University of California, San Diego – Winter 2022
CHEM 187 EDS 122: Foundations of Teaching and Learning Science

Instructors:	Nicole A. Suarez, nasuarez@ucsd.edu Dr. Stacey Brydges, sbrydges@ucsd.edu
Class Time:	Tuesdays and Thursdays 2:00-3:20 PM PT
Class Location:	SEQUO 147, but on Zoom until further notice https://ucsd.zoom.us/j/99566720871 Meeting ID: 995 6672 0871
Office Hours:	Nicole on Tuesdays 1:00-2:00 PM PT (using course Zoom link) or by appointment
Course Web Page:	Canvas

Special Accommodations:
If you have been given an Authorization for Accommodation (AFA) letter from the Office of Students with Disabilities (OSD), you must provide the instructor, your TA, and the OSD Chemistry Department Liaison with a copy of the letter before any accommodations will be provided. All exam scheduling will be coordinated by you and the instructor, with involvement from the OSD Liaison as needed. In order to guarantee accommodations, you must follow the guidelines established by the Instructor and/or Liaison. OSD exams will run concurrently with the scheduled exam.

CATALOG DESCRIPTION

CHEM 187. Foundations of Teaching and Learning Science. (Cross-listed with EDS 122.) Examine theories of learning and how they are important in the science classroom. Conceptual development in the individual student, as well as the development of knowledge in the history of science. Key conceptual obstacles in science will be explored. ***Prerequisites:*** CHEM 6c and CHEM 96. 4 credits.

COURSE OBJECTIVES

This course is designed to develop an understanding of the theoretical ideas related to how people learn scientific concepts and how best to approach teaching those concepts. Using a combination of current research from cognitive science, educational psychology, and evaluations of classroom interventions, students will explore a range of topics that relate directly to science learning. Course topics include: current cognitive models, perspectives on science learning, the impact of context on science learning, motivation for science learning, conceptual change, scientific literacy, and classroom inquiry.

GRADING PHILOSOPHY

This course will be delivered under a mastery performance framework whereby the course requirements are given a grade of unacceptable (U), acceptable (A), or target (T). With the exception of the professional attitude component, all course requirements

may be redone until the target standard is met. All work will be returned with feedback. Unsatisfactory work can be re-done until a grade of target is achieved.

Incomplete grades will be provided in special situations for students who require more time to improve all assignments to a target level than the quarter requires. The instructor reserves the right to assign ANY other grade as I see fit for students who do not provide satisfactory work.

COURSE REQUIREMENTS

Assessment	Occurrence	Approximate Percentage of Final Grade
Reflective Essays	Weekly	25%
Discussion Facilitation and Participation	Facilitation – twice during quarter	25%
Mock Lesson	Twice during the quarter	25%
Topic Paper	Second ½ of the quarter	25%

Reflective Essays
Students are required to complete a reflective essay focusing on at least one of the readings from each of the topics each week. These essays must be posted on Canvas Discussions pertaining to each week by Friday at 11:59 pm. Students must continue to attempt these formative assessments until they have been successfully mastered.

Discussion Facilitation and Participation
This class will be conducted in a seminar format where all members take responsibility for organizing and facilitating two of the class discussions. Discussion will be related to the reading assignment. By the beginning of class, the assigned facilitators will provide the group with a type-written outline to serve as a framework for discussion. The outline and subsequent discussion will focus on the most salient issues identified by the presenters. Presentation to the group may take many creative forms, but must include at least 2-3 questions for discussion. All class members are required to complete the assigned reading in advance. The discussion leaders will provide the framework and everyone is responsible for the content of the discussion.

