ED 276C: CURRICULUM AND INSTRUCTION IN SCIENCE
COURSE SYLLABUS
Winter, 2018

Course Information	
Curriculum and Instruction in Science Education Tuesdays CERAS Room 308 3:00pm- 5.50pm	
Instructor Information	
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COURSE DESCRIPTION AND LEARNING GOALS:

Where we have been in C&I to date

By this time of the year at STEP, you are each in different places with respect to your learning and understanding about how to teach any particular science topic well for your specific students. In our summer and fall courses, you have been studying in four major sources of understanding that inform effective science teaching: the Nature of Science, the Nature of Learning, the Nature of Learners, and the Nature of Teaching. This spiral curriculum continues in this winter course. Although each of you has begun to construct your own sense of these four areas, and are making connections from them to your work as a teacher in your placement school, we do expect that you will put these understandings into practice as you embark on Independent Student Teaching.

Where we are going

This third quarter you will continue to study in the four areas identified above: the Nature of Science, the Nature of Learning, the Nature of Learners, and the Nature of Teaching (for a more detailed description of each, please see the final pages of this syllabus). Our primary goal of the winter quarter is to support you as you prepare to pass (and, hopefully, ace) the edTPA.

As you prepare for the edTPA and also continue to grow in the areas identified above, we will work from two 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, and

- ***The B***ig Questions of Science Education: Beyond your own classrooms, at the national and even international levels so that you are positioned to take your place as a leader in the world of science education.

Hence, in our weekly sessions, we will revisit the same four areas of learning for teaching, again and again, in the spiral curriculum of C&I, but we will also engage what scholars have to say about questions such as: 'Why teach science?', 'What is science?', and 'What science should we teach?'

The philosophy of our sessions

First that science is engaging because it is either AWESOME or it is DISTURBING or both. That means rethinking about how the ordinary may seem extraordinary. The essential didactic task is to instill in the student the habit of enthusiasm, gratitude and awe. Enthusiasm for science; gratitude for an engaging and stimulating experience; and awe and wonder at the material world we inhabit. All else is secondary.

Second, that teaching science is really teaching a set of CRAZY IDEAS e.g. that day and night are caused by a spinning Earth rather than a moving Sun, that air has mass, that the continents have moved, that you look like your parents because every cell in your body carries a chemically coded message about how to reproduce yourself and so on.

Third, that is there are 5 elements to learning science. These are:

Doing Science –	this is the experimental exploration part.
Talking Science –	by the students or with the students but not just you the teacher
Writing Science –	and not just lab reports.
Reading Science –	how do you help students to read science texts. It is your responsibility not that of the language arts teacher.
Representing Science –	ways of representing (drawing, modeling, etc.) scientific ideas

Fourth and finally, that this knowledge has been achieved through a set of Scientific and Engineering Practices. These are:

1. Asking questions (for science) and defining problems (for engineering)
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 (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

So in each session, we will explore how you can enable students to do one or more of these elements.

We believe that you become a better teacher by sharing your challenges with others, reflecting on them and learning from your mistakes. Hence many of these sessions will have an element where you will share your work (videos, written reflections, lesson ideas, or other) 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. Hence, we will look at a few seminal 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. And, just as you would not like to be in a plane where the pilot had not studied any of the theory of navigation, neither does society like its teachers not to know some of the knowledge that differentiates the teacher as a professional.

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 (srafanelli@stanford.edu and osbornej@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,
- that you learn at different rates and in different chunks,
- that you will have each gained, at least, the fundamental understandings and skills that we intend by course end.

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%	1. Reading Assignments	Graded
20%	2. Practicum Assignments	Graded
10%	3. Classroom video and commentary	Credit/No Credit
10%	4. Preparation for your Course Unit Plan	Graded
50%	5. Final Authentic Performance Task: A Curriculum Unit	Graded With rubric

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.

Haysom, J., & Bowen, M. (2010). *Predict, Observe, Explain: Activities Enhancing Scientific Understanding*. Arlington, VA: NSTA Press.

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

Selected readings: See listings as assignments in the syllabus. Available on Canvas.

