Science Education Curriculum & Instruction
2021

Course Information
Curriculum and Instruction in Science Education Tuesdays CERAS 300 Course Website: http://canvas.stanford.edu 3:15pm- 6:05pm

Instructor Information	
Bryan Brown, Ph.D. *Associate Professor – Science Education* Office: 228 CERAS (650) 725-4662 brbrown@stanford.edu Office Hours: by appointment	**Daniel Pimmentel** *Ph.D. Candidate in Science Education* dpimente@stanford.edu Office Hours: by appointment

COURSE GOALS

This course will focus on preparing pre-service teachers to plan learning 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 prepare all 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, and
- To prepare all pre-service teachers to analyze and assess the impact of their planning strategies on student learning 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 the C&I series placed an emphasis on planning for instruction. This quarter will focus on creating learning segments 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.

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 this iterative process by planning learning segments and revising them as we come to understand their effectiveness. We will also learn new concepts and revisit them as we come across alternative understandings. 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 truly integrate our learning experiences with the experiences we are gaining as student teachers. 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 four 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.

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

Theme #3: *Meaningful Participation*
Successful science teaching requires the development of a classroom culture that promotes participation in meaningful ways.

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

Reviewing these themes suggests that successful teaching requires development of a balance of knowing **what** to teach, knowing **how** to teach, and knowing **how to assess** students' learning. 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 matters and how to teach them

This past summer, we focused on telling the "story" of the big science ideas that you want students to learn. We will review this issue and also consider how you can have students apply these ideas. In doing this you may find yourself 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 ideas. 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 learning segment.

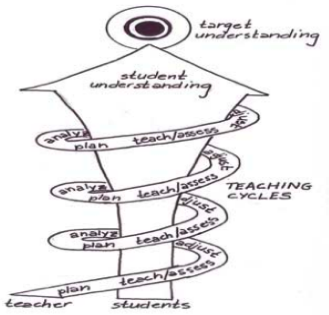
Assessing and working with students

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 that consider 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.

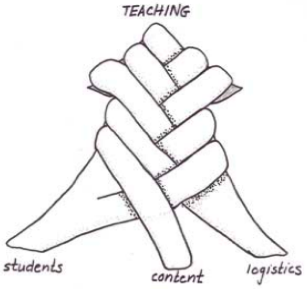
Creating and managing a learning community

We will work on understanding what makes individual students tick and identify routines and policies that support a well-managed classroom. Management and motivation will be issues that we

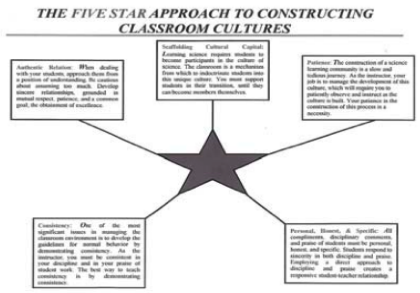
address every time we consider a new teaching technique. We will identify how many aspects of teaching affect management and the quality of a classroom learning community.



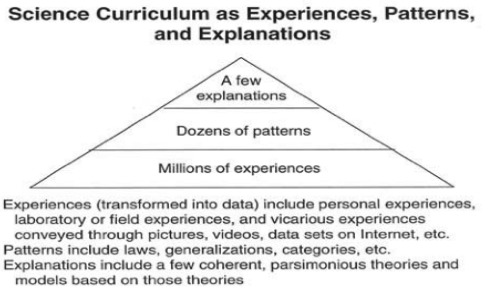
Teaching is a nested set of teaching cycles where you plan, teach and assess, analyze and adjust, and plan again. This approach requires more work than copycat teaching or teaching without planning, but it will enable you to learn from and adapt to any situation you encounter during your teaching career.



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



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*

'Doing' towards understanding

In addition to our emphasis on these basic themes of teaching, we will organize this course around three 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. To do this you will complete a detailed analysis of your students that includes video-based analyses of students' engagement and students' learning.

