about. Several times throughout the semester 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 in a handout on D2L. This fieldnotes will make up 20% of your grade.

Final Project*

A final project of your choosing will be due at the end of term. The purpose of the final project is 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. 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. Guidelines for the final project (worth 25% of your grade) is described in a handout on D2L.

TENTATIVE SCHEDULE OF READINGS

This schedule will be updated as we continue through the course (see D2L!) ***You have significant say in what happens when.*** Here's a starting possibility:

Date	Topic, Readings	Assignments Due
	What is PER and where did it begin?	
Jan 13 & Jan 15	*Introduction* **An Introduction to Physics Education Research,** pp. 1 -10, Beichner	
Jan 20 & Jan 22	*Content Based Research – Schaffer & McDermott, Research as a guide for curriculum development: an example from introductory electricity Parts I&II" AJP 60(11), (1992), 994-1013* *Physics content analysis 1*	*Physics content analysis 1*
	How do people learn?	
Jan 27 & Jan 29	***Constructivism**,* *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).;* *Driver, R., Asoko, H., Leach, J., Scott, P., & Mortimer, E. (1994). Constructing scientific knowledge in the classroom. American Educational Researcher, 23(7), 5–12.* *Physics content analysis 2*	*Fieldwork placement done* *Physics content analysis 2*
Feb 3 & Feb 5	***Knowledge in Pieces*** *diSessa, A.A., "Knowledge in Pieces," in Forman and Puffall Constructivism in the Computer Age, Hillsdale NJ: Lawernce Erlbaum (1988)* *Physics content analysis 3*	*Fieldnotes 1*
Feb 10 & Feb 12	***Situated Cognition*** *Brown, Collins, Duguid, "Situated Cognition and the Culture of Learning," Educational Researcher, Jan - Feb 1989, 32-42* *Physics content analysis 4*	*Proposal for final project*

	What to do Students Learn in Physics?	
Feb 17 & Feb 19	***Symbolizing and Representing in Physics*** *Chi, M. T., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. Cognitive Science, 5(2), 121–152* *Ochs, E., Gonzales, P., & Jacoby, S. (1996). When I come down I'm in the domain state": Grammar and graphic representation in the interpretive activity of physicists. Interaction and grammar, 328–369.*	*Fieldnotes 2*
Feb 24 & Feb 26	***Hidden Curriculum: Attitudes & Beliefs*** *Elby, A. (2001). Helping physics students learn how to learn. American Journal of Physics, 69(S1), S54. doi:10.1119/1.1377283* *Brewe, E., Traxler, A., la Garza, de, J., & Kramer, L. H. (2013). Extending positive CLASS results across multiple instructors and multiple classes of Modeling Instruction. Physical Review Special Topics - Physics Education Research, 9(2), 020116. doi:10.1103/PhysRevSTPER.9.020116* *Physics content analysis 5*	*Draft outline/resources for final project*
	How do we assess what students learn?	
Mar 3 & Mar 5	***Assessment*** *Hammer, D. (2012). Challenges and possibilities of meaningful assessment in large lecture introductory physics. "Background Research Paper No. 40" for the National Study of Education in Undergraduate Science, University of Alabama, Tuscaloosa.* *Coffey, J. E., Hammer, D., Levin, D. M., & Grant, T. (2011). The missing disciplinary substance of formative assessment. Journal of Research in Science Teaching, 48(10), 1109-1136. Read pp. 1109-1113 only.* *Physics content analysis 6 – exam*	*Physics content analysis 6*
Mar 10 & Mar 12	***SPRING BREAK***	
Mar 17 &	***Problem Solving*** *D. P. Maloney, "An Overview of Physics Education Research on Problem Solving," in Getting Started in PER, edited by C. Henderson and K. A. Harper (American Association of Physics Teachers, College Park, MD, 2011), Reviews in PER Vol. 2, Read pp. 1-12.* *Heller, P., Keith, R., & Anderson, S. (1992). Teaching problem solving through cooperative grouping. Part 1: Group versus individual problem solving. American Journal of Physics, 60(7), 627–636.*	

Mar 19	*Physics content analysis 7*	*Physics content analysis 7*
	What role do student backgrounds play in learning science?	
Mar 24 & Mar 26	***Role of student identity in doing and learning science*** Carlone, H., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187–1218. *Hazari, Z., Potvin, G., Tai, R. H., & Almarode, J. (2010). For the love of learning science: Connecting learning orientation and career productivity in physics and chemistry. Physical Review Special Topics - Physics Education Research, 6(1), 010107. doi:10.1103/PhysRevSTPER.6.010107*	*Fieldnotes 3*
Mar 31 & Apr 2	***Role of culture and community in doing and learning of science*** *Saxe, G. (1988). Candy selling and math learning. Educational Researcher, 17(6), 14-21.* *Goertzen, R. M., Brewe, E., & Kramer, L. (2013). Expanded Markers of Success in Introductory University Physics. International Journal of Science Education, 35(2), 262–288. doi:10.1080/09500693.2012.718099*	
Apr 7 & Apr 9	***Inclusion & Teaching for Equity*** *Baker, D. (2002). Where is gender and equity in science education? Journal of Research in Science Teaching, 39(8), 659–663. doi:10.1002/tea.10044* *Kost-Smith, L., Pollock, S., & Finkelstein, N. (2010). Gender disparities in second-semester college physics: The incremental effects of a "smog of bias." Physical Review Special Topics - Physics Education Research, 6(2), 020112.* *Esmonde, I. (2009). Mathematics Learning in Groups: Analyzing Equity in Two Cooperative Activity Structures. Journal of the Learning Sciences, 18(2), 247–284. doi:10.1080/10508400902797958, Read pp 247 – 265.*	
	Besides content, what goals for learning do physics classes have?	
Apr 14 &	***Modeling*** *Hestenes, D. (1987). Toward a modeling theory of physics instruction. American Journal of Physics, 55(5), 440–454.* *Windschitl, M., Thompson, J., & Braaten, M. (2008). Beyond the scientific method:*	

Apr 16	*Model-based inquiry as a new paradigm of preference for school science investigations. Science Education, 92(5), 941–967. doi:10.1002/sce.20259*	*Draft of final project*
Apr 21 & Apr 23	***Argumentation*** *Jimenez-Aleixandre, M. P., Rodriguez, A. B., & Duschl, R. A. (2000). " Doing the Lesson" or" Doing Science": Argument in High School Genetics. Science Education, 84(6), 757–792.* *Passmore, C. M., & Svoboda, J. (2012). Exploring Opportunities for Argumentation in Modelling Classrooms. International Journal of Science Education, 34(10), 1535–1554. doi:10.1080/09500693.2011.577842*	
Apr 28 & Apr 30	***Projects & Presentations***	*Final Project Due*