EDUC 267B

Science Education Curriculum & Instruction

Fall 2019

Course Information	
Curriculum and Instruction in Science Education Tuesdays 3:00pm- 5:50pm CERAS 308 (STEP Library) Science C&I Google Drive	
Instructor Information	
Kathryn Ribay *Ph.D. Candidate in Science Education* kribay@stanford.edu Office Hours: https://kribay.youcanbook.me	**Sara Dozier** *Ph.D. Candidate in Science Education* dozier@stanford.edu Office Hours: by appointment

COURSE GOALS

This course prepares pre-service teachers to plan science instructional segments that support learning for all students. To that end, teachers will:

- design lessons based on their understanding of students' competencies, backgrounds, and needs.
- design sequential, integrated learning segments and corresponding lesson plans that allow their students to develop competency in science practices and to gain and apply related conceptual understanding.
- analyze and assess the impact of their planning strategies and lesson implementation on student learning to adjust their instruction.

COURSE OVERVIEW AND THEMES

The process of teaching is more complicated than it may appear. Teachers make hundreds of decisions every day, though very few of the intricate details of teaching are visible to the common observer. In this course, you will explore a theoretical framework for effective science teaching and apply that framework to make instructional decisions. While the summer quarter of curriculum and instruction emphasized planning for instruction (knowing the students and knowing the science), this quarter will focus on designing learning segments for your students. During this quarter, we will work between theory and practice, and between individual aspects of teaching and the whole group learning.

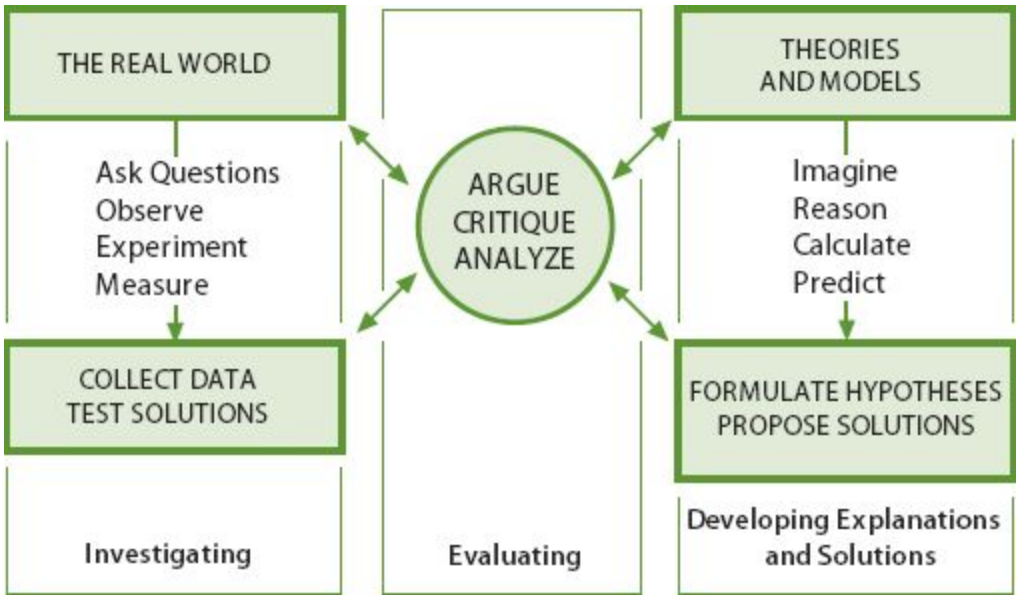
This course will differ from traditional science classes in which you typically "finish" a topic and move on. Instead, you will approach teaching and learning as an iterative process of planning learning segments, reflecting on their impact, and adjusting the instructional approach. This cyclical instructional approach will allow you to integrate your learning in the course with your experiences in your placement. Through weekly working sessions, we will strive to build strong connections between theory and practice through the following four themes:

Theme #1: *Teaching as Cyclical*
Teaching is a nested set of teaching cycles where you plan, teach and assess, analyze, and adjust, and plan again.

Theme #2: *The Planning Junction*
Decisions about teaching require an interrelated knowledge of students, subject matter, and the practical logistics of the classroom.

