Physics Education
Physics 21:750:450/26:755:650

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. The class will largely depend upon your input. You will help create and direct the class.

Class Goals and Roles

Learning Objectives: Course-scale. By the end of the course participants will have:

- engaged as members of the physics education research (PER) community
- demonstrated (and externalized) a foundational understanding of the span of the field (PER theory, practices, curricula and key studies)
- enacted their skills at putting theory and experimental work into practice (in real educational settings)
- analyzed curricula and foundational studies in PER
- conducted original scholarly work
- defined areas of their own interest in the field

Student responsibilities:

- be active participation in and out of class.
- thoroughly conduct weekly homeworks (readings, reflections, physics content analysis, fieldwork, and fieldnotes)
- define, conduct and write-up a final project (project of your own design)
- monitor your own understanding and progress
- reach out to me if you have questions or concerns

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 office hours.

Logistics:

Class Meeting: Monday 6-9 pm in Smith 206
Instructor: Diane Jammula (diane.jammula@rutgers.edu)
Office Hours: Tu 1-2p, and by appointment in Smith 211

Texts:

- E.F. Redish, Teaching and Learning Physics Also available online for free: **http://www2.physics.umd.edu/~redish/Book/**
- Introductory Physics Textbook: College Physics, 2nd Ed. by Etkina

- Weekly readings on **Canvas**

Student Work / Expectations

There will be 3 types of regular work in this course: (1) readings/reflections on PER foundations theory and experimental studies, (2) review of PER curricula & review of traditional physics content, (3) practicum in teaching or research & fieldnotes.

1) **Theory Readings in PER:** The first half of class we'll be discussing readings on theory in PER. We'll be reading from Redish's book Teaching Physics and original sources that are on Canvas. You are to post at least 3 comments or responses to comments online for each paper by ***Sunday 5pm***. You are to review your colleagues notes on the reading and respond to one of the questions / comments or queries by ***Monday noon***. Also, 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. Submit this paragraph summary and 3 comments / questions on Canvas [The goal here is for you to have an annotated bibliography of readings and be prepared to engage in class]. While, I will lead the first week or few of readings, our operation may be handed over to you to lead the discussions for future classes. As you are interested, we will have students sign-up to lead the discussion once or twice over the course of the term. These weeks you should produce an online summary of the reading (1 paragraph to one page is fine), 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.

2) **Curricula & Pedagogy Analysis:** The second half of class we'll be analyzing physics curricula and pedagogy. There will also be readings about physics pedagogy for each class. You are to post at least 3 comments or responses to comments online for each paper on Canvas by ***Sunday 5pm***. You are to review your colleagues notes on the reading and respond to one of the questions / comments or queries by **Monday noon**. Write a paragraph summary of each paper/ reading, and list 3 questions, or points of interest that the paper brought up. Submit this paragraph summary and 3 comments / questions on Canvas. Again this is to provide you with an annotated bibliography and prepare you to engage in class.

   Also, we'll be grounding these curricula / pedagogy by covering the intro sequence of physics at the same time we are reading about student

learning. Our class will roughly parallel the University and General Physics calendar of topics. Each week you are expected to review the relevant sections in the introductory physics textbook College Physics 2nd Edition by Etkina. There may also be assignments to review student reasoning of course content. This may vary from analyzing student work, analyzing homework problems / approaches in the traditional or per-based curriculum. See the assignments page on Canvas to keep up on these.

3) **Teaching / Fieldwork (your choice):** You are expected to spend a minimum of ~3 hrs per week teaching in, working in, or studying educational environments. Possible environments are: introductory physics classroom (college or high school) or a different science classroom or setting with permission of the instructor. Each week you will be expected to send in ethnographic fieldnotes describing your experience. These should be no shorter than a page (and no more than a few pages). The format for these notes is described in detail and I provide an example of fieldnotes on Canvas. These are due within 24 hrs of fieldwork and submitted online. They are to be reviewed on Sunday nights (that is Week 1 ends Jan 20). You are expected to complete about a dozen high quality fieldnotes / site visits over the 15 week semester.

Final Project: a final project of your choosing will be due at the end of term. The format of the final project is described on Canvas. Projects may include: analysis of student work or classroom video/dialogue/fieldnotes to answer a research question; curriculum design based on tenets of PER; or a novel project with permission of the instructor. 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 we are 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. The rough / default weighting of grades will be based on:

25% Theory readings / participation (Monday 6-7:30)
20% Curricula & pedagogy analysis / participation (Monday 7:30-9:00)
25% Field work & fieldnotes
30% Final project and associated drafts
Yes, this is a lot of work. But rewarding. And all directed at your learning.

