ED 267C: CURRICULUM AND INSTRUCTION IN SCIENCE
COURSE SYLLABUS
Winter 2020

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 DESCRIPTION AND LEARNING GOALS:

In this third quarter of Curriculum and Instruction in Science Education, you will continue to study the practice and theory of science teaching and learning. As you prepare for the edTPA and continue to grow in the areas discussed in the summer and fall sessions, we will work from three perspectives:

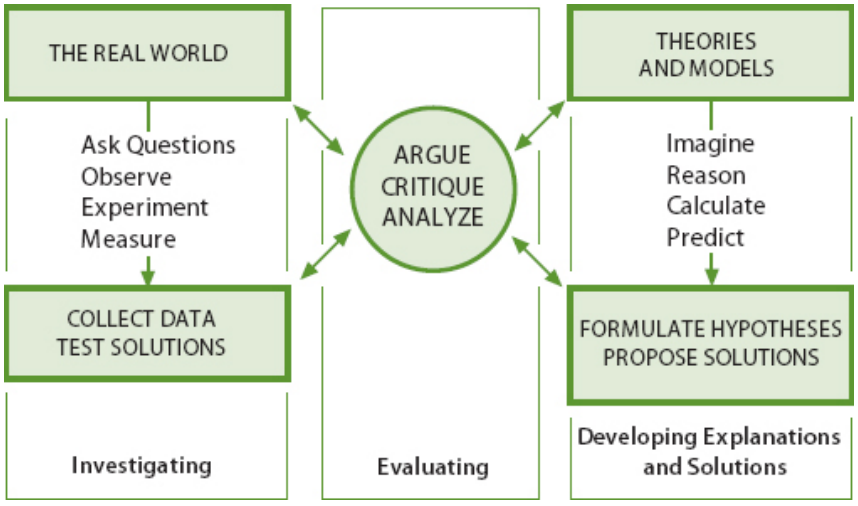
- ***Your Context:*** The very individual issues of **your** own teaching context, shaping **your** teaching, to help **your** students, in **your** school, to make progress and to achieve in science, i.e. for you to continue to make yourself into an effective science teacher.
- ***The Big Questions*** of Science Education: Beyond your own classrooms, at the national and even international levels so that you can tell your own story to answer the question "Why science education?"
- ***Science Practices:*** Integrating the Science and Engineering Practices into planning, instruction, and assessment in order to make sense of phenomena.

The Philosophy of Our Sessions
This quarter, we will focus on several themes: developing confidence as an instructor, continuing to plan for effective lessons, exploring how to create a cohesive unit plan, assessing student progress toward learning goals, and engaging in reflective practice around your own professional goals. During each session, we will highlight a particular aspect of science teaching, explore the theory underlying this aspect, and engage in specific strategies that you can use in your placement. Over the course of the quarter, you will develop a unit plan that follows the principles of Understanding by Design

(Wiggings and McTighe, 2005) and supports students in using the science and engineering practices to make sense of an anchoring phenomenon. To build your confidence and support your own reflective practice, you will record video of yourself teaching and work in reflective triads to set goals for your own growth and monitor your progress.

As part of this process, we will explore the Scientific and Engineering Practices. These are:

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information



Quinn, H., Schweingruber, H., & Keller, T. (2012). *A framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. National Academies Press.

Using this approach, we will follow this basic routine for every session:

1. Unpack one of the science and engineering practices.
2. Introduce at least one new strategy to support the implementation of the science practices.
3. Reflect on your progress toward your own professional goal in small groups. This may include video sharing and written reflection.
4. Design parts of your own NGSS-aligned unit plan.
5. Discuss the big picture purposes and goals of science education.

Reflecting on Practice

We believe that you become a better teacher by becoming a reflective practitioner (see Schön, D. A. (1987). *Educating the Reflective Practitioner*. San Francisco: Jossey-Bass). Reflective practice is enhanced by sharing your challenges with others, reflecting on them, and learning from your mistakes. Therefore, many class sessions will have an element where you will share your work (e.g. videos, written reflections, lesson ideas) with your peers and be asked to constructively reflect on the work of others.