ASSIGNMENTS

#	NAME	DESCRIPTION	EVAL. TYPE	PERCENT	DUE DATE(S)
1	**Reading Reflections**	You have four different reading reflections this quarter. Please see below for detailed descriptions of each task.	Graded	10%	1/16, 1/30, 2/13, 2/20
2	**Reading Practicum**	For this activity, you are asked to think about how you might structure a learning activity that requires reading.	Graded	6.7%	1/23
3	**Preparation for your Course Unit Plan**	In this assignment, you will plan for your final assignment in three parts: Assignment 3A: What is the Big Idea for your Unit? Assignment 3B: The Pre-Assessment Plan Assignment 2C: The Pre-Assessment Results	Graded	10%	3A: 1/30 3B: 2/6 3C: 2/27
4	**Inquiry Practicum**	For this activity, you are asked to think about how you might structure a learning activity that requires students to engage in collecting data and justifying their conclusions.	Graded	6.7%	2/6
5	**Talking Practicum** **OR** **Writing Practicum**	For this activity, you are asked to think about how you might structure a learning activity that requires students to engage in science discussion OR a learning activity that requires students to engage in science writing.	Graded	6.7%	3/6
6	**Video**	You will bring about 8 minutes of video of your class to C&I, share in small groups, and reflect on evidence of your students engaging in any of the scientific practices. These videos need to show evidence of you scaffolding and supporting their practice and monitoring their understanding.	Credit/ No credit	10%	1/30, 2/6, 2/13, or 2/20
7	**A Curriculum Unit**	You are asked to select a unit of study in which your class will engage during several days in April – May.		50%	3/20 (before 9AM)

Assignment due dates by Week:

2: RR1
3: Reading Practicum
4: RR2; 3A; Video Group 1
5: 3B; Inquiry Practicum; Video Group 2
6: RR3; Video Group 3
7: RR4; Student responses to 3B; Video Group 4
8: 3C
9: Talking or Writing Practicum
11: A Curriculum Unit

COURSE ASSIGNMENTS IN DETAIL:

Assignment 1: Reading Reflections Due on the dates indicated below, graded
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 quarter. It is, however, expected that your work will be based on these texts. Other texts have been suggested as a good source for relevant instructional practices.

- Readings are assigned in four areas this quarter, and are intended to help frame answers to the big questions cited in the course description, the due dates accompany the assignment list below.
- For each reading assigned, there is a written summary required. Its exact nature is specified in the details below.
- You may read each piece as part of a reading group or as an individual. For the first two reading reflections, you and a partner will submit one reflection. For the final two reflections, you will prepare and submit each paper individually.

Topic 1: What account of science should we teach? Due 1/16
For this assignment, you must work in pairs. Read this piece and create one 2-page summary response, attach both names. Your piece should attempt to (a) identify the main arguments; and (b) identify any strengths and weaknesses that emerge in your reflection.

Reading: Osborne, J. F. (2014). Teaching Scientific Practices: Meeting the Challenge of Change. *Journal of Science Teacher Education, 25*, 177-196.

Topic 2: Argument in Science Due 1/30
Work in pairs. Each should respond to: **"**What is the main point made by this paper and what is its justification?" Your response should be on no more than 2 pages with both names.

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

Topic 3: Why teach science? Due 2/13
Create a personal, 2-page paper re. one of the following pieces in the format:

1) a paragraph of your own answer to this question **before** you read,
2) a paragraph summarizing the author's answer(s) to the question,
3) a response to the author's position.

Reading: Shamos M (1995) *The Myth of Scientific Literacy* pp. 215-228, Rutgers University Press, New Jersey

Reading: Bang, M., Medin, D. L., & Atran, S. (2007). Cultural mosaics and mental models of nature. *Proceedings of the National Academy of Sciences*, *104*, 13868–13874.

Topic 4: Learning Science outside of School Due 2/20

Create a personal, 2-page paper responding to the following pieces in the format:

1) Why are science learning experiences outside of school valuable?
2) What can you do to support these?

Reading: DeWitt, J. and L. Archer (2017). "Participation in informal science learning experiences: the rich get richer?" International Journal of Science Education, Part B **7**(4): 356-373. [Read pp. 356-358 and Conclusions and Implications pp. 369-370]

Reading: Falk, J. and L. Dierking (2010). "The 95 Percent Solution: School is not where most of Americans learn most of their science." American Scientist **98**: 486-493.

Assignment 2: A Reading Practicum Activity Due Jan 23, graded

For this activity, you are asked to think about how you might structure a learning activity that requires reading. You will need to explicitly say what you will do before the reading to activate prior knowledge, what you will do during the activity to ensure that the activity requires re-reading and processing of the text, and what you will do post-reading to summarize the main points emerging from the reading.

In addition, you should consider using a website like wordsift.org to identify what the grade level of the text, what are the main science words that might pose a challenge, and what academic words might need discussing with the class. Another website that will give you more ideas is the one we developed here at Stanford (http://serpmedia.org/rtls/).

