

**Science Education Curriculum & Instruction  
Fall 2017**

Course Information	
Curriculum and Instruction in Science Education Tuesdays CERAS Room 308 3:00pm- 5.50pm	
Instructor Information	
Jonathan Osborne, Ph.D. Office: Cubberley 222 (650) 725-1247 <a href="mailto:osbornej@stanford.edu">osbornej@stanford.edu</a> Office Hours: by appointment	Stephanie Rafanelli Ph.D. Candidate in Science Education Office: Cubberley 336 <a href="mailto:stephraf@stanford.edu">stephraf@stanford.edu</a> Office Hours: by appointment

**COURSE GOALS**

This course will focus on preparing pre-service teachers to plan lesson segments and curricular units to be used for science teaching. The course is designed to achieve the following goals:

- To prepare all pre-service teachers to design learning segments based on their understanding of students' skills, backgrounds and needs
- To develop knowledge of the skills and strategies teachers use to teach science and of the methods teachers use to make science engaging
- To build an understanding and vision of the Next Generation Science Standards
- To prepare pre-service teachers to design lesson plans, learning segments, and curricular units that create deeply integrated learning segments that enable students to understand and apply their conceptual understanding
- To prepare all pre-service teachers to analyze and assess the impact of their planning strategies on student learning in an effort to revise and improve their instructional performance

**COURSE OVERVIEW**

The process of teaching is more complicated than it may appear. Very few of the intricate details of teaching are visible to the common observer. Teachers make hundreds of decisions every day. As a science teacher, you will develop a theoretical framework for effective science teaching and learn how to translate that framework into instructional decisions. The summer quarter of C&I series placed an emphasis on planning for instruction. This quarter will focus on creating lesson

segments and activities especially designed for your students. During this quarter, we will work between theory and practice and between individual aspects of teaching and whole group learning. By the end of the course, we want you to put these learning segments together to make a coherent and complete lesson.

In this way, the fall quarter differs from traditional science courses where you “finish” a topic and move on. During this quarter, you will explore the iterative process that is teaching and learning. We will focus on the iterative process of teaching by planning learning segments, and revising them as we come to understand their effectiveness. To do this, we will engage in a sequence of exercises where you will each present a lesson/learning segment, explain your choices, and how you think it will work. The group will then comment on your plan and you will be asked to revise and submit it as an assessment. In this sense, our planning and learning will involve constant revision and reflection on new concepts and instructional strategies. This approach is designed to model the instructional cycle that includes *Planning, Teaching, Analyzing, Adjusting, and Reevaluating*.

Using this cyclical instructional approach will enable us to integrate our learning experiences with the experiences we are gaining as interns. Our weekly working sessions will enable us to build a strong connection between our practical and theoretical education. To highlight this process, we have implemented three themes for our course:

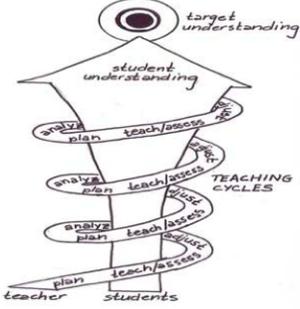
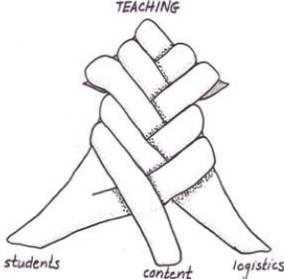
Theme #1:                    *Teaching as Cycles*  
Teaching is a nested set of teaching cycles where you plan, teach and assess, analyze, and adjust, and plan again. This requires

- Decisions about teaching require an interrelated knowledge of student, subject matter, and logistics.
- The development of a classroom culture that promotes participation in meaningful ways by all students.
- Science is an iterative process of observing/taking data, finding patterns in the observations, and explaining the patterns (*see the theme diagrams below*).

Theme #2:                    *Teaching Science as a Language*  
All teaching is teaching a language of science. Concepts and ideas are communicated through language. In the case of science that language uses mathematics, graphs, charts, symbols and models. Learning science means providing students opportunities to read, write, talk, do, and represent and model science. How this can be done will be a constant theme of our sessions.

Theme #3:                    *Building Your Vision of the Science that you are teaching*  
Your job is to teach science? But what science and why? To be an effective teacher you need to have a vision of the broad goals you are teaching and how each element you are teaching might contribute to those goals. In particular, what is different about the Next Generation Science Standards and how do you present science so as to make even

the mundane awesome or disturbing. What are the major styles of reasoning that we use in science?