Theme #3: *Classroom Culture and Meaningful Participation*
Successful science teaching requires the development of a classroom culture that promotes the meaningful participation of all students. We will work on understanding what makes individual students tick and identify routines and policies that support a well-managed classroom

Theme #4: *Iterative Science Instruction*
Science is an ongoing process that builds and organizes knowledge about the universe. Observation, experimentation, model construction, and explanation, among other practices, are used to iteratively construct and revise our understanding. Teaching science should reflect the ongoing and provisional nature of professional science by encouraging students to continuously develop their own understanding.



Quinn, H., Schweingruber, H., & Keller, T. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. National Academies Press.

ASSIGNMENTS AND EVALUATION

	Assignment	Evaluation	%	Due Date*
1	Understanding Your Students	Credit/No Credit	10%	October 1, 2019
2	Reading Assignment 1	Credit/No Credit	5%	October 8, 2019
3	Reading Assignment 2	Credit/No Credit	5%	October 15, 2019
4	Video Analysis	Credit/No Credit	10%	October 22, 2019
5	Practicum Task A: Guided Inquiry	Credit/No Credit	10%	October 29, 2019
6	Practicum Task B: Data Logging	Credit/No Credit	10%	November 5, 2019
7	Formative Assessment	Credit/No Credit	10%	November 12, 2019
8	Plan for a Single Lesson	Rubric	10%	November 19, 2019
9	Series of Lesson Plans	Rubric	30%	December 10, 2019

*All assignments are due at 2:30pm on the due date. All due dates are Tuesdays, the day that class meets, with the exception of the final assignment.

ASSIGNMENT 1: Understanding Your Students

Goal: Demonstrate an understanding of your current students, including both general patterns in the class and specific characteristics of certain learners.

Excellent teaching requires that we truly understand our students. In this assignment, you will conduct a detailed analysis of your student population that will serve to help you design instruction to meet their interests and needs. Your report should include a **macro-level** analysis of general patterns in the class, as well as a **micro-level** analysis of two specific students of your choosing. In your description, explain how you gained the information you present. Be careful about making assumptions about students based on limited information.

Submission: Upload the completed assignment template to Canvas.

ASSIGNMENT 2: Theories of Learning

Goal: Summarize basic principles about theories of learning in a way that can help students to understand the purpose behind classroom learning segments.

The required Session 3 readings address basic theories about how students come to know. In response to these readings, you will design a way to explain basic ideas about learning to your students. (Think about the multiple forms of literacies that might be meaningful to your students.) Your product should explain key learning principles and illustrate them with practical examples of what you might have students do in the classroom, making the link to the theories explicit. Be sure to cite the research articles where appropriate (any citation format is fine as long as it is used consistently).

Submission: Upload to Canvas.

ASSIGNMENT 3: Reading the "Reading" Research

Goal: Formulate a position on the role of reading in science education and explore practical activities and structures for teaching reading.

The required Session 4 readings address research on reading in science education ("Language and Literacy"). In response to these readings, write a short reflection on both the theory and practice of reading in science education. It should contain two parts:

- A summary (approx. 250-300 words) of the role of reading in science teaching and learning that draws from the reading.
- A short description of four reading comprehension activities that you could use in your classroom. For each activity, briefly explain (1-2 sentences) how it will benefit students based on your summary about the role of reading.

Submission: Upload a single Word document containing both sections of the assignment to Canvas.

ASSIGNMENT 4: Video Analysis – Student Engagement versus Student Learning
Goal: Examine student engagement in a learning segment to identify and discriminate evidence of engagement and evidence of learning.

For this assignment, you will record a three to five-minute episode of your students engaged in science learning. You can record small group or whole group interactions. Using the assignment template, you will identify episodes of student interaction that constitute "engagement" on the part of one or more students (treat students individually rather than collectively). Support your analysis with transcribed excerpts of student talk as evidence and corresponding interpretations. You will also identify episodes of "learning," specifying what you think each student has learned. Again, you should support your analysis with transcribed examples of student talk as evidence and corresponding interpretations.

Submission: Bring your videoclip to class in a shareable fashion. Submit the completed assignment template to Canvas.

