PHYS 7685: Introduction to Discipline-based Education Research

Course Overview

Instructor:

Natasha G. Holmes Assistant Professor, Laboratory of Atomic and Solid State Physics, Department of Physics

Contact info:

Email: ngholmes@cornell.edu Office: 406 Physical Sciences Building Lecture: TR 10:10am - 11:25am, Clark Hall 294G Office hours: Tuesdays, 11:25am, Clark Hall 294G Required Reading: The ABCs of How We Learn, by Daniel L. Schwartz, Jessica M. Tsang, and Kristen P. Blair Online course information: On Blackboard: Phys 7685 Special Topics Holmes, N (8565_2017FA)

Course Description and objectives

The aim of this course is to introduce students to the topics, literature, and methods of discipline-based education research. By the end of the course, students will be able to:

- Describe the development and goals of discipline-based education research in post-secondary institutions
- Consider issues of ethics for working with human subjects in education research
- Draw on a number of fundamental results about how people learn to motivate or explain DBER studies
- Use results from research to design and evaluate classroom activities
- Discuss methods of studying learning including cognitive interviews, research-based assessments, and observations
- Evaluate the mechanisms and issues for encouraging adoption of research-based teaching methods in universities

Teaching and learning philosophy

There are many resources that can deliver facts and equations, but my role as an instructor is to help students develop skills that will support them in their future work and learning. As a researcher in physics education, my teaching philosophy is heavily shaped by research-based teaching and learning practices. In this course, we will use a 'flipped classroom' model, whereby students are given pre-reading assignments so that class time is reserved for deeper engagement, application, and problem-solving with the material. There will also be larger out-of-class activities that span multiple weeks. I distinguish learning from performing: performing is something that should be done well when being judged (or graded); learning often happens when something does not go right the first time, but we have an opportunity to reflect and improve. For that reason, I will provide several opportunities for students to revise and improve submitted work before being evaluated. I will treat our classroom as a community of practice and expect students to support each other in learning, provide constructive feedback when elicited, and ask for help and support.

Activities and grading

Throughout the course, students will engage in a number of in-class and out-of-class activities, including:

Reading education research articles and leading and participating in discussion of the readings

Students will be assigned 2-3 readings per week, which they will be expected to be prepared to discuss in class. Each student will be responsible for leading discussions about an assigned reading. Students are strongly encouraged to apply lessons from this course when facilitating in-class discussion.

Evaluating classroom activities or examples from research based on the learning mechanism being considered

Each week, there will be an out-of-class activity related to the assigned reading. These will be discussed in-class so each student can obtain feedback on their assignment. Students will be expected to come to class with a draft of the assignment, which they can then revise based on the in-class feedback, before submitting for instructor feedback.

Collecting and analyzing education research data

Throughout the course, students will collect and analyze data related to education research activities. These will include using a classroom observation protocol, conducting a cognitive interview, and developing a research-validated multiple-choice assessment item. Students will work in pairs on these projects (does not need to be the same pair each time).

Final portfolio, reflection, and presentation

At the end of the course, students will submit a final portfolio and reflection document that includes final versions of all submitted work throughout the course. These versions can be updated since obtaining instructor feedback or can be exact versions of previously submitted work. This portfolio should also describe some of the ways work was improved over the course. In the last two weeks of class, students will present a short summary of one of the course activities to the whole class.

Academic integrity

Each student in this course is expected to abide by the Cornell Code of Academic Integrity. "Any work submitted by a student in this course for academic credit will be the student's own work." While learning in the course will be collaborative, each student is expected to submit products that are their own. Students are encouraged to obtain and incorporate feedback, resources, or ideas from other sources, as long as appropriate credit is provided. We will impose the highest penalties permitted for violation of this policy. For further details see: http://cuinfo.cornell.edu/aic.cfm.