 <p>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.</p>	 <p>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.</p>
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*\*\*Special Thanks to Dr. Joyce Parker & Dr. Amy Anderson for the above images*

Reviewing these themes suggests that successful teaching requires development of a balance of knowing what to teach, knowing how to teach, knowing how to assess students' learning. In order to accomplish this, teachers must develop a dynamic understanding of classroom learning that integrates knowing the subject matter, skillfully using assessment, and creating productive learning communities.

#### *Knowing subject matter and how to teach it*

This quarter, we will be unpacking the Next Generation Science Standards, with three themes of disciplinary core ideas, 8 scientific practices and 7 cross-cutting concepts. We review this issue of identifying what big ideas/disciplinary core ideas of science you will choose to teach, what scientific practices you will be developing, and what cross-cutting themes these may illustrate. Then we will look at how you can have students apply these ideas. In doing this you may find yourselves reorganizing your own understanding of science so that it is more useful for you as a teacher. Then we will consider how to teach these aspects of NGSS. You will have many opportunities to work through teaching cycles where you plan, teach and assess, then reflect and adjust your teaching. In this course, our semester will be centered on planning a single lesson.

#### *Assessing and working with students*

Through your field experience, you will have opportunities to work with many students, many of whom will be different from the student that you were. You will learn how to assess students' understanding every time you teach and how to plan lessons taking into account how and what students are learning. You will have to observe individual students and gain insight about their understanding of science and what their social issues are.

#### *Creating and managing a learning community*

We will work on understanding what motivates and engages individual students and identify routines and policies that support a well-managed classroom. Management and motivation will be issues that we address every time we consider a new teaching technique. We will identify how many aspects of teaching affect management and the quality of a classroom learning community.

**‘Building’ your understanding of what it means to teach science**

In addition to our emphasis on these basic themes of teaching, we will organize this course around four basic tasks. First, you will continue to collect and use multiple sources of information to pre-assess students in an order to design an effective student-learning environment.

Second, we will ask you to design, plan and present detailed lesson/learning segments for critical feedback. After the feedback, you will revise and submit your plan for assessment. At the end of the quarter, you will demonstrate your understanding of how to synthesize these into one detailed lesson plan for a single lesson plan. This lesson plan will be designed to reflect your students’ interest, prior knowledge, and skills and to support their learning.

Third, you will design a unit plan that provides a plan for a series of lesson plans. This unit plan will provide a map of how to plan to engage students in fruitful learning activities that extended over several lessons of instruction. One of the lessons will be described in detail. The aim of this exercise is to set a lesson in the context of building a disciplinary core idea and show how it builds on what has come before and how it will contribute to what is to come.

Fourth, we will return iteratively across both this quarter and next to the theme that learning science is learning a language and we will explore what you can do to support the *reading, writing, talking, doing, and modeling and representing* science.

### ASSIGNMENTS AND EVALUATION

There are 8 assignments this quarter:

#	ASSIGNMENT NAME	DESCRIPTION	EVALUATION TYPE	% OF TOTAL
1	<b>Reading Assignments</b>	Working as a pair, your task will be to introduce the reading and questions for discussion. You will organize the discussion how you see fit in the time we have allotted of 20 min. The other students will have read the reading. After the discussion, as a pair you will be asked to produce a 2 page summary of the paper, the responses it generated in the discussion and your own reflections	Credit / No Credit	10%
2	<b>Understanding Your Students</b>	You will provide a 2-page analysis of your students. You will analyze both the entire class and select 2 students to focus on. You will provide a description of how you will design instruction to meet the needs of all of your students.	Credit / No Credit	10%
3	<b>Practicum Task A: A Learning Activity</b>	For this task you will be asked to design a learning activity for your students and explain and justify your design	Credit / No Credit (Complete the analysis form)	5%
4	<b>Practicum Task B: Eliciting Student Understanding</b>	For this task you will design and use an activity to elicit student understanding of a science concept you will be teaching	Credit / No Credit (Complete the analysis form)	8%
5	<b>Practicum Task C: Using IT in the classroom</b>	You will design a student learning activity which makes use of IT in its broadest sense.	Credit / No Credit (Complete the analysis form)	10%
6	<b>Practicum Task D: A Learning Activity</b>	For this task you will be asked to design a learning activity for your students and explain and justify your design. It should be different from Practicum Task A	Credit / No Credit (Complete the analysis form)	12%
7	<b>Plan for a Single Lesson</b>	You will design a complete lesson plan for a single learning segment.	Graded by Rubric	15%