ASSIGNMENT 5: Practicum Task – Guided Inquiry
Goal: Design, implement, and reflect on a learning segment that allows students to engage in inquiry to explain a scientific phenomenon.

For this assignment, you will plan and implement a short learning segment (10 to 20 minutes) in your school placement. This learning segment should engage students in guided inquiry using science practices to explain a scientific phenomenon. The learning segment should include several phases:

- Prior to engaging in inquiry, students should have an opportunity to explain what they know about the phenomenon and concepts of interest.
- Then, the students should engage in some kind of practice-based inquiry in which they develop an understanding of concepts that will help them to explain the phenomenon. The students should not be provided with a step-wise set of instructions; neither should the learning segment be completely open-ended. Rather, the students should be given choices, but supported in ensuring that they develop the target understandings.
- After engaging in the experience, students should have an opportunity to explain what they have come to understand about the phenomenon of interest and how they came to that understanding.

For this assignment, you do not turn in a formal lesson plan. Instead, you will turn in a short description of the activity you planned, the element of a Science and Engineering Practice students worked toward, and a reflection on its implementation. Please ensure that you include enough information for the reader to understand what students did in the learning segment. If relevant, include links or copies of student materials, such as handouts.

Submission: Submit the completed assignment template to Canvas.

ASSIGNMENT 6: Practicum Task – Data Analysis
Goal: Design, implement and reflect on a learning segment that asks students to analyze data for patterns and make related predictions.

For this assignment, you will plan and implement a short learning segment (10 to 20 minutes) in your school placement. This learning segment should engage students in science practices to allow students to analyze data for patterns and make related predictions.

- Data collection could take many forms: students could analyze data they collected in small groups, students could share their data with the class and analyze the group's data set, or students could analyze a provided data set.
- Students should be supported in finding patterns and trends in the data. They might also analyze limitations of the data, such as anomalies.
- Finally, students are asked to ask a question or make a prediction that derives from the identified patterns and give associated reasoning.

For this assignment, you do not turn in a formal lesson plan. Instead, you will turn in a short description of the activity you planned and a reflection on its implementation. Please ensure that you include enough information for the reader to understand what students did in the learning segment. If relevant, include links or copies of student materials, such as handouts.

Submission: Submit the completed assignment template to Canvas.

ASSIGNMENT 7: Formative Assessment
Goal: Interpret data from a formative assessment in order to inform next instructional steps.

For this assignment, you will administer a formative assessment of your choice in your placement that helps you understand your students' progress towards the goals for understanding for the lesson. You should collect the work from your students and look for patterns in what they understand and what needs more support. Then, you should look at these results and determine next instructional steps for the class. For next steps, you should include both an overall instructional plan for the entire class and personalized next steps that you will take with at least two students. The template on Canvas will have suggestions for structuring your analysis.

Ensure that you have a record of your students' work that you can submit on Canvas to accompany your analysis. Any format is fine: photos/pdf, google document, etc. Make sure that you clearly mark the work of any student for whom you are suggesting personalized next steps.

Submission: Submit the completed analysis template and a single document that includes the work of all of your students.

ASSIGNMENT 8: Plan for a Single Lesson
Goal: Develop a plan for a single lesson that demonstrates understanding of standards-aligned planning, strategies for engaging students, and strategies for assessment.

In this assignment, you will write a plan for a single lesson (anywhere from 50 to 90 minutes, depending on your school's schedule). This plan will use a specific format that will be discussed and illustrated in class. (Note: This lesson plan may have differences from the one you are using in supervisory. For questions on lesson planning formats, talk to the instructors.) The plan should

include the following sections and sub-sections. Resources will be linked to the assignment description on Canvas by Week 6 to support your completion of this assignment.

Component		Evidence
1	What students will come to understand	Associated NGSS Performance Expectation and/or DCI/SEP/CCC
		A list of goals for understanding (GFU) for the learning segment
		Content and support vocabulary.
2	What students will do to reach the GFU	A sequence of activities
		A list of resources
3	How I will know what they understand	An assessment plan
4	Pacing guide	An agenda including timing for all activities
		A description of teacher and student actions

Please ensure that you include enough information for the reader to understand what students will do in the learning segment. If relevant, include links or copies of student materials, such as handouts.