Activities and assignments schedule

R (Aug 22-25)				
 Tues: Overview of course and structure Concept map of DBER (what, why, and how?) Thurs: Discuss readings (Facilitation by NH) Peer discussion of ethics in education research 	• Ethics training	• Fri Aug 25		
t 1)				
 Tues: Discuss readings (student-led facilitation) Check in on course, structure, and out-of-class activity Thurs: Peer discussion of deliberate practice tasks Brainstorm research questions and methods about learning from deliberate practice 	 Take an existing classroom activity and: describe ways in which it does or does not provide deliberate practice modify it to add components of deliberate practice 	 Draft: Thurs Aug 31 Final: Mon Sept 5 		
tivism (Sept 5-8)				
 Iues: Discuss and synthesize readings (student-led facilitation) Thurs: Peer discussion of activities Brainstorm research questions and methods about learning from contrasting cases, generation, and just-in- time telling 	 Find existing classroom activities that do and don't involve elements contrasting cases, generation, and/or just-in-time telling and explain how they do, don't, or could be modified to 	 Draft: Thurs Sept 8 Final: Mon Sept 11) 		
Week 4: Identifying prior knowledge and misconceptions and developing conceptual understanding (ZPD) (Sept 11- 15)				
Tues: • Discuss and synthesize readings (student-led	• Find examples of research characterizing	 Draft: Thurs Sept 14 Final: Mon 		
	 (Aug 22-25) Tues: Overview of course and structure Concept map of DBER (what, why, and how?) Thurs: Discuss readings (Facilitation by NH) Peer discussion of ethics in education research 1) Tues: Discuss readings (student- led facilitation) Check in on course, structure, and out-of-class activity Thurs: Peer discussion of deliberate practice tasks Brainstorm research questions and methods about learning from deliberate practice tivism (Sept 5-8) Tues: Discuss and synthesize readings (student-led facilitation) Thurs: Peer discussion of activities Brainstorm research questions and methods about learning from deliberate practice tivism (Sept 5-8) Tues: Discuss and synthesize readings (student-led facilitation) Thurs: Peer discussion of activities Brainstorm research questions and methods about learning from contrasting cases, generation, and just-in- time telling nisconceptions and developing contrasting cases, generation, and just-in- time telling 	C(Aug 22-25)Tues:• Ethics training• Overview of course and structure• Ethics training• Concept map of DBER (what, why, and how?)• Ethics trainingThurs:• Discuss readings (Facilitation by NH)• Peer discussion of ethics in education research• Take an existing classroom activity and:1)Tues:• Discuss readings (student- led facilitation)• Take an existing classroom activity and:• Check in on course, structure, and out-of-class activity• describe ways in which it does or does not provide deliberate practice• Peer discussion of deliberate practice tasks• desirate practice omodify it to add components of deliberate practice• Discuss and synthesize readings (student-led facilitation)• Find existing classroom activities that do and don't involve elements contrasting cases, generation, and just-in- time telling anisconceptions and developing• Find examples of research characterizing studentTues: • Discuss and synthesize readings (student-led facilitation)• Find examples of research characterizing student		