*The Readings and Analysis will fade as the semester moves on and you focus more on your projects.

Class Project Schedule:

Week 1: Introduction
Week 2: Identify preliminary fieldsite(s)
Week 4: Identify area of interest for project - Turn in 1 paragraph description
Week 7: Outline of project due
Week 10: Workshop on Projects
Week 14: Rough cut of final project due
Week 15: Last week -- project presentations

Additional Information / Thoughts:

I know I am demanding a great deal of you but also know you can succeed and thrive in this environment. I am here to support you in your studies and development. If you have any concerns please check in with me.

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 plagiarize. If you are concerned about what this means, speak to me.

Rutgers Academic Integrity Policy Academic Integrity: As an academic community dedicated to the creation, dissemination, and application of knowledge, Rutgers University is committed to fostering an intellectual and ethical environment based on the principles of academic integrity. Academic integrity is essential to the success of the University's educational and research missions, and violations of academic integrity constitute serious offenses against the entire academic community. Academic Integrity Policy: http://academicintegrity.rutgers.edu/academicintegrity-policy/

Disability Services Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, you must complete and submit the Registration Form, schedule and complete an intake meeting, and submit appropriate documentation. If your request for reasonable accommodations is approved, you will receive a Letter of Accommodations (LOA), which you should present privately to the instructor as early in the semester as possible. Accommodations are not retroactive and are effective only upon submission of the LOA to the instructor. Please begin the process by completing and submitting the Registration Form, Applying for Services, available at the website below.

- Applying for Services: https://ods.rutgers.edu/students/applying-for-services

- Documentation Guidelines: https://ods.rutgers.edu/students/documentationguidelines
- Letter of Accommodations (LOA): https://ods.rutgers.edu/myaccommodations/letter-of-accommodations
- Office of Disability Services (ODS) Suite 219, Paul Robeson Campus Center (973) 353-5315 odsnewark@rutgers.edu

Religious Holiday Policy Students are advised to provide timely notification to instructors about necessary absences for religious observances and are responsible for making up the work or exams according to an agreed-upon schedule.

Counseling Services Counseling Center Room 101, Blumenthal Hall, (973) 353-5805 or http://counseling.newark.rutgers.edu/.

Students with Temporary Conditions/Injuries Students experiencing a temporary condition or injury that is adversely affecting their ability to fully participate in their courses should submit a request for assistance at: https://temporaryconditions.rutgers.edu.

Students Who are Pregnant The Office of Title IX and ADA Compliance is available to assist students with any concerns or potential accommodations related to pregnancy: (973) 353-1906 or TitleIX@newark.rutgers.edu.

Gender or Sex-Based Discrimination or Harassment Students experiencing any form of gender or sex-based discrimination or harassment, including sexual assault, sexual harassment, relationship violence, or stalking, should know that help and support are available. To report an incident, contact the Office of Title IX and ADA Compliance:

- (973) 353-1906 or TitleIX@newark.rutgers.edu.
- To submit an incident report: http://tinyurl.com/RUNReportingForm.
- To speak with a staff member who is confidential and does NOT have a reporting responsibility, contact the Office for Violence Prevention and Victim Assistance: (973) 353-1918 or run.vpva@rutgers.edu.

Schedule of Topics and Possible Readings (In addition to textbooks):

Date	Topic, Readings
Week 1	*Introduction* **An Introduction to Physics Education Research,** pp. 1 -10, Beichner
Week 2	*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*
Week 3	***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.*
Week 4	***Knowledge in Pieces*** *diSessa, A.A., "Knowledge in Pieces," in Forman and Puffall Constructivism in the Computer Age, Hillsdale NJ: Lawernce Erlbaum (1988)*
Week 5	***Situated Cognition*** *Brown, Collins, Duguid, "Situated Cognition and the Culture of Learning," Educational Researcher, Jan - Feb 1989, 32-42*
Week 6	***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.*
Week 7	***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
Week 8	***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.*
Week 9	***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.*
Week 10	***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*
Week 11	***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*

Week 12	***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.*
Week 13	***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: Model-based inquiry as a new paradigm of preference for school science investigations. Science Education, 92(5), 941–967. doi:10.1002/sce.20259*
Week 14	***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*
Week 15	***Projects & Presentations***

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