EDUC 267B

Science Education Curriculum & Instruction

Fall 2018

Course Information
Curriculum and Instruction in Science Education Tuesdays 3:15pm- 6:05pm CERAS 302/Maker Space Google Drive: Course Website: http://canvas.stanford.edu

Instructor Information	
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COURSE GOALS

This course prepares pre-service teachers to plan science instructional segments that support learning for all students. The course aims to achieve the following goals:

- To prepare pre-service teachers to design lessons based on their understanding of students' competencies, backgrounds, and needs.
- To prepare pre-service teachers to 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.
- To prepare pre-service teachers to analyze and assess the impact of their planning strategies and lesson implementation on student learning in order 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 on the levels of both theory and practice. In addition, we will consider both individual aspects of teaching and whole group learning.

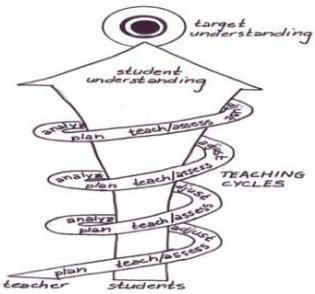
This course will differ from traditional science classes in which you typically "finish" a topic and move on. Instead, you will approach teaching and learning as an iterative process of planning learning segments, reflecting on their impact, and adjusting the instructional approach. This cyclical instructional 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, assess, analyze, and adjust, and start again.

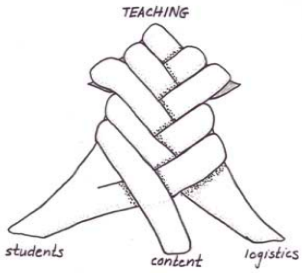
Theme #2: *The Planning Junction*
Decisions about teaching require an interrelated knowledge of students, subject matter, and the practical logistics of the classroom.

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

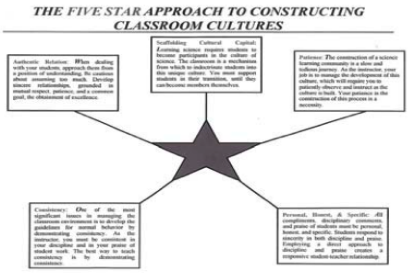
Theme #4: *Science as an Iterative Process*
Science is an iterative process of observing/taking data, finding patterns in the observations, and explaining the patterns (*see the theme diagrams below*).



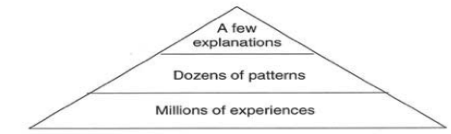
Teaching is a nested set of teaching cycles where you plan, teach and assess, analyze and adjust, and plan again. This approach requires more work than copycat teaching or teaching without planning, but it will enable you to learn from and adapt to any situation you encounter during your teaching career.



Decisions about teaching require knowledge of students, subject matter, and logistics. In your field and lab experiences, all three aspects are at play all of the time and you will learn how to look for each aspect. In class we will work on these aspects separately before you learn to weave them together.



Successful science teaching requires the **development of a classroom culture that promotes participation** in meaningful ways. The challenge of managing students' behavior, while nurturing a rich communicative environment becomes an important component of your instructional objectives. This complicated task requires a



Experiences (transformed into data) include personal experiences, laboratory or field experiences, and vicarious experiences conveyed through pictures, videos, data sets on Internet, etc.
Patterns include laws, generalizations, categories, etc.
Explanations include a few coherent, parsimonious theories and models based on those theories

Charles W. Anderson

Science is an iterative process of observing/taking data, finding patterns in the observations, and explaining the patterns. We need to teach all of the scientific process.

***Special Thanks to Dr. Joyce Parker & Dr. Any Anderson for the above images*

ASSIGNMENTS AND EVALUATION

#	Assignment	Evaluation	%	Due Date*
1	Understanding Your Students	Credit/No Credit	10%	October 2, 2018
2	Reading Assignment 1	Credit/No Credit	5%	October 9, 2018
3	Reading Assignment 2	Credit/No Credit	5%	October 16, 2018
4	Video Analysis	Credit/No Credit	10%	October 23, 2018
5	Practicum Task A: Guided Inquiry	Credit/No Credit	10%	October 30, 2018
6	Practicum Task B: Data Logging	Credit/No Credit	10%	November 6, 2018
7	Plan for a Single Learning Segment	Rubric	10%	November 13, 2018
8	Formative Assessment	Credit/No Credit	10%	November 27, 2018
9	Series of Lesson Plans	Rubric	30%	December 9, 2018

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

ASSIGNMENT 1: Understanding Your Students

Goal: to demonstrate 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 interest 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, be attentive to 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: to 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 write a newsletter to your students that explains basic ideas about how they learn. The newsletter should offer a simple 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. This newsletter should be able to serve as a rationale to students about the organization of learning segments in the classroom. The newsletter should cite the research articles (any citation format is fine as long as it is used consistently) and should be about one single-spaced page or two double-spaced pages.