Submission: Submit the lesson plan and any supporting materials to Canvas.

ASSIGNMENT 9: Series of Lesson Plans

Goal: to create a series of lesson plans that follow the model of Understanding by Design.
In this assignment, you will create a series of lesson plans that constitute three to five days of classroom instruction. The series of lesson plans should have the following components.

Section	Description
Description of Context	A detailed description of the learning context that addresses both the students and the science content you will address. ● Explanation of who your students are ● Description of the issues and resources available for the unit ● Rationales (why you want the students to know it and why the students would want to know it) with associated data to justify your statements.
An Essential Question	A driving question that the sequence helps to answer, in whole or in part. This could take the form of a "unit question" in Wiggins and McTighe.
Learning Goals	A set of science statements.
Assessment Scheme	Design a plan to assess your students' understanding of the lesson goals and describe the rationale for your plan.
Three Lesson Plans	Three lesson plans (each constituting 50-90 minutes of instruction). At some point in the series, you should engage students in ONE of the following. ● Guided inquiry using science practices to explain a scientific phenomenon. ● Analyzing patterns in data to make evidence-based explanations or predictions regarding real world events. Each lesson plan should include: ● What students will come to understand (GFU) ● What students will do to reach the GFU ● How I will know what they understand ● Pacing guide (See assignment 7 above for more details on the contents of lesson plans.)

Please ensure that you include enough information for the reader to understand what students will do in the learning segment. If relevant, include links or copies of student materials, such as handouts.

Submission: Submit the lesson plan series and any supporting materials to Canvas.

COURSE READINGS AND MATERIALS

Session 1: September 24, 2019

Required:

Milne, C. (2005). In praise of questions: Elevating the role of questions for inquiry in secondary school science. *Science as inquiry in the secondary setting*, pp 99-106. [7 pgs.]

Tolbert, S. (2016). Contextualizing Science Activity. In Lyon, E. G., Tolbert, S., Solís, J., Stoddart, P., & Bunch, G. C. (Eds). *Secondary science teaching for English learners: Developing supportive and responsive learning contexts for sense-making and language development*. Rowman & Littlefield (pp 59-78). [19 pgs.]

Session 2: October 1, 2019

Required:

Greenberg, D. (2017). Why Science Teachers Should Care about Social Justice. (PA) [4 pgs.]

Fay, M. E., & Bretz, S. L. (2008). Structuring the level of inquiry in your classroom. *The Science Teacher*, *75*(5), 38-44. (PA) [6 pgs.]

Windschitl, M. (2008). What is inquiry? A framework for thinking about authentic scientific practice in the classroom. *Science as inquiry in the secondary setting*, 1-20. (PA) [19 pgs.]

Session 3: October 8, 2019

Required for reading assignment:

National Academy of Sciences. (2018). *How People Learn II: Learners, Contexts, and Cultures*. Chapter 3: Types of Learning and the Developing Brain (pp. 35-55 and 67-68) Washington, DC: National Academies Press. https://doi.org/10.17226/24783 [20 pgs.]

Roth, W. M., & Jornet, A. (2013). Situated cognition. Wiley Interdisciplinary Reviews: Cognitive Science, 4(5), 463–478. https://doi.org/10.1002/wcs.1242 [16 pgs.]

Gargroetzi, E. C., Chavez, R. D., Munson, J., Langer-Osuna, J. M., & Lange, K. E. (2019). Can off-task be on-track? Phi Delta Kappan, 100(8), 62–66. https://doi.org/10.1177/0031721719846892 [5 pgs]

Supplementary:

NGSS Lead States. (2013). Appendix A: Shifts in the NGSS (PCD) [5 pgs.]

Colson, M., & Colson, R. (2016). Planning NGSS-Based Instruction: Where do you start? *Science Scope*, *39*(6), 50-53. [4 pgs].

Duncan, R. G., & Cavera, V. L. (2015). DCIs, SEPs, and CCCs, oh my! Understanding the three dimensions of the NGSS. *Science Scope*, *39*(2), 67-71. [5 pgs.]

Session 4: October 15, 2019

Required for reading assignment:

Glynn & Muth (1994). *Reading and Writing to Learn Science: Achieving Scientific Literacy.* Journal of Research in Science Teaching, 31, 1057-1073. [26 pgs.]