In-Class Discussion Facilitation Rubric

I. Knowledge of the Topic	**U**	**A**	**T**
A clear outline of the reading is provided (handout).	**U**	**A**	**T**
The leader demonstrates a thorough grasp of the reading.	**U**	**A**	**T**
The discussion reflects the ideas/research in the reading.	**U**	**A**	**T**
The discussion expands on the general course topic.	**U**	**A**	**T**
II. Presentation/Discussion	**U**	**A**	**T**
The presentation/discussion is organized.	**U**	**A**	**T**
The leader encourages discussion by raising important issues/questions.	**U**	**A**	**T**
Class involvement is achieved.	**U**	**A**	**T**
Overall	**U**	**A**	**T**

Mock Lessons
During the quarter, students will work in groups to present two lessons (one asynchronous and one synchronous) designed to address a specific learning objective they observed or participated in during a science class (any topic and any grade level). The purpose of the presentation is to transition from an observer of science teaching to a designer of instructional materials and facilitator of science content to gain experience teaching a particular learning objective. Then to critique the mock lesson based on the course material. The same learning objective should be used for both lessons; however, the delivery and structure of material may be revised. Mock lessons are expected to be about 20 minutes.

Final Topic Paper
This paper allows each student to gain some depth related to one of the major topics introduced in this course. Using the provided readings as a starting point, students will construct a 5 – 7 page review using at least 10 references. This topic paper will explore the recent theoretical ideas related to a course topic of particular interest. References should be primary, empirical sources from peer-reviewed educational journals or books. Student writing should follow APA format (7th Edition).

Final Grading Rubric

	Essay Writing	**Discussion Facilitation**	**Discussion Participation**	**Student Presentation**	**Topic Paper**
Target					
Acceptable					
Unacceptable					

Grade	Student Characteristics
A+	All student activities demonstrate a degree of thoughtful consideration and creativity beyond the stated expectations (target). All student work is appropriate and on time. Discussion facilitation goes beyond the readings and demonstrates a deep understanding of the material. Discussion/weekly comments go beyond generating effortless responses. The topic paper is complete and demonstrates an understanding of the material beyond the weekly readings. The mock lessons demonstrate consideration and application beyond a simple correct answer. The quality of any group activity/discussion would be significantly less without this student's contribution and participation.
A	All student activities are graded acceptable. At least four of the activities demonstrate a degree of thoughtful consideration and creativity (target). All student work is appropriate and on time. Discussion facilitation summarizes readings and demonstrates a good understanding of the material. Discussion/weekly comments are thoughtful and helpful. The topic paper is complete and demonstrates a good understanding of the material discussed in class (target). The mock lessons demonstrate consideration and application of the material. The student's contribution and participation in any group activity is obvious.
B	All student activities are graded acceptable with at least two activities at the target level. Thoughtful consideration and creativity are obviously lacking in certain student projects. A majority, but not all, of student work is appropriate and/or on time. Discussion facilitation summarizes the most salient aspects of the readings and demonstrates a basic understanding of the material. Discussion/weekly comments typically demonstrate a minimal attempt at stimulating discussion. The topic paper is complete and demonstrates a basic understanding of the material discussed in class (acceptable). The mock lessons demonstrate basic preparation but a lack of consideration and/or application of the material (acceptable). The student's contribution and participation in any group activity is very limited.
C	All student activities are graded acceptable. A majority of student projects are lacking in thoughtful consideration and creativity. Most student work is not on time, is inappropriate, or is not completed at all. Discussion facilitation summarizes some of the salient aspects of the readings and demonstrates a minimal understanding of the material. Discussion/weekly comments demonstrate a minimal attempt at stimulating discussion. Student requires multiple attempts at mastery for most writings due to lack of effort. The topic paper is complete and demonstrates an understanding of some of the material discussed in class. The mock lessons demonstrate minimal preparation and a lack of consideration and/or application of the material. The student's contribution and participation in any group activity is minimal or nonexistent.
D	A maximum of one student activity is graded unacceptable. All student projects lack thoughtful consideration and creativity. Student work is significantly late (greater than 2 weeks) or not completed at all. Student relies on the instructor/other students to direct the content of the discussion facilitation and demonstrates a lack of understanding of the material. Student posts and discussion/weekly comments are generally not helpful to discussion. The topic paper is complete and demonstrates an understanding of a minimal amount of material discussed in class (acceptable). The mock lessons demonstrate minimal preparation and a lack of consideration and/or application of the material. The student's contribution and participation in any group activity is minimal or nonexistent.
F	A combination of any of the following are true: A) Two or more student activities were either not attempted or completed to the acceptable standards. B) The topic paper was either not completed or completed to the acceptable standards. C) The mock lessons were either not completed or completed to the acceptable standards. D) The discussion facilitation was either not completed or completed to the acceptable standards.