Second, you will demonstrate your understanding of how to design learning segments by creating a detailed plan for a single lesson. This lesson plan will be designed to reflect your students' interest, prior knowledge, and skills.

Third, you will design a complete learning segment that provides a detailed plan for 1-2 days of instruction. This unit plan will provide a detailed map of how to plan to engage students in fruitful learning activities that extend over a few days of instruction.

ASSIGNMENTS AND EVALUATION

There are 6 assignments this quarter:

#	ASSIGNMENT NAME	DESCRIPTION	EVALUATION TYPE	% OF TOTAL
1	**Reading Assignment #1**	You will read several articles about reading. In response you will create a list of 4 reading comprehension learning segments based on what you learn from your reading.	Credit / No Credit	**10%**
2	**Reading Assignment #2**	You will read several articles about learning and will create a newsletter to your students explaining to your students how learning works and what you do to support their learning	Credit / No Credit	**10%**
3	**Practicum Task: Guided Inquiry**	You will design a brief (15 min) learning segment that provides an opportunity for students to engage in a structured inquiry activity.	Credit / No Credit (Complete the analysis form)	**15%**
4	**Cognitive Apprenticeship Lesson Conversion**	You will receive an existing lesson plan. You will revise the lesson plan according to Cognitive Apprenticeship Lesson planning principles	Credit / No Credit	**15%**
5	**Plan for a Single Lesson**	You will design and complete an original lesson plan for a single learning segment.	Graded by Rubric	**20%**
6	**Full Lesson Plan with Materials**	You will design a completed lesson plan (1-2 days) with all instructional materials.	Graded by Rubric	**30%**

ASSIGNMENT 1: READING ASSIGNMENTS (10% PER ASSIGNMENT)

You will be asked to complete a reading assignment based on the information you gain from reading each of the articles assigned for class. This reading will focus on basic principles of reading to develop and understanding.

In response to the 3 readings from week 1 (Barton et al., Glynn & Muth; & O'Reily et al.) you will write a short document that explains your position on the role of reading in science teaching and learning. This document will also include a list of *4* reading activities that you can use to promote and enhance improved reading comprehension in your classroom. The document should include two parts: (1) a 1-page description of your position on the role of reading comprehension in science teaching and learning. This should reflect an understanding that you developed through the readings and (II) a list of 4 reading comprehension activities and descriptions of those activities that can be used in your

classroom that reflect your understanding of reading comprehension in science. [This should be a maximum of 2 pages – Double Spaced]
[Due: September 28, 2021, by 3pm via Canvas]

ASSIGNMENT 2: READING ASSIGNMENT #2 (10% per assignment)

Week 3: Learning: Explain it So They Know
This series of articles explores a series of research discussing some basic principles about how students come to know. These learning articles provide a list of principles about how students come to understand phenomenon. In connection with the ideas associated with Metacognition, you will generate a newsletter that is to be distributed to the students you will be teaching next year. You will create a 1–2-page newsletter that explains some basic ideas about how they learn. This document will use references from the articles we read, explanations of key learning concepts, and descriptions of the knowledge derived from reading the articles. This will offer your students a simple introduction to how learning happens in your classroom. To provide them a sense of structure, your newsletter **must also explain** how what you have students do in class is connected to these theories of learning.
[Due: October 5, 2021, by 3pm via Canvas]

ASSIGNMENT 3: Practicum Task: Guided Inquiry

In a short 5-to-15-minute activity students will be given several items that will be used to help them develop an understanding of some scientific phenomenon. The students will not be provided a set of stepwise instructions. Instead, the students are free to design a way to assess an understanding. Prior to engaging with the materials, the students will tell you what they know about the content prior to experiencing it. After engaging in the guided inquiry experience, students are to tell you what new understanding they have arrived at and how they have come to that understanding.
[Due: October 12, 2021, by 3pm via Canvas]

