Goals

In this course you will study and discuss recent developments in our understanding of how students learn physics. Emphasis will be placed on models of learning and teaching techniques which can be applied to the teaching of physics to university students. After completion of this course, you will have a have a better grasp of the issues and techniques pertaining to the teaching and learning of undergraduate physics.

Topics

The class discussion will concentrate on topics which are part of ongoing efforts in physics education. We will touch upon almost all of the topics, but not necessarily in equal depth. The list, especially the last two sections are negotiable in that if you collectively would like to discuss a different topic related to physics education, I will try to accommodate it. Please feel free to make recommendations for topics.

Section I: Development of Reasoning & Conceptual Understanding in Physics

We will discuss models and strategies which research suggests are most appropriate for conceptual change among college students and the learning theories which support these models.

Section II: Problem Solving in Physics

Problem solving in physics is often the focus of most university level physics courses. Our discussion will focus on some efforts to study and improve problem solving in physics.

Section III: Research-Based Instructional Methods

We will review a wide range of research-based instructional methods and models that have been used in undergraduate physics education and examine the pros and cons of each strategy.

Section IV: Assessment of Student Learning, Attitudes & Instruction

Assessment is the key to any curricular change. We will discuss several instruments that assess student conceptual understanding as well as attitudes in physics. We will also discuss instruments that can be used to assess the quality of instruction.

Section V: Teaching to Diversity

We will discuss how to address diversity in students' learning styles as well underrepresented groups in physics.

Section VI (Optional): Use of Technology in Learning & Teaching Physics

Computers and information technology has been playing an increasing role in teaching and learning physics. We will review literature on the role these tools play in learning physics.

Section VII (Optional): Effecting Change in Physics Departments

We will discuss the extent to which ideas and methods of physics education research are being assimilated in physics departments.

General Procedures

This course will operate in a discussion format. In some cases the class will discuss topics as a whole; in others, we will break into small groups to discuss topics and then each group will report back to the rest of the class. For this format to work everyone must come to class prepared. Assignments need to be completed before class begins.

Texts

There is no formal textbook for this course. However, there are some books that we will refer to quite often during the course. A list of these books will be placed on the course website and will be updated when necessary. If you are aware of any books that could be useful in this class, please let me know.

Readings

We will use a series of readings from reports, workshops and journals. These readings will be made available on the class website. In addition to the readings that will be used as the basis for discussion, several other documents will be used as reference materials.


**Class Participation**
Each of you can be called upon to contribute to the discussion at any time and it is essential that you do so in a meaningful way. Class participation is worth 15% of your course grade. Please complete the readings and be prepared to participate in these discussions.

**Weekly Reviews**
Independent reading will be an important part of this course. Each week (starting Week 2) you must submit a short review of material which falls into one of the following areas:

- a paper on physics or science education. Over the course of the semester, please make sure that you review at least one article from each of the following: The Physics Teacher, American Journal of Physics, European Journal of Physics, Physics Education, Journal of Research in Science Teaching, International Journal of Science Education. Web links to these journals are on the course website.
- a chapter in a book which discusses physics and/or university education,
- a teaching tool such as software, a videodisc or CD-ROM, or
- a World Wide Web site related to physics education.

By the end of the semester you must have completed at least two reviews from each of the last three areas above as well as one review from each of the journals listed in the first bullet. Recommended journals are listed on the course website.

Reviews are due by **5:00 p.m. on Friday** of each week of the semester except the first week. Each review is one page, single spaced with 1-inch margins and 12 point font (~2,000 characters). Please limit your reviews to this length. Reviews should be uploaded in PDF onto the website using the "File drop box" link under "Tools" on the left navigation bar on the course website. These weekly reviews are worth 30% of your course grade.

**Projects**
There will be major projects due on the dates indicated below. Each project is worth 10% of the course grade.

1st Project: **Philosophy of Teaching & Learning (individual)** Due Monday, February 2nd at 5:00 p.m., subsequently revised on Monday, March 2nd Monday, April 6th and finally on Monday, May 4th.

You will formulate and then continually revise your philosophy of learning and teaching physics. Your philosophy statement should continuously reflect the insights you have learned through this course.

2nd Project: **Analysis of a teaching technique or tool in terms of development of reasoning (collaborative)** Due Monday, February 16th at 5:00 p.m.

Select a teaching tool such as a textbook, lab manual, videodisc or CD-ROM. Use the ideas that are presented in the Workshop on Physics Teaching and the Development of Reasoning and related papers to analyze the effectiveness of this tool for teaching introductory physics at the undergraduate level.

3rd Project: **Annotated Bibliography (individual)** Due Friday, November 12 at 5:00 p.m.

Choose a theme in physics education research that interests you. It may or may not be related to topics which we have discussed in class. You will create an annotated bibliography of peer reviewed literature on the topic. The annotations will include a summary and critiques of each paper, not to exceed 50 words for each paper. The annotated bibliography may include papers that you have already discussed in the Weekly reviews, however they must be under a common theme.