Tentative Course Schedule*

*This schedule is subject to change based on the needs of the class.

Date		Facilitator(s)	Discussion Topic	Science Focus	Readings	Assignments Due
January	4	N/A	N/A	N/A	N/A	N/A
	6	Nicole & Stacey	Introduction to Course; 5 Teaching Perspectives	N/A	N/A	N/A
	11	Nicole	Course Structure; Reading and Writing Scientific Articles	N/A	N/A	• NSTA Lesson Plan Activity (due Jan 13) • Week 2 Reflective Essay (due Jan 14)
	13	Nicole	First Principles	Physics	Linn, M.C. (2000). Designing the knowledge integration environment. *International Journal of Science Education, 22*(8), 781-796. Collins, A. (2002). How students learn and how teachers teach. In R.W. Bybee (Ed.), *Learning science and the science of learning* (pp. 3-11). Arlington, VA: NSTA Press.	
	18		Cognitive Perspectives on Science Learning	Chemistry	Bussey, T. J., Orgill, M., & Crippen, K. J. (2013). Variation theory: A theory of learning and a useful theoretical framework for chemical education research. *Chemical Education Research and Practice, 14*, 9-22. Scott, P., Asoko, H., & Leach, J. (2006). Student Conceptions and Conceptual Learning in Science. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education.* Lawrence Erlbaum. Dunbar, K. (2000). How scientists think in the real world:	• Week 3 Reflective Essay (due Jan 21)

					Implications for science education. *Journal of Applied Developmental Psychology, 21*(1), 49-58.	
	20		"Cold" Conceptual Change	Earth Science	Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education, 66*, 211-227. Smith, J. P., diSessa, A. A., & Roschelle, J. (1993). Misconceptions reconceived: A constructivist analysis of knowledge in transition. *The Journal of the Learning Sciences, 3*(2), 115-163. Vosniadou, S., & Brewer, W. F. (1992). Mental models of the earth: A study of conceptual change in childhood. *Cognitive Psychology, 24*(4), 535-585.	
	25		Socio-cultural Perspectives on Science Learning	Biology and Physics	Anderson, C. W. (2007). Perspectives on science learning. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education.* Lawrence Erlbaum. Collins, A., Brown, J. S., & Holum, A. (1991). Cognitive apprenticeship: Making thinking visible. *American Educator.* Brotman, J. S., & Moore, F. M. (2008). Girls and science: A review of four themes in the science education literature. *Journal of Research in Science*	• Week 4 Reflective Essay (due Jan 28) • Part 1 of Mock Lesson (due Jan 28)

					Teaching, 45(9), 971-1002.	
	27		The Role of Motivation and Affect in Science Learning	Nature of Science	Koballa, T. R., & Glynn, S. M. (2007). Attitudinal and motivational constructs in science learning. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education.* Lawrence Erlbaum. Mallow, J. (2007). Science anxiety: research and action. In J. J. Mintzes & W. H. Leonard (Eds.), Handbook of College Science Teaching (pp. 3-14): NSTA Press. Osborne, J., Simon, S., & Collins, S. (2003). Attitude towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.	
February	1		"Warm" Conceptual Change	Biology	Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research, 63*(2), 167-199. Sinatra, G. M., Southerland, S. A., McConaughy, F., & Demastes, J. W. (2003). Intentions and beliefs in students' understanding and acceptance of biological evolution. *Journal of Research in Science Teaching, 40*(5), 510-528.	• Week 5 Reflective Essay (due Feb 4) • Synopsis of Final Topic Paper for approval (due Feb 4)
	3		Scientific Reasoning	Biology	Zimmerman, C. (2000). The development of scientific reasoning	