Your assignment should include all additional materials including a text, a description of the activities (such as anticipation guides, Freyer models, Cornell notes, etc.), and any rationale which might justify the choices that you have made. Your reflection and rationale should be 1.5-2 pages with no limit on the additional materials attached.

Finally, if you use the activity, a reflective piece on how effective it is would be a worthwhile additional piece but is not required for the grade.

Assignment 3. Preparation for your Course Unit Plan (Final Assignment) Due in three parts, see dates below, graded

Assignment 3A: What is the Big Idea for your Unit? For this you are asked by Jan 30th to produce a 500-word document which outline what the focus of your course unit will be (this part of the assignment is credit only). The 500 words should explain:

a) What the big idea is?
b) What is challenging, disruptive or simply awesome about this idea.
c) A version of this that can be stated in a paragraph – the elevator pitch.

Assignment 3B: ***The Pre-Assessment Plan*** For this assignment you are asked to produce a short document (about one page and no more than two pages) describing what strategy you have chosen to elicit and activate student prior knowledge and why you think it is appropriate. This is due *on Feb 6th*.

Assignment 3C: The Pre-Assessment Results. In class, session 7, February 20th, you are asked to bring in a class set of work that your students have completed. You should have given them some work to do the prior week, so you can collect a class set to bring to C&I. In class you will analyze the class set and discuss the process and the findings with other STEPPIES. You are asked to complete and write up an analysis of student work for the following week; so this assignment is due *February 27th*. In the edTPA, you are required to:

> Justify how your understanding of your students' prior academic learning and personal, cultural, and community assets (from prompts 2a–b above) guided your choice or adaptation of learning tasks and materials. Be explicit about the connections between the learning tasks and students' prior academic learning, their assets, and research/theory.

In your work, you should discuss the following three questions:

1. What assessment did you use and why?
2. What were the main features observed in the student responses (with some measure of their frequency)
3. What are the implications for your teaching of this topic?

Assignment 4: A Doing/Inquiry Activity Due Feb 6, graded

For this activity, you are asked to think about how you might structure a learning activity that requires students to engage in collecting data and justifying their conclusions. Student can work in groups or individually. You will need to justify your choice. You will need to say what you will do to introduce the activity and how you will scaffold it. In addition, you will need to explain what product you will require students to produce either during or after the activity. You should think of this activity as being one you will use to collect the video materials required for the edTPA

Your assignment should include any materials you use and any rationale which might justify the choices that you have made.

Finally, if you use the activity, a reflective piece on how effective it is would be a worthwhile additional piece but is not required for the grade.

Assignment 5: A Talking Activity OR A Writing Activity Due 3/6, graded
For this activity, you are asked to think about how you might structure either:

- a learning activity that requires students to engage in science discussion. This could be either small-group or whole class. You will need to say what you will do to introduce the activity and how you will scaffold it. In addition, you will need to explain what product you will require students to produce either while they are talking or after they have finished talking OR
- a learning activity that requires students to engage in science writing. This could be either individual, small-group or whole class. The written product can be text, a PowerPoint or a poster. You will need to say what you will do to introduce the activity and how you will scaffold it. In addition, you will need to explain what product you will require students to produce either during or after the activity.

Your assignment should include any materials you use and any rationale which might justify the choices that you have made.

Finally, if you use the activity, a reflective piece on how effective it is would be a worthwhile additional piece but is not required for the grade.

Assignment 6: Classroom video and commentary Due on date chosen between Weeks 4 and 7, credit

Starting on week 4, Jan 30th, and for four consecutive weeks, we will have 4 of your classroom videos in C&I; you will select you preferred presentation date during class, Week 1..

We will, in groups of four, watch the videos assigned for the day and then discuss evidence of your students engaging in any of the scientific practices requiring either reading, writing, talking, or doing science (or any combination of these). These videos need to show evidence of you scaffolding and supporting their practice and monitoring their understanding.

You will bring about 8 minutes of video of your class to C&I (according to the edTPA, it must be at least 3 min, no more than 10 min). The 8 minutes can be one continuous piece of video, or the sum of two smaller continuous pieces of video. The video should show

lessons that show you interacting with students in a positive learning environment to support them to:

(1) analyze and interpret evidence and/or data they have collected or selected from a scientific inquiry and

(2) use their analysis to construct and evaluate explanations of or predictions about a real-world phenomenon.