<b>8</b>	<b>Series of Lesson Plans</b>	You will design a sequence of lessons in outline to address a topic and provide a detailed lesson plan for one lesson	Graded by Rubric	<b>30%</b>
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**ASSIGNMENT 1: Reading Assignments (5% per assignment)**

Every week from week 2 to 9, we will all read one paper for discussion by the class. One pair of students will have the task of preparing and leading the class in a discussion of the paper in any way they feel fit. We will devote a maximum of 30 min to this activity. The discussion can be led by simply preparing a set of questions or by choosing to use a strategy such as an argument line, four corners, Socratic, a gallery walk or any other format. You should try and be imaginative about how to generate the discussion and to get all to participate.

After the discussion, you will be required to write a summary of the paper, its main arguments and the responses and criticisms that emerged in the discussion that is at least 2 pages.

**Readings**

- Week 2: · Pearson, D., Moje, E. B., & Greenleaf, C. (2010). Literacy and Science: Each in the Service of the Other. *Science*, 328, 459-463.
- Week 3: Chapter 1: Wiggins, G. P., & McTighe, J. (2004). *Understanding by Design* (2nd ed.). Alexandria, Va.: Association for Supervision and Curriculum Development.
- Week 4: Chapter 2, page 22-37. National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (N. A. Press Ed.). Washington, DC.: Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education.
- Week 5: · Millar, R. (1991). Why is Science hard to learn? *Journal of Computer Assisted Learning*, 7, 66-74.
- Johnstone, A. H. (1991). Why is science difficult to learn? Things are seldom what they seem. *Journal of computer assisted learning*, 7(2), 75-83.
- Week 6: · Driver, R., Guesne, E., & Tiberghien, A. (1985). Children's ideas and the learning of science. In R. Driver, E. Guesne, & A. Tiberghien (Eds.), *Children's ideas in science* (pp. 1-9). Milton Keynes: Open University Press.
- Week 7: Osborne, J. F. (2002). Science without Literacy: a ship without a sail? *Cambridge Journal of Education*, 32(2), 203-215.
- Week 8: Lee, O., Quinn, H., & Valdés, G. (2013). Science and Language for English Language Learners in Relation to Next Generation Science Standards and with Implications for Common Core State Standards for English Language Arts and Mathematics. *Educational Researcher*, 42(4), 223-233.

Week 9: · Chi, M. (2009). Active-Constructive-Interactive: A Conceptual Framework for Differentiating Learning Activities. *Topics in Cognitive Science, 1*, 73-105.

[Due in class the week after you present]

### **ASSIGNMENT 2: UNDERSTANDING YOUR STUDENTS**

In line with our assumption that excellent teaching occurs in those situations where we truly understand our learners, this assignment involves your conducting a detailed analysis of your student population in order to design instruction to meet their specific needs. This assignment will require you to complete a 2-page analysis sheet that involves a series of questions associated with your students. Your analysis of your students will include a Macro-Level analysis **of all of your students**, as well as a Micro-Level analysis of **2-specific students**. This will provide you an opportunity to appraise what works best for your entire student population while simultaneously focusing on specific students. We will use this document as a working-document throughout the quarter to provide evidence for some of the choices that you might make. The handout will be made available online.

[Due in class October 10, 2017]

### **ASSIGNMENT 3: PRACTICUM TASK A – A LEARNING ACTIVITY**

You will design a short learning activity/lesson segment which supports student learning through reading, writing, talking, doing or modeling and representing. Prior to engaging with the materials, you will need some activity that will elicit what students know about the content prior to experiencing it. This does not need to be planned in detail but you should describe the activity, what information it will elicit and how you might use it.

After engaging in the guided inquiry experience, students will need some assessment activity to tell you what new understanding they have arrived at and how they have come to that understanding. Again, this part does not need to be planned in detail but you should describe the assessment activity, what information it will elicit.

The students should not be provided a set of step-wise instructions but have some measure of independence in how to do the activity.

[Due in class October 17, 2017]

### **ASSIGNMENT 4. PRACTICUM TASK B: ELICITING STUDENT UNDERSTANDING**

Using a Page Keeley Probe, a concept map, a concept cartoon, a diagnostic question or other form of probe, you should ask a group of students to undertake the task. You should then analyze the responses and write a summary of what it tells you about their understanding of this topic.