	What is a cognitive	understanding of		
	Interview?	concepts in your		
	Inurs:	Design questions	• Draft: Thurs	
	Peer discussion of cognitive	• Design questions	Sept 14	
	Discussions	interview to		
	Discuss research studies on	mossure student		
	uisciplinary conceptual	understanding and		
	understanding	nrior knowledge		
		and identify		
		misconceptions		
Week 5: How people learn grab bag (Sep	t 18-22)			
Read two of the following:	Tues:	 Design and pilot 	 Draft: Thurs 	
 A is for analogy 	 Jigsaw discussion 	questions for the	Sept 21	
 S is for self-explanation 	(facilitated by NH)	cognitive interview		
 Q is for question-driven 	Thurs:			
 W is for worked examples 	 Peer discussion of cognitive 			
• E is for elaboration	interviews			
Week 6: Attitudes and motivation (Sept 2	25-29)			
• R is for reward	Tues:	 Design and pilot 	 Draft: Thurs 	
 X is for excitement 	 Discuss and synthesize 	questions for the	Sept 28	
 Y is for Yes I can 	readings (student-led	cognitive interview		
	facilitation)	 Evaluate two 		
	Thurs:	existing classroom	 Draft: Thurs 	
	 Discuss classroom activities 	activities in terms	Sept 28	
	for student motivation	of how they affect	 Final: Mon 	
	 Check in on cognitive 	student attitudes,	Oct 2	
	interviews	motivation,		
		belonging, or		
		identity		
week 7: Epistemology and resources (Oc	t 2-6)	. Commune of	Due ft. Thurs	
• D. Hammer, "Student resources for	Discuss and synthesise	• Summary of	• Draft: Thurs	
learning introductory physics, Am. J.	Discuss and synthesize	cognitive		
Priys., PER Suppl. 68, 552–559 (2000)	feading (student-ied	Interview	• Final: wed	
• Redish EF (2014) Oersted Lecture			00111	
2013: How should we think about	Create a general rule to define and distinguish terms			
NOW OUT SLUDENLS LINKER ATT J PHYS	(onistom ology is frames			
82(0):537-551.	(epistem-ology,-ic, frames,			
• Elby A (2001) Helping physics		-		
Phys 60(S1):SE4_S64				
Phys 69(31).334-364.	• Discuss cognitive interviews			
Week 8: Research methods: Diagnostic assessments of student learning Part I (Oct 11-13)				
 Reeves TD, Marbach-Ad G (2016) 	Tues: No class	Develop	Mon Oct 16	
Contemporary Test Validity in Theory	Thurs:	presentation	(presentations	
and Practice: A Primer for Discipline-		about an existing	due Tues Oct	
1		research-based	1	

 Based Education Researchers. <i>CBE</i> <i>Life Sci Educ</i> 15(1):rm1 Either: Scott M, Stelzer T, Gladding G (2006) Evaluating multiple-choice exams in large introductory physics courses. <i>Phys Rev Spec Top - Phys Educ Res</i> 2(2):20102. Hubbard JK, Potts MA, Couch BA (2017) How Question Types Reveal Student Thinking: An Experimental Comparison of Multiple-True-False and Free-Response Formats. <i>CBE Life</i> <i>Sci Educ</i> 16(2):ar26. Wilcox BR, Pollock SJ (2014) Coupled multiple-response versus free- 	 Discuss and synthesize readings (student-led facilitation) (optional additional reading) Adams WK, Wieman CE (2011) Development and Validation of Instruments to Measure Learning of Expert- Like Thinking. Int J Sci Educ 33(9):1289–1312. 	diagnostic assessment of student learning in your discipline (to be presented on in Week 9)	17 or Thurs Oct 19)		
response conceptual assessment: An example from upper-division physics. <i>Phys Rev Spec Top - Phys Educ Res</i> 10(2):20124.					
Week 9: Research methods: Diagnostic as	sessments of student learning Pa	rt II (Oct 16-20)			
 Articles on selected diagnostic assessment (see out of class assignment) 	Tues: • Diagnostic Presentations Thurs: • Diagnostic Presentations • Run open-response questions to sub-group and discuss process	 Convert cognitive interview question(s) into multiple-choice format 	• Draft: Wed Oct 25		
Week 10: Active learning and dealing with	n large lectures (Oct 23-27)				
 L is for listening and sharing T is for teaching Either: Freeman S, et al. (2014) Active learning increases student 	 Tues: Discuss and synthesize readings (student-led facilitation) 	 Describe how an existing large- lecture activity does/could incorporate 	 Draft: Thurs Oct 26 Final: Mon Oct 30 		
 performance in science, engineering, and mathematics. <i>PNAS</i> 111(23):8410–8415. Stoltzfus JR, Libarkin J (2016) Does the Room Matter? Active Learning in 	 Thurs: Peer discussion of large- lecture activities Run diagnostic multiple- choice questions 	 concepts from course so far Analyze data on multiple-choice questions 	• Mon Oct 30		
Iraditional and Enhanced Lecture Spaces, <i>CBE Life Sci Educ</i> 15(4):ar68.					
Week 11: Adoption of RBI at universities (Oct 30-Nov 3)					
• Either:	Tues:	• Collect and analyze	Collection (1		
 Brownell SE, Tanner KD (2012) Barriers to faculty pedagogical change: lack of training, time, 	 Discuss and synthesize readings (student-led facilitation) 	observation protocol data for	class): Thurs Nov 2		