Your discussion in class should focus on what evidence there is of any student understanding of the science content or failure to understand. In particular, you should use the edTPA rubric (you have the electronic version and we will supply a printed version in class) to evaluate the quality of your video.

On your assigned day, you will bring the video clip, arrange a camera or other projection mechanism, be prepared to show the clip, provide your group with 1) a written list of the learning goals for that day, 2) a transcript as necessary, and 3) verbally, in about a minute, any information about specific students that we need in order to interpret what is happening in the video.

You will also provide instructors (submit on Canvas prior to your assigned presentation day) with one printed copy of a short, written response to the following prompts:

a) What is important for an observer to know in order to understand and interpret the interactions between and among you and your students? Please provide any other information needed to interpret the events and interactions in the video clips.
b) How novel or familiar is this activity for these students in science?
c) **In the clip**, what aspect of data collection(s) is/are shown?
d) **In the clip** what did you do to further the students' understanding, and/or try to engage them intellectually while they were engaged in this scientific practice?
e) **In the clip**, what strategies did you use to monitor student learning during the portion of the task shown?
f) Cite examples of interactions **in the clip**, between you and a student(s) that provide evidence of what students were understanding, and discuss this evidence in light of your learning goals for the day.
g) In the clip or lesson, what specific strategies did you use to monitor student learning, either of all of your students and/or specific individual needs, especially address any language supports you used to help your students (including English language learners as well as other students struggling with language) understand the content and/or academic language central to the lesson.

This assignment will be assessed against how well the features (a) to (g) above are discussed.

Assignment 7: A Curriculum Unit Due Mar 20 before 9AM, graded

You are asked to select a unit of study in which your class will engage during several days in April – May. You will develop a Science Curriculum Unit 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, and will be assessed according to the rubric provided.

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.
You should make a plan to work on a section each week, from Assignment 3 on. We encourage you to take the initiative to send us frequent and regular drafts for conversation and feedback as you work. This has to be an Individualized Learning Plan, since you will creating a unique plan. Your plan of work and drafts should be in the order of "Backwards by Design" and as in the order of listing below. The point 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 thorough discussion and revision.

The Curriculum Unit is due on Canvas or emailed directly to both instructors, at the very latest, on Tuesday, March 20th, before 9.00am.

It should have the following components (note: the components below are taken from the edTPA Secondary Science Handbook):

Context description
This should include:

1) Your Big Idea for the Unit. This can be an updated and improved version of Assignment 3A.

2) A description of how some data or information that you have about your students, the school, the department, the time of year, and etc. helped shape the unit plan,
   - ~ please pay particular attention to explaining what academic language issues you have identified in your students and how you might have allowed for these in your prior assessment.
   - ~ please describe and justify your chosen strategy for eliciting prior knowledge.
   - ~ please include a summary of your pre-assessment findings. The instrument and real data can be place in the Appendix.

3) Your Rationales both for teaching this content area, why it might be engaging for students, and for students wanting to learn it.

This section should include references to readings and any other relevant data to provide a context and justification for your choices.

Essential Question(s)

This could look be a Topical or an Overarching Question (see Wiggins & McTighe Ch 5, for more detail). It is important that what your unit is addressing is 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 course unit

Learning Goals

1) These should be written as aims representing some understanding rather than single sentence definitions, equations. These chunks of aims can be lifted directly from, and will together comprise, your science statement and so will exemplify Pedagogical Content Knowledge.
2) The aims will be spelt out as outcomes – what will the students be able to do when you have finished the unit. The outcomes will be measurable and should draw on the Next Generation Science Standards and specify which performance expectations are being addressed. They should make clear both what disciplinary core ideas will be included, *what scientific practices* will be addressed and any cross-cutting concepts

Final Performance Task

This task is an authentic summative assessment, given at the end of the unit and assigned a grade that is to be reported outside the classroom. You will have chosen to give your students both a description of this final project and the grading mechanism at the start of the unit.

The Assessment Guide

1) The criteria for assigning grades or assessing at a rubric level.
2) The way in which "grades" will be assigned on the final performance task will be either a grading scheme and the rationale for it, *and* a rubric that tells the students why they earn what on the task. The grading scheme should be written in terms of the kinds of performance that might be expected from students.

Lesson Plans

You will provide a set of fully developed, sequential lesson plans for **three to five** "instructional hours" or typical 50 minute high school class periods [this means

only 3 to 4 of the 90 – 100 minute block class periods]. It could involve more, but talk to us first if it needs to be a little longer.