With at least two of the students, you should discuss their responses and explore why they responded as they did.

[Due in class October 24, 2017]

### **ASSIGNMENT 5: PRACTICUM TASK C – USING IT IN THE CLASSROOM**

A second type of practicum, or in school assignment, involves using IT. The goal of this activity is to exploit the potential of IT to support learning. You may use Socrative, Google Docs, an iPhone app, a PhET simulation or any other form of IT that will support a science learning activity. The activity should be related to a scientific practice and you should gather student work that emerges from the activity. You should then provide a summary of the activity, its goals, a rationale for its choice, samples of the student product or screenshots of what emerged and discuss your reflections on the experience.

[Due in class October 31, 2017]

### **ASSIGNMENT 6: PRACTICUM TASK D – A LEARNING ACTIVITY**

You will design a short learning activity/lesson segment which supports student learning through *talking*. You should explain how the activity will foster talk and how it will engage all students in a non-threatening manner.

After engaging in the guided inquiry experience, students will need some activity to summarize the outcome of what they have been discussing.

The students should not be provided a set of step-wise instructions but have some measure of independence in how to do the activity.

[Due in class Nov 7, 2017]

### **ASSIGNMENT 7: PLAN FOR A SINGLE LESSON PLAN**

You will write a single learning plan. This plan will include a detailed description of the plan for students' learning that will include the following components:

#### **Part 1: What will they come to understand:**

- (a) A reference to an NGSS performance expectation (or a California State Standard)
- (b) A list of the goals for the learning segment [Objectives]
- (c) A list of ideas, content and associated vocabulary to be addressed by the lesson

**Part 2: What students will be asked to do to potentially achieve these goals:**

- (d) A description of learning activities to be engaged in during the lesson
- (e) A description of resources needed

**Part 3: How will I know what they understand:**

- (f) A description of a formative assessment plan and what you will do with the information you obtain.

**Part 4: A pacing guide**

- (g) An agenda of the time for the things to be done (*both teacher and student*)

**Part 5: A rationale for your design.**

- (h) An explanation for your choices and arguments for why you think they might engage students and help them to learn.

[Due in class November 14, 2010]

**ASSIGNMENT 8: A Lesson Sequence**

You will create the beginning of a curriculum unit patterned after the model developed by Wiggins and McTighe, both in process and in content. It will have the following components:

**Context description**

This section provides a **detailed description** of the context of your learning environment. You will provide an explanation of *who* your students are and what broader *issues and resources* shape the teaching of this particular unit. This should include your *Rationale(s)* and any *data or information* that helped shape the unit plan in any way.

**Learning Goals**

These will be presented as a set of science statements and should include one NGSS performance expectation.

You will include an answer which will explain to student why they are learning. Ideally, it should explain why it is awesome, disturbing or both and it should explain how it is relevant to their lives.

**An essential question(s)**

This could look like a “Unit Question” (see Wiggins and McTighe)

**A 3-5 Lesson Sequence**

You will provide an outline of the lessons that will address the topic. Your narrative should include brief description of the lesson activities/learning strategies you will use and explain why you think this will help achieve your goals. You can plan to use the typical 50-minute high school class period or the extended 90 to 100 minute version. You should aim to cover 150-200 min of instruction in summary form.

**A Detailed Lesson plan**

For one of the lessons in your outline, you should provide a detailed lesson plan. It should include all the elements required for Assignment 7 and show how it will build on what has gone before and how it will contribute to what is to come.

You should provide all handouts that accompany the lesson plan and cite all resources that will not be included in the plans (*e.g. citing that students will read pages 10-14 from the Holt Chemistry textbook*).

[Due Dec 12, 2017]

**DUE DATES**

WEEK #	DATE	ASSIGNMENT DUE
1	September 26, 2017	No Assignments Due
2	October 3, 2017	No Assignments Due
3	October 10, 2017	Assignment 2: Understanding Your Students
4	October 17, 2017	Assignment 3: Practicum Task A
5	October 24, 2017	Assignment 4: Practicum Task B
6	October 31, 2017	Assignment 5: Practicum Task C
7	November 7, 2017	Assignment 6: Practicum Task D
8	November 14, 2017	Assignment 7: Plan for a Single Lesson
9	November 28, 2017	
10	December 5, 2017	
	December 12, 2017	Assignment 8

\*November 21 – No class this week for Thanksgiving holiday