					skills. *Developmental Review, 20*(1), 99-149. Lawson, A. E. (2005). What is the role of induction and deduction in reasoning and scientific inquiry? *Journal of Research in Science Teaching, 42*(6), 716-740.	
	8		The Role of Models and Modeling in Science Learning	Biochemistry	Coll, R. K., France, B., & Taylor, I. (2005). The role of models and analogies in science education: Implications from research. *International Journal of Science Education, 27*(2), 183-198. Treagust, D. F., Chittleborough, G., & Mamiala, T. L. (2002). Students' understanding of the role of scientific models in learning science. *International Journal of Science Education, 24*(4), 357-368. Orgill, M., Bussey, T. J., Bodner, G. M. (2015). Biochemistry instructors' perceptions of analogies and their classroom use. *Chemistry Education Research and Practice, 16*, 731-746.	• Week 6 Reflective Essay (due Feb 11) • Part 2 of Mock Lesson (due Feb 11)
	10		Problem Solving	Engineering	Taconis, R., Ferguson-Hessler, M. G. M., & Broekkamp, H. (2001). Teaching science problem solving: An overview of experimental work. *Journal of Research in Science Teaching, 38*(4), 442-468. Atkinson, R. K., Derry, S. J., Renkl, A., & Wortham, D. (2000). Learning from examples:	

					Instructional principles from the worked examples research. *Review of Educational Research, 70*(2), 181-214. Kalyuga, S., Chandler, P., Tuovinen, J., & Sweller, J. (2001). When problem solving is superior to studying worked examples. *Journal of Educational Psychology, 93*(3), 579-588.	
	15		Learning in the Laboratory	Physics	NRC. (2006). Laboratory experiences and student learning. In *America's lab report: Investigations in high school science* (pp. 75-115). Washington, DC: National Academies Press. Clough, M. P. (2002). Using the laboratory to enhance student learning. In R. W. Bybee (Ed.), *Learning science and the science of learning* (pp. 85-94). Arlington, VA: NSTA Press. Klahr, D. & Li, J. (2005). Cognitive research and elementary science instruction: From the laboratory, to the classroom, and back. *Journal of Science and Educational Technology, 4*, 217-238.	• Week 7 Reflective Essay (due Feb 18)
	17		Learning through Inquiry	Chemistry	Colburn, A. (2000). A primer on inquiry. Science Scope (March), 42-44. Bybee, R. W. (2002). Scientific inquiry, student learning, and the science curriculum. In R. W. Bybee (Ed.), *Learning science and the science of learning*	

					(pp. 25-35). Arlington, VA: NSTA Press. Volkmann, M. J., & Abell, S. K. (2003). Rethinking laboratories: Transforming cookbook labs into inquiry. *The Science Teacher, 70*(6), 38-41.	
	22		Challenges to Classroom Inquiry	Medicine	Klahr, D. & Nigam, M. (2004) The equivalence of learning paths in early science instruction: effects of direct instruction and discovery learning. *Psychological Science, 15*, 661-667. Kirschner, P., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75-86. Hmelo-Silver, C. E., Duncan, R. G., and Chinn, C. A. (2007). Scaffolding and Achievement in Problem-based and Inquiry Learning: A Response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99-107.	• Week 8 Reflective Essay (due Feb 25)
	24	Asynchronous Mock Lessons				
March	1	Work Day for Mock Lessons				
	3	Synchronous Mock Lessons				
	8	Synchronous Mock Lessons				• Draft of Final Topic paper for Peer Review (due in class Mar 10)
	10	Work Day for Final Topic				