Finally, this may be one of the few opportunities that you will have to think a little bit more broadly about some of the challenges of teaching science. Therefore, we will look at a few theoretical readings. While these may seem initially removed from your daily practice, they have guided much of the thinking about the conduct and practice of science education.

Support

Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Student Disability Resource Center (SDRC) located within the Office of Accessible Education (OAE). SDRC staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is being made. Students should contact the SDRC as soon as possible since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk (phone: 650-723-1066).

Preferred Name & Preferred Gender Pronouns

Class rosters are provided to the instructors with the student's legal name and gender designation; these records might not correspond to the name and gender pronouns you use. We will gladly honor your request to address you by your preferred name and pronouns. Please advise us of these preferences so we can make appropriate changes to our records. Please also let us know if these change at any point.

Stanford Honor Code

You are expected to follow the Stanford Honor Code. For an explanation of the Honor Code, please go to: https://communitystandards.stanford.edu/policies-and-guidance/honor-code.
If you have any questions about how it applies to a particular assignment, please ask.

COURSE GRADING SYSTEM

Course Expectations for Evaluation
Regular attendance in class is expected. If you are going to be absent, please let us both know in advance via email (kribay@stanford.edu and dozier@stanford.edu).

As usual, you should assume you have an A in this course, which is to say that the A is yours to lose. This acknowledges that:

- you are each here to gain as much understanding and skill as you can
- you learn at different rates and in different chunks
- you will have each gained at least the fundamental understandings and skills that we intend by course end

At each checkpoint for your final project, we will provide feedback on how to improve your plan. If checkpoint assignments are not submitted by the due date, you may not receive feedback. All assignments are due before the start of class on the date specified.

The grade for the course will be assigned on the basis of assignments as detailed below.

Contribution of Assignments to the final grade
There are five kinds of assignments this quarter:

Portion	**Assignment**	**Graded**
10%	Readings and annotated bibliography entry	Credit/No Credit
10%	Purpose of science education statement	Credit/No Credit
20%	Classroom video and commentary (2x10%)	Credit/No Credit
10%	Development of unit plan: Checkpoints	Credit/No Credit
50%	Final performance task: A curriculum unit	Criterion graded

REFERENCE TEXTS
(Found in STEP library and/or in prior C&I course materials):

Wiggins, G. P., & McTighe, J. (2005). *Understanding by Design* (Expanded 2nd ed). Alexandria, VA: Association for Supervision and Curriculum Development.

Keeley, P., Eberle, F., & Farrin, L. (2005). *Uncovering Student Ideas in Science, Vol. I: 25 Formative Assessment Probes*. Arlington: VA: NSTA Press.

Keeley, P., Eberle, F., & Farrin, L. (2007). *Uncovering Student Ideas in Science, Vol. 2: 25 Formative Assessment Probes*. Arlington: VA: NSTA Press.

Keeley, P., Eberle, F., & Farrin, L. (2008). *Uncovering Student Ideas in Science, Vol. 3: 25 Formative Assessment Probes.* Arlington: VA: NSTA Press.

Keeley, P. (2008). *Science Formative Assessment*. Thousand Oaks, California: Corwin Press.