ASSIGNMENT 4: Cognitive Apprenticeship Lesson Conversation

A component of teaching involves using existing lesson plans and turn them into the type of lesson plans you want to use in your classroom. Your task is to convert and existing lesson plan into Cognitive Apprenticeship Lesson Plan. Your lesson plan will need to have 4 types of activities: (1) Establishing A Problem – Create an activity that introduces the concept in a context that makes the content necessary, (2) Modeling- Create a set of activities that are teacher-centered. These activities are intended to introduce the students to the big ideas of the unit with the teacher's assistance., (3) Coaching- These are student-centered learning segments that allow the students to explain, analyze, and explore the concepts together., (4) Fading – The final aspect of the activities will be learning segments that allow students opportunities to explain the ideas towards mastery. Use the course lesson planning template to list your activities, writing learning goals, and to create a timed instructional agenda.
[Due: October 26, 2021, by 3pm via Canvas]

ASSIGNMENT 5: PLAN FOR A SINGLE LESSON

You will write a single learning plan. This plan will include a detailed description of the plan for students' learning that will include three primary sections. You will have a section that focuses on identifying a. what students will come to understand, b. a section focusing on what students will do to gain that understanding, c. a section describing how you will assess how they are progressing, and d. a detailed agenda and pacing guide. We will use a lesson planning template that is available on canvas. The following components must be present in each lesson plan:

Part 1: What will they come to understand:
(a) A Reference to NGSS Standards
(b) A list of the goals for understanding for the learning segment [Objectives]
(c) A list of content and support vocabulary

Part 2: What will they do to get there:
(d) A list of activities to be engaged in during the lesson
(e) A list of resources needed

Part 3: How will I know what they understand:
(f) A description of a formative assessment plan
(g) A description of the final summative assessment plan

Part 4: A pacing guide
(h) An agenda of the time for the things to be done *(both teacher and student)*

[Due: November 9, 2021, by 3pm via Canvas]

ASSIGNMENT 6: A FULL LESSON PLAN W/ CURRIULUM MATERIALS

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 3 components: (a) A Lesson Plan, (b) A Slide deck, & (c) A handout for students.

Part 1: The Lesson Plan

Create a lesson plan using the lesson planning template that is provided on canvas. This lesson plan should cover 1-2 days of instruction. Include a clearly articulated set of goals for understanding, NGSS standards, assessments plans, and a detailed instructional agenda.

Part 2: The Slide Deck

Prepare a slide deck to provide directions and media resources for your instruction. For each corresponding learning segments, prepare a slide deck to guide students' activities. This slide deck can be submitted in the form of a PowerPoint deck or a Google Slide deck.

Part 3: The Handout

Prepare a handout to guide students in each of the activities associated with their classroom tasks. For each of the classroom learning activities use the handout to provide students ways to share their thinking, evaluate other student's ideas, and ways to engage in laboratory tasks and analysis. This document should be uploaded to Canvas as either a PDF or Google Doc.

[Due: December 8, 2021, by 3pm via Canvas]

DUE DATES OVERVIEW

WEEK #	DATE	ASSIGNMENT DUE
1	September 21, 2021	No Assignments Due
2	September 28, 2021	Reading Assignment #1
3	October 5, 2021	Reading Assignment #2
4	October 12, 2021	Guided Inquiry
5	October 19, 2021	No Assignment
6	October 26, 2021	Cognitive Apprenticeship Lesson Conversion
7	November 2, 2021	No Assignment
8	November 9, 2021	Single Lesson Plan
9	November 16, 2021	No Assignment
10	December 8, 2021	Full Lesson Plan with Materials

No class for Thanksgiving holiday – November 23, 2021.

COURSE READING

The following are the due dates for the readings.

9/29 READINGS FOR SESSION 2: Language and Literacy

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

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.

Barton, ML, Heidema, C., & Jordan, D. (2002). *Teaching reading in mathematics and science. Educational Leadership,* 60, 24-31.

10/6 READINGS FOR SESSION 3: Learning

Bransford, J. (2000) How People Learn (Chp 3.) Learning & Transfer. Washington, DC: National Academies Press.

Brown, J.; Collins, A.; & Duguid, P. (1989) Situated Cognition and the culture of learning. Educational Researchers, 18, 32-41.