Osborne, J., Sedlacek, Q. C., Friend, M., & Lemmi, C. (2016). Learning to Read Science. *Science Scope*, *40*(3), 36-42. [8 pgs.]

Román, D., Briceño, A., & Basaraba, D. (2018). English Learners and the Complex Language of Written Science Texts. Science Scope, 42(3), 48–55. [8 pgs.]

Supplementary:

O'Reilly, T.; & McNamara, D. (2007) *The impact of science knowledge, Reading Skill, and Reading Strategy Knowledge on More Traditional "High-Stakes" Measures of High School Students' Science Achievement*. American Educational Research Journal, 44, 161-196.

Session 5: October 22, 2019

Required:

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas.* Washington: The National Academies Press. pp. 41-53 [14 pgs.]

Furtak, E. M., & Penuel, W. R. (2019). Coming to terms: Addressing the persistence of "hands-on" and other reform terminology in the era of science as practice. Science Education, 103(1), 167–186. https://doi.org/10.1002/sce.21488 [21 pgs.]

Inquiry and the 5E Instructional Model. [5 pgs.]

Supplementary:

Crawford, B. (2014). From Inquiry to Scientific Practices in the Science Classroom. In Lederman, N., Abell, K. (Eds.) *Handbook of Research in Science Education*. (pp. 593-613). [20 pgs].

Furtak, E. M. (2006). The problem with answers: An exploration of guided scientific inquiry teaching. *Science Education*, *90*(3), 453-467. [14 pgs.]

Session 6: October 29, 2019
No required readings

Session 7: November 5, 2019

Required:

Furtak, E. M., & Heredia, S. C. (2016). A virtuous cycle. *The Science Teacher*, *83*(2), 36-44. [8 pgs.]

Supplementary:

Bell, B., & Cowie, B. (2001). The characteristics of formative assessment in science education. *Science Education*, *85*(5), 536-553. [18 pgs.]

Session 8: November 12, 2019
No required readings

Session 9: November 19, 2019

Choose 1 (but recommend to take a look at both).

Windschitl, M., & Thompson, J. J. (2013). The modeling toolkit. *The Science Teacher*, *80*(6), 63-69. [7 pgs.] Bryce et al. (2016).

Exploring Models in the Biology Classroom. *The American Biology Teacher*, *78(*1), 35-42. [8 pgs.]

Choose 1

Biology:

Robertson, C. (2018). Using modeling to teach DNA replication. *The Science Teacher*, *85*(2), 47-53. [8 pgs.]

Chemistry:

Carroll, D. (2017). Modeling Periodic Patterns. *The Science Teacher*, *84*(6), 43-49. [7 pgs.]

Biology/Environmental Science:

Schlussel, A., Rhoades, A., Neiles, K. Y., & Elliott, S. L. (2018). Simulating Biomagnification to Illustrate Trophic Pyramids in the Middle School Classroom. *The American Biology Teacher*, *80*(5), 385-389.

Physics:

Breil, B. Y. B. (2018). Using a systems thinking approach to figure out why a ball drops, bounces, and stops. Science Scope, 42(4), 74–83. [10 pgs.]

Session 10: December 3, 2019

Required:

NGSS Lead States. (2013). Appendix D: Case Studies (Race and Ethnicity + One choice). [12 pgs.]

Morales-Doyle, D. (2017). Justice-centered science pedagogy: A catalyst for academic achievement and social transformation. *Science Education*, *101*(6), 1034-1038, 1043-1054. [18 pgs.]

Supplementary:

Bang, M., Warren, B., Rosebery, A. S., & Medin, D. (2012). Desettling expectations in science education. *Human Development*, *55*(5-6), 302-318.

Barton, A. C. (1998). *Feminist science education*. Teachers College Press. (Chapters 1 and 6).

Donovan, B. M. (2015). Reclaiming race as a topic of the US Biology textbook curriculum. *Science Education*, *99*(6), 1092-1117.

Braaten, M., & Sheth, M. (2017). Tensions Teaching Science for Equity: Lessons Learned From the Case of Ms. Dawson. Science Education, 101(1), 134–164.