National Research Council (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Available for free download at: http://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts

Achieve, Inc. (2014). *Next Generation Science Standards (NGSS).* Available for free download at: http://www.nextgenscience.org/next-generation-science-standards

California Science Framework: https://www.cde.ca.gov/ci/sc/cf/

ASSIGNMENTS OVERVIEW

#	NAME	DESCRIPTION	EVAL. TYPE	%	DUE DATE(S)
1	**Reading Assignments**	**Readings:** Each week there will be assigned reading(s). It is your responsibility to come to class prepared to discuss these readings. **Annotated bibliography:** You will write an annotated bibliography entry in the shared Google spreadsheet for the article you select in the first class. The summary will be due before class the following week.	Credit/ No Credit	10%	Ongoing
2	**Purpose of Science Education**	For this assignment, you will write a 250-500 word statement about why science education is important for secondary school students.	Credit / No Credit	10%	1/14
3	**Classroom Video and Commentary**	For these assignments, you will record 3-5 minutes of teaching; share it with your triad members, Kathryn, and Sara; discuss the video in class; and write a reflection.	Credit/ No Credit	20%	Video 1: Share 1/28 Reflection 2/4 Video 2: Share 2/18 Reflection 2/25
4	**Development of Unit Plan**	In this assignment, you will design a unit plan. At each checkpoint, we will provide feedback on parts of your unit plan. You will incorporate this feedback into your final project. Unit checkpoint 1: Unit overview, performance expectations, anchoring phenomenon, essential question, and enduring understandings. Unit checkpoint 2: Pre-assessment plan Unit checkpoint 3: Pre-assessment analysis Unit checkpoint 4: Performance assessment task draft, lesson sequence overviews Unit checkpoint 5: Lesson plan 1 draft Unit checkpoint 6: Lesson plan 2 draft Unit checkpoint 7: Lesson plan 3 draft In-class presentation	Credit/ No Credit	10%	Check 1: 1/21 Check 2: 1/28 Check 3: 2/4 Check 4: 2/11 Check 5: 2/18 Check 6: 2/25 Check 7: 3/3 Present: 3/10
5	**Final Task: Unit Plan**	Final project incorporating all sections above, revised to incorporate feedback.	Criterion Graded	50%	3/17

COURSE ASSIGNMENTS IN DETAIL

Assignment 1: Reading

Class readings *(Weekly)*
Each week there will be assigned reading(s). Class sessions will be structured around discussion and engagement with these readings. It is your responsibility to come to class prepared to discuss these readings.

Neither readings in the Understanding by Design text nor readings in the NGSS Standards documents are assigned again, as you read them in the prior quarters. It is, however, expected that your work will be based on these texts. Other reference texts have been suggested as a good source for relevant instructional practices.

Annotated bibliography (Due 1 week after class discussion)
Each student will select one article from the course reading list on January 7. After class on your assigned week, you will be responsible for writing an annotated bibliography entry for that article in the shared Google spreadsheet based on our discussion. Your entry will be due before class the following week.

Submission: Add entry to shared Google spreadsheet. Upload spreadsheet link to Canvas when complete.

Assignment 2: The purpose of science education (Due 1/14)

For this assignment, you will write a 250-500 word statement about why science education is important for secondary school students. Your audience may be students, parents, administrators, other staff, or community members. Your statement should draw on relevant readings and your own experiences. This document can serve as a blueprint for your future communications about the importance of your courses.

Submission: Upload document to Canvas.

Assignment 3: Classroom video and commentary

You will work in triads this quarter to set goals and share classroom video documenting your progress towards those goals. In planning lessons, it is possible to make the mistake of offering truly engaging activities that are entertaining, but do not enhance student progress toward the designated learning goals. Therefore, our goal is to maximize students' engagement, while also ensuring they are learning science.

In your groups, you will watch and discuss evidence of your students engaging in any of the scientific practices aligned to your individual goals. These videos should provide

evidence of you scaffolding and supporting their practice and monitoring their understanding.