4th Project: **Conceptual learning at different levels (collaborative)** Due Monday, April 20th at 5:00 p.m.

Choose a topic in physics that is taught in conceptual-based (e.g. P. World), algebra-based (e.g. General Physics), or calculus-based (e.g. Engineering Physics) courses, as well as an advanced undergraduate course. By analyzing the textbook presentation at each level compare and contrast how the presentations help students develop a conceptual understanding of the topic. The choice of topic should be discussed with the instructor.

**Final Project** Due Wednesday, May 13th at 5:00 p.m.

The final project is your opportunity to demonstrate what you have learned and the quality of your understanding. Thus, it should include information from all aspects of the course as well as the literature in physics education. For a final project you have two choices:

- **Creation of teaching materials (collaborative)** Develop some teaching materials that can be used in a physics class at the introductory level requiring about 4-6 hours of student activity. You should provide a complete description of what the students will do as well as references to any other instructional materials that they will need. In addition to the instructional materials, you should write a paper which connects your instructional design to the various topics that we have discussed throughout the semester. You are required to test the lesson that you design with a group of at least 5 students of the level for which the lesson is designed.
Completion of a small research project (collaborative) Design and complete a small research project related to learning and teaching of physics at the undergraduate level. The project needs to address issues which are discussed during class and must follow proper research techniques. The project should connect with readings and other materials that you have learned in this course. You will write a paper that connects this research with various topics that we have discussed throughout this semester. Your research project can involve either qualitative or quantitative research. Quantitative projects collect data from at least 30 participants. Qualitative projects collect data from at least 5 participants.

All projects will involve interactions with students or analyses of classroom interactions. Thus, you will need to start early. Proposals for projects must be discussed with the instructor no later than Monday, April 13th. The Final Project is worth 20% of your course grade.

Guidelines for Collaborations
- If an assignment is labeled collaborative, you may collaborate with one other student to complete the assignment. If you choose to collaborate, you and your partner will submit one assignment that represents both of your work. This assignment should represent about twice as much work as one you would have done by yourself.
- For a collaborative project both students will receive identical grades. You may not collaborate on two different projects with the same student.
- The materials that you submit for each project should represent a significant effort. You are not limited to paper and ink but may use any available resource including World Wide Web, audio - and videotape, digital audio and video, etc. You are encouraged to submit assignments electronically.

Grades Course grades will depend on all aspects of the class with the distribution listed below:

<table>
<thead>
<tr>
<th>Project/Activity</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Projects during Semester (4 Projects x 10%)</td>
<td>40%</td>
</tr>
<tr>
<td>Weekly Reviews (13 Reviews x 2%)</td>
<td>25%</td>
</tr>
<tr>
<td>Class Participation (15 Weeks x 1%)</td>
<td>15%</td>
</tr>
<tr>
<td>Final Project</td>
<td>20%</td>
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Other Related Activities You are strongly encouraged to attend the Physics Education Seminars that meet Friday, 10:30 – 11:20 A.M. in Cardwell 119. The seminar is somewhat informal. A schedule will appear on the Web soon. At least one Physics Colloquium this semester will focus on material related to physics education. This colloquium is scheduled for March 23rd. I will keep you informed of any other talks, colloquia or workshops on campus relevant to physics or science education that you might find interesting to attend.

K-STATE COURSE SYLLABI STATEMENTS

1. Statement Regarding Academic Honesty
Kansas State University has an Honor System based on personal integrity, which is presumed to be sufficient assurance that, in academic matters, one's work is performed honestly and without unauthorized assistance. Undergraduate and graduate students, by registration, acknowledge the jurisdiction of the Honor System. The policies and procedures of the Honor System apply to all full and part-time students enrolled in undergraduate and graduate courses on-campus, off-campus, and via distance learning. The honor system website can be reached via the following URL: http://www.ksu.edu/honor. A component vital to the Honor System is the inclusion of the Honor Pledge which applies to all assignments, examinations, or other course work undertaken by students. The Honor Pledge is implied, whether or not it is stated: "On my honor, as a student, I have neither given nor received unauthorized aid on this academic work." A grade of XF can result from a breach of academic honesty. The F indicates failure in the course; the X indicates the reason is an Honor Pledge violation.

2. Statements for Academic Accommodations for Students with Disabilities
Any student with a disability who needs a classroom accommodation, access to technology or other academic assistance in this course should contact Disability Support Services (dss@k-state.edu) and/or the instructor. DSS serves students with a wide range of disabilities including, but not limited to, physical disabilities, sensory impairments, learning disabilities, attention deficit disorder, depression, and anxiety.

3. Statement Defining Expectations for Classroom Conduct
All student activities in the University, including this course, are governed by the Student Judicial Conduct Code as outlined in the Student Governing Association By Laws, Article VI, Section 3, number 2. Students who engage in behavior that disrupts the learning environment may be asked to leave the class.