Incentives, and tensions with professional identity? CBE Life Sci Educ 11(4):339?46.Thurs: Discuss different observation protocols and data collectiontwo different courses0Dancy M, Henderson C (2010) Pedagogical practices and instructional change of physics faculty. Am Phys 78(10):1056.• Discuss different observation protocol (either RIOT, COPUS, RTOP, or other ones I haven't heard of).• Discuss and synthesize readings (student-led facilitation)• Collect and analyze observation protocol (either RIOT, COPUS, RTOP, or other ones I haven't heard of).• Draft Summary: notocol (either RIOT, COPUS, RTOP, or other ones I haven't heard of).• Discuss and synthesize readings (student-led facilitation)• Collect and analyze observation protocol data for two different courses (continued)• Draft Summary: Mon Nov 13• Aguilar L, Walton G, Wieman C (2014) Psychological insights for improved physics teaching. Phys Trady 67(5):43-49.Thurs: • Discuss observation protocol data collection and analysis - compare data across courses and protocols• Collect and analyze observation protocol data for thurs Nov 9• Tanner KD (2013) Structure Matters: Twenty-One Teaching Stradegies to Promote Student Engagement and Cultivate Classroom Equity. Cell Biol facilitation)• Activity TBD • Final tradit of final reflections • Fiscult and synthesize readings (student-led facilitation)• TBDTues: • Discuss and synthesize readings (student-led facilitation)• Activity TBD • First draft of final reflections • Prepare final presentations and reflections• Week 14: Student presentations (Nov 27-Dct 1)				
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Additional topic suggestions (with possible readings):

Computer-based learning

• Finkelstein ND, et al. (2005) When learning about the real world is better done virtually: A study of substituting computer simulations for laboratory equipment. Phys Rev Spec Top - Phys Educ Res 1(1):10103

• Salehi S, Keil M, Kuo E, Wieman CE (2015) How to structure an unstructured activity: Generating physics rules from simulation or contrasting cases. 2015 Physics Education Research Conference Proceedings (American Association of Physics Teachers), pp 291-294.

Cognitive science and educational psychology

- Schoenfeld AH (1987) What's All the Fuss About Metacognition? Cogn Sci Math Educ:189.
- Bransford JD, Franks JJ, Vye NJ, Sherwood RD (1989) New approaches to instruction: because wisdom can't be told, pp 470–497.
- Nokes-Malach TJ, Mestre JP (2013) Toward a Model of Transfer as Sense-Making. Educ Psychol 48(3):184–207.
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Labs

- Holmes NG, Wieman CE, Bonn DA (2015) Teaching critical thinking. PNAS 112(36):11199–11204.
- Wieman C, Holmes NG (2015) Measuring the impact of an instructional laboratory on the learning of introductory physics. Am J Phys 83(11):972–978.
- Auchincloss LC, et al. (2014) Assessment of course-based undergraduate research experiences: a meeting report. CBE Life Sci Educ 13(1):29–40.
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How to measure learning?

- Bissonnette SA, et al. (2017) Using the Biology Card Sorting Task to Measure Changes in Conceptual Expertise during Postsecondary Biology Education. CBE Life Sci Educ 16(1):ar14.
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Demonstrations:

- Crouch C, Fagen AP, Callan JP, Mazur E (2004) Classroom demonstrations: Learning tools or entertainment? Am J Phys 72(6):835–838.
- Sokoloff DR, Thornton RK (1997) Using interactive lecture demonstrations to create an active learning environment (American Institute of Physics), pp 1061–1074.
- Miller K, Lasry N, Chu K, Mazur E (2013) Role of physics lecture demonstrations in conceptual learning. Phys Rev Spec Top Phys Educ Res 9(2):20113.
- Moll RF, Milner-Bolotin M (2009) The effect of interactive lecture experiments on student academic achievement and attitudes towards physics. Can J Phys 87(8):917–924.

ABC's chapters not included

- H is for hands on
- I is for imaginative play
- M is for making
- O is for observation
- V is for visualization
- Z is for Zzzs