Part 1: Share Video *(Video 1 due 1/28; Video 2 due 2/18)*
You will record video of your class, upload to Torsh Talent, create a 3-5 minute clip from that video showing a moment you would like feedback on, and add comments (as described below). On the weeks listed in the syllabus, you will share your 3-5 minute clip and comments with your triad members, Kathryn, and Sara prior to the start of class. During class you will watch each other's videos and discuss evidence of how students are making progress toward the lesson objectives and how you are making progress toward your goal for practice. Prior to sharing your video, create comments in Torsh Talent that respond to the following prompts:

1. Lesson objective: At the beginning of your video, add a time-stamped comment with "Lesson Objective" at the top and write your 2-dimensional lesson objective.
2. Your goal for practice: After the lesson objective comment, add a time-stamped comment with "My Goal" at the top and write the goal you are working toward in your own practice this quarter.
3. Intended learning: Identify a moment in your video where you noticed students making progress toward your lesson objective. Add a time-stamped comment at that moment with "Intended Learning" at the top. In this comment, describe your evidence that they are making progress toward your lesson objective.
4. My progress: Identify a moment in your video where you notice yourself making progress toward your own goal for practice. Add a time-stamped comment at that moment with "My Progress" at the top. In this comment, describe evidence that you are making progress toward your own goal for practice.
5. Question: Think about a question you have or feedback you would like from your group. At a relevant moment in the video, add a time-stamped comment with "Question" at the top. In this comment, ask for feedback about how you might move toward your goal for practice.

Part 2: Reflection *(Reflection 1 due 2/4, reflection 2 due 2/25)*
In a summary comment, address these prompts:

1. What progress town my own goal for practice did I show during this clip?
2. What are my next steps toward my goal? How will I enact them?

Submission: Submit the completed assignment via Talent by sharing with Kathryn and Sara and submitting a link to the video on Canvas.

Assignment 4: Development of Unit Plan

In this assignment, you will design a unit plan according to the principles of Understanding by Design. The curriculum unit should be patterned after, but not limited to, the model developed by Wiggins and McTighe (2005), both in process and in content. This task is both a learning and an assessment task in C&I. It is not intended that you complete this on your own and hand it in, de novo, at the end of the quarter. We have

scaffolded this large task by creating checkpoints throughout the quarter. At each checkpoint, we will provide feedback on parts of your unit plan. You will incorporate this feedback into your final project. The purpose of this revision and feedback is that by the time the unit is presented as a whole, summative project, you will have learned a lot about planning for learning through discussion and revision.

Unit checkpoint 1 *(Due 1/21)*:

- **Unit overview:** This set of two slides includes a description of the learning context that addresses both the students and the science content you will address; an explanation of who your students are; the teacher rationale for why you believe students should learn this material; and the student rationale for why you think students would be excited to learn this material and how it is relevant to their lives.
- **Performance expectations:** This slide lists all performance expectations you intend to assess over the course of the unit and the associated foundation boxes.
- **Anchoring phenomenon:** The phenomenon that students will *explore throughout the unit.* Phenomena are observable and can arise from either a natural or designed system. More detail about Anchoring Phenomena.
- **Phenomenon-driven question:** The question students will be able to answer at the end of the unit, related to the phenomenon and includes both an SEP and DCI.
- **Essential question:** It is important that your unit addresses a question designed to "guide student inquiry toward a deeper understanding of a big idea" (Wiggins & McTighe, 2005, p. 116) and whose answer will be understood by studying your unit. This question should be central to science and promote inquiry and "uncoverage" of a subject. Students' answers to this question at the end of the unit will shed light on their learning related to the enduring understandings.
- **Enduring understandings:** The statements summarizing important ideas and core processes that are central to science and have lasting value beyond the classroom. On the Unit Flow slide, write the names of each SEP, DCI sub-idea, and CCC. On the Essential Question and Enduring Understandings slide, write the full statements of understanding in complete sentences.

Submission: A link on Canvas to your updated Unit Plan.

Unit checkpoint 2 *(Due 1/28)*:

- **Pre-assessment plan:** You will engage in formative assessment in your placement that helps you understand your students' prior knowledge of the Anchoring Phenomenon or Enduring Understandings. You will create a formative assessment task that will be given prior to the start of the unit to help you understand how to support your students during the unit.

Submission: A link on Canvas to your updated Unit Plan with your pre-assessment task linked on the Pre-Assessment slide.