Submission: Upload a single word document (or PDF) of your newsletter to Canvas.

ASSIGNMENT 3: Reading "Reading" Research

Goal: to 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 one-page (double-spaced) summary 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: to 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). You should 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: to 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 and a reflection on its implementation. The relevant assignment template will be posted on Canvas. 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: to design, implement and reflect on a learning segment that allows students to analyze data for patterns and made 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 allows students to analyze data for patterns and made 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 should be allowed to 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. The relevant assignment template will be posted on Canvas. 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: Plan for a Single Lesson

Goal: to 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 Emily.) 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.

Part 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
		A list of content and support vocabulary.
Part 2	What students will do to reach the GFU	A list of activities
		A list of resources
Part 3	How I will know what they understand	A formative assessment plan
		A summative assessment plan
Part 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 8: Formative Assessment

Goal: to 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 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
Final Performance Task	A task that would be completed at the conclusion of the lessons presented in the series.
Assessment Scheme	This pertains to the final performance assessment and will be both a grading scheme and the rationale for it, or a rubric of some sort that tells the students why they earn what on the task. It could involve peer and/or self- assessment components as well as the teacher assessment.
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 and any supporting materials to Canvas.

COURSE READINGS AND MATERIALS

(CRA): Conceptual Research Article
(ERA): Empirical Research Article
(PA): Practitioner Article
(PCD): Policy or Curriculum Document
(O): Other material (e.g. video, blog, standards document, etc.)
Required Optional Choose one from the set of readings

Session 1: September 25, 2018

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. (PA) [7 pgs.] Optional

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). (RA) [19 pgs.] Optional

Session 2: October 2, 2018

Social Justice Belongs in Our Schools – TED talk (link) (O) Required

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

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.] Required

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.] Required

Session 3: October 9, 2018

Bransford, J. (2000) How People Learn (Chp 3.) Learning & Transfer. Washington, DC: National Academies Press. (CRA) [20 pgs.] Reading Assignment

Brown, J.; Collins, A.; & Duguid, P. (1989) Situated Cognition and the culture of learning. Educational Researchers, 18, 32-41. (CRA) [10 pgs.] Reading Assignment

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

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

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. (PA). [5 pgs.] Optional

Session 4: October 16, 2018

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

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

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. Reading Assignment

Session 5: October 23, 2018

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 (PCD) [14 pgs.] Required

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). (CRA) [20 pgs]. Optional

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

Inquiry and the 5E Instructional Model. (O) [5 pgs.] Required

Session 6: October 30, 2018

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

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

Session 7: November 6, 2018

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

Oh, P. S., & Oh, S. J. (2011). What teachers of science need to know about models: An overview. *International Journal of Science Education*, *33*(8), 1109-1130. (CRA) [21 pgs.] Optional

Robertson, C. (2018). Using modeling to teach DNA replication. *The Science Teacher*, *85*(2), 47-53. (PA) [8 pgs.] Choice 1

Carroll, D. (2017). Modeling Periodic Patterns. *The Science Teacher*, *84*(6), 43-49. (PA) [7 pgs.] Choice 2

Session 8: November 13, 2018 (Subject to Change)

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

Rodriguez, A. J. (2015). What about a dimension of engagement, equity, and diversity practices? A critique of the next generation science standards. *Journal of Research in Science Teaching*, *52*(7), 1031-1051. (RA) [20 pgs.] (CRA) Choice 1

Parsons, E. C., & Dorsey, D. N. T. (2015). The race problem: Its perpetuation in the Next Generation of Science Standards. *The race controversy in American education*, *2*, 215-235. (CRA) Choice 2

Session 9: November 27, 2018

Morales-Doyle, D. (2017). Justice-centered science pedagogy: A catalyst for academic achievement and social transformation. *Science Education*, *101*(6), 1034-1060. (ERA) [26 pgs.] Choice 1

Carlone, H. B., Haun-Frank, J., & Webb, A. (2011). Assessing equity beyond knowledge-and skills-based outcomes: A comparative ethnography of two fourth-grade reform-based science classrooms. *Journal of Research in Science Teaching*, *48*(5), 459-485. (ERA) [26 pgs.] Choice 2

Session 10: December 4, 2018

Bang, M., Warren, B., Rosebery, A. S., & Medin, D. (2012). Desettling expectations in science education. *Human Development*, *55*(5-6), 302-318. (CRA) Choice 1

Barton, A. C. (1998). *Feminist science education*. Teachers College Press. (Chapters 1 and 6). (CRA) Choice 2

Donovan, B. M. (2015). Reclaiming race as a topic of the US Biology textbook curriculum. *Science Education*, *99*(6), 1092-1117. (CRA) Choice 3