			• Mock Lesson Experience Reflection (due Mar 11)
	17	No class (Final Topic Paper Due)	

TEACHING AND LEARNING DURING THE COVID-19 PANDEMIC

We, as instructors and members of the UC San Diego community, recognize that the COVID-19 pandemic is ongoing and continues to affect the well-being, employment, and family commitments of the students, faculty, and staff. We are committed to resilient teaching and want to support students by creating an equitable, inclusive, flexible, and accessible learning environment. Your safety, health, and well-being are our primary concern; we want to be a resource for you and support you in any way that we can. We encourage you to reach out to us with any questions or concerns. Additional wellness resources are listed on our Canvas course page.

CAMPUS SAFETY REQUIREMENTS AND EXPECTATIONS (excerpted)

Keeping our campus healthy takes all of us. You are expected to follow the campus safety requirements and pursue personal protection practices to protect yourself and the other around you. These include

Participate in the university's daily screen process.
Everyone must complete a Daily Symptom Survey to access a university-controlled facility.

Participate in the university's testing program.
All students are required to participate in the COVID-19 Testing program as required by their vaccination status:

- Unvaccinated students with approved exceptions must complete a COVID-19 test twice a week.
- Students who are fully vaccinated must complete a COVID-19 test once a week, for the first four weeks of the quarter.

Wear a well-fitted face covering that covers your nose and mouth at all times.
Everyone is required to wear face coverings indoors regardless of vaccination status. If you see someone not wearing a face covering or wearing it incorrectly, then kindly ask them to mask up.

Monitor the daily potential exposure report.
Every day the university will update the potential exposure report with building and some classroom information and the dates of exposure. Download the CA COVID Notify app to your phone to receive an alert if you have been potentially exposed to COVID-19.

Assist in the contact tracing process.

If you're contacted by a case investigator, it means you have been identified as close contact, please respond promptly. You must assist with identifying other individuals who might have some degree of risk due to close contact with individuals who have been diagnosed with COVID-19.

Contact the instructional team if you are impacted by COVID-19

Please note that due to the ongoing COVID-19 Pandemic, changes may be made in response to new developments and information.

UC SAN DIEGO POLICY ON INTEGRITY OF SCHOLARSHIP (excerpted)

Integrity of scholarship is essential for an academic community. The University expects that both faculty and students will honor this principle and in so doing protect the validity of University intellectual work. For students, this means that all academic work will be done by the individual to whom it is assigned, without unauthorized aid of any kind. Instructors, for their part, will exercise care in planning and supervising academic work, so that honest effort will be upheld.

Instructors' Responsibility
The Instructor shall state in writing how graded assignments and exams will contribute to the final grade in the course. If there are any course-specific rules required by the Instructor for maintaining academic integrity, the instructor shall also inform students of these in writing.

Students' Responsibility
Students are expected to complete the course in compliance with the instructor's standards. No student shall engage in an activity that involves attempting to receive a grade by means other than honest effort; for example:

- No student shall knowingly procure, provide, or accept any unauthorized material that contains questions or answers to any examination or assignment that is being, or will be, administered.
- No student shall complete, in part or in total, any examination or assignment for another person.
- No student shall knowingly allow any examination or assignment to be completed, in part or in whole, for himself or herself by another person.
- No student shall plagiarize or copy the work of another person and submit it as his or her own work.
- No student shall employ aids excluded by the instructor in undertaking course work or in completing any exam or assignment.
- No student shall alter graded class assignments or examinations and then resubmit them for regrading.
- No student shall submit substantially the same material in more than one course without prior authorization.

For the full UCSD policy, visit http://senate.ucsd.edu/Operating-Procedures/Senate-Manual/appendices/2. For additional information, visit the Academic Integrity Office (https://students.ucsd.edu/academics/academic-integrity/index.html).

Syllabus template, course structure, activities, and readings were graciously developed, shared, and/or suggested by Dr. Thomas Bussey, UC San Diego, Department of Chemistry and Biochemistry.