Unit checkpoint 3 *(Due 2/4)*:

- **Pre-assessment analysis:** Continue the formative assessment cycle in your placement. You will administer the task to your students, collect their work

samples, and look for patterns in what they understand and what needs more support. Then, you will use these results to inform your planning.

Submission: A link on Canvas to your updated Unit Plan with your completed analysis template and a single document that includes the work of all of your students linked on the Pre-Assessment slide.

Unit checkpoint 4 *(Due 2/11)*:

- **Performance assessment task draft:** Continue working on assessment for your unit by developing a performance task that will measure your students' progress at or near the end of the unit. This may take the form of a summative assessment task that will be graded and returned to students at the end of their learning. This task may also be formative if you intend to have students undergo a feedback-revision cycle at the end of the unit. *Note: this kind of task is often referred to as summative, due to the timing at the end of the unit.* In developing the task, you will unpack the relevant NGSS standard(s); identify a high-quality phenomenon; create prompts and supporting materials that will elicit student understanding; and begin a scoring guide by describing the categories you will look for and the details a proficient response should contain.
- **Lesson sequence overviews:** For each lesson sequence in the unit, you will describe the 2-dimensional central focus of the lesson sequence and an example lesson objective for one of the lessons in the series. You do not need to create the lessons for each of these series. You may create 4-6 lesson sequences (add or delete a slide if needed and update the Unit Flow Slide). Lesson objectives are measurable, draw on the Next Generation Science Standards, and are 2- or 3-dimensional. Importantly, they should make clear both what disciplinary core ideas will be included, what scientific practices will be addressed, and any cross-cutting concepts that will be explicitly assessed.

Submission: A link on Canvas to your updated Unit Plan with your Performance Assessment Task linked on the Performance Assessment slide.

Unit checkpoint 5: **Lesson plan 1 draft** *(Due 2/18)*
Unit checkpoint 6: **Lesson plan 2 draft** *(Due 2/25)*
Unit checkpoint 7: **Lesson plan 3 draft** *(Due 3/3)*

- For each lesson plan checkpoint, you will draft one complete lesson plan that is part of a series of 3 connected lessons that fit within your unit. Each lesson plan should include lesson timing; lesson topic; NGSS performance expectations addressed; lesson learning objectives; instructional resources; a timeline of instructional tasks with times, student actions, teacher actions, and opportunities for formative assessment; language demands; language supports; accommodations, modifications and scaffolds; and relevant theories.

Submission: A link on Canvas to your updated Unit Plan with your updated Lesson Series Plan linked on the appropriate Lesson Series slide.

In-class presentation *(Due 3/10)*

- You will have 5 minutes to present your unit to your classmates. Focus on the big picture, rationales, phenomena, and how you will know what students have learned. Think of this as a way to help others in the group get creative teaching ideas. Keep it interesting!

Submission: A link on Canvas to your updated Unit Plan.

Assignment 5: Final Project *(Due 3/17)*

Your final project should address all comments made by Sara and Kathryn. The comments should be addressed by modifying the plan in blue font.

Submission: A link on Canvas to your updated Unit Plan with all components linked.

WEEKLY ASSIGNMENTS

Week 1: Why teach science? (Jan 7)

Readings:

Patterson, A., & Gray, S. (2019). Teaching to transform: (W)holistic science pedagogy. Theory Into Practice, 0(0), 1–10. https://doi.org/10.1080/00405841.2019.1626616

Osborne, J. F. (2014). Teaching scientific practices: Meeting the challenge of change. *Journal of Science Teacher Education*, *25*(2), 177–196. https://doi.org/10.1007/s10972-014-9384-1

Assignments due:

None.

Week 2: Unit building: Phenomena and storylines (Jan 14)

Readings:

Lowell, B. R., & McNeill, K. L. (2019). Keeping critical thinking afloat. Science Scope, (August), 64–69.

NextGen Storylines:

- Teacher Handbook for NextGen Science Storylines (**Part A only**): What is a NextGen Storyline?
- One storyline of your choice from https://www.nextgenstorylines.org

Assignments due:

- Statement: Why teach science?

Week 3: Unit building: Pre-assessment (Jan 21)

Readings:
Mestad, I., & Kolstø, S. D. (2014). Using the concept of zone of proximal development to explore the challenges of and opportunities in designing discourse activities based on practical work. *Science Education*, *98*(6), 1054–1076. https://doi.org/10.1002/sce.21139

Assignments due:
- Unit checkpoint 1:
    - Unit overview
    - Performance expectations
    - Anchoring phenomenon
    - Essential question
    - Enduring understandings.

Week 4: Explanation and Argument, part 1 (Jan 28)

Readings:
McNeill, K. L., & Krajcik, J. (2007). Scientific explanations: Characterizing and evaluating the effects of teachers' instructional practices on student learning. Journal of Research in Science Teaching, 45(1), 53–78. https://doi.org/10.1002/tea
Pages 53-57 and 69-72 ONLY

Assignments due:
- Unit checkpoint 2:
    - Pre-assessment plan
- Share classroom video 1

Week 5: Unit building: Performance assessments (Feb 4)

Readings:
Stoll, L., & Schultz, S. (2019). How to Design a Performance Task. Science Scope, 042(07), 40–45. https://doi.org/10.2505/4/ss19_042_07_40

Deer performance task at: https://scienceeducation.stanford.edu/assessment/short-performance-assessments

Supplemental Reading:
Mutegi, J. W. (2011). The inadequacies of "science for all" and the necessity and nature of a socially transformative curriculum approach for African American science education. Journal of Research in Science Teaching.

Assignments due:
- Unit checkpoint 3: Pre-assessment analysis
- Classroom video reflection 1

Week 6: Explanation and Argument, part 2 (Feb 11)

Readings:
Osborne, J. (2010). Arguing to Learn in Science: The Role of Collaborative, Critical Discourse. Science, 328, 463-466.

Berland, L. K., & Mcneill, K. L. (2012). For whom is argument and explanation a necessary distinction? A response to Osborne and Patterson. Science Education, 96(5), 808–813. https://doi.org/10.1002/sce.21000

Supplemental reading:
Osborne, J. F., & Patterson, A. (2011). Scientific argument and explanation: A necessary distinction? Science Education, 95(4), 627–638. https://doi.org/10.1002/sce.20438

Assignments due:
- Unit checkpoint 4:
    - Performance assessment task draft
    - Lesson sequence overviews

Week 7: Unit building: Assessing investigations (Feb 18)

Readings:
Panadero, E., & Jonsson, A. (2013). The use of scoring rubrics for formative assessment purposes revisited: A review. Educational Research Review, 9, 129–144. **Skip Section 3**

Assignments due:
- Unit checkpoint 5:
    - Lesson plan 1 draft
- Share classroom video 2

Week 8: Learning through authentic contexts (Feb 25)

Readings:
Roth, W.-M. (2003). Scientific literacy as an emergent feature of collective human praxis. Journal of Curriculum Studies, 35(1), 9–23.

Butera, B., & Esser, S. (2019). A Forest in Motion. The Science Teacher, (January), 22–33.

Assignments due:
- Unit checkpoint 6:
    - Lesson plan 2 draft
- Classroom video reflection 2

Week 9: Group work (Mar 3)

Readings:
Patterson, A. D. (2019). Equity in groupwork: The social process of creating justice in a science classroom. Cultural Studies of Science Education, 14(2), 361–381.

Supplemental Reading:
STEM Teaching Tools Brief: Creating science learning experiences that support learners receiving special education services

Assignments due:
- Unit checkpoint 7:
    - Lesson plan 3 draft

Week 10: Celebration of learning (Mar 10)

Readings:
None

Assignments due:
- Unit overview presentation

Final project due Tuesday March 17, 2020