- At least one lesson should require students to interact with data en route to creating an argument and a conclusion; so Inquiry should be central in these plans.
- At least one lesson should involve the use of current technology as a route to learning
- Daily formative assessment strategies = strategies for monitoring learning and finding learning gaps during the lesson should be explicit.
- Plans for students to produce work of some sort during the unit should be explicit.
- The Lesson Plan format you use for the lesson plans should include the three key elements:
- Goals: They will come to understand that: (these ARE some of those already listed)
- Activities: To come to understand they will:
- Assessing: I'll know they understand when they:
- It is useful also to have the teacher's agenda and materials so include your To Do agenda for each lesson as well
- Each lesson plan should have attached to it all the handouts that accompany each lesson plan, and cite all resources by complete reference data.

NB: Extensive rationales are not needed for these lesson plans as they should be part of the lesson commentary

Lesson Commentary

Please refer to the edTPA guidelines for this but you should answer the following questions in no more than 9 pages:

1. Central Focus

a) Describe the central focus and purpose of the content you will teach in the learning segment. Given the central focus, describe how the standards and learning objectives within your learning segment address

- the use of science concepts,
- the application of scientific practices through

inquiry, and

- the development and evaluation of evidence-based explanations of or reasonable predictions about a real-world phenomenon based on patterns of evidence and/or data.

b) Explain how your plans build on each other to help students understand relationships between scientific concepts, scientific practices through inquiry, and the phenomenon in the learning segment.

2. Knowledge of Your Students to Inform Teaching

a) Prior academic learning and prerequisite skills related to the central focus—Cite evidence of what students know, what they can do, and what they are still learning to do.

b) Personal, cultural, and community assets related to the central focus—What do you know about your students' everyday experiences, cultural and language backgrounds and practices, and interests?

3. Supporting Students Learning

a) Justify how your understanding of your students' prior academic learning and personal, cultural, and community assets (from prompts 2a–b above) guided your choice or adaptation of learning tasks and materials. Be explicit about the connections between the learning tasks and students' prior academic learning, their assets, and research/theory.

b) Describe and justify why your instructional strategies and planned supports are appropriate for **the whole class, individuals, and groups of students with specific learning needs.**

c) Describe common preconceptions (based on prior academic learning and experiences) within your central focus and how you will identify and address them.

4. Supporting Science Development through Language

a) Language Function. Using information about your student's language assets and needs, identify one language function, from the list below, essential for students to develop understanding of science

concepts, the phenomenon, and the application of scientific practices through inquiry within your central focus.

Functions: Analyze, Explain, Interpret, Justify with evidence, Predict

b) Identify a key learning task from your plans that provides students with opportunities to practice using the language function. Identify the lesson in which the learning task occurs. (Give the lesson/day and number.

c) Additional Language Demands. Given the language function and learning task identified above, describe the following associated language demands (written or oral) students need to understand and/or use:

- Vocabulary and/or symbols
- Plus at least one of the following:
  - Syntax
  - Discourse

d) Language Supports. Refer to your lesson plans and instructional materials as needed in your response to the prompt.

- Identify and describe the planned instructional supports (during and/or prior to the learning task) to help students understand, develop, and use the identified language demands (function, vocabulary and/or symbols, syntax, or discourse).

5. Monitoring Student Learning

a) Describe how your planned formal and informal assessments will provide direct evidence of students' understanding of

- science concepts,
- the real-world phenomenon, AND
- the application of scientific practices through inquiry throughout the learning segment.

b) Explain how the design or adaptation of your planned assessments allows students with specific needs to demonstrate their learning.

Appendices The pre-assessment instrument and data should be included.

More on where we are going during this final quarter in C& I

This third quarter you will continue to study in the four areas:

The Nature of Science:
We will examine the nature of science, for two reasons in order for you to:

1. Restructure your own science knowledge into a deeper understanding of the subject you have chosen to teach and to deliberately develop your Pedagogical Content Knowledge (PCK), by:
   a) understanding that, since the best way for people to make meaning in science is for them to begin with objects and a phenomenon to be explained, teachers need to put the events and objects of the real world as central to their science lesson plans.
   b) helping make meaning clear for your students first, adding definitions, equations, and specialized vocabulary only after some understanding exists and the concept labels can be attached to some objects and events.
   c) making evident both your deep understanding and the values that you have attached to particular content through a "60 second story" which represents the big picture of a particular scientific view of the world, e.g. photosynthesis, so you can examine it in a new way and use it in curriculum development,
   d) developing real ownership of the science by critical examination of misconceptions and alternate conceptions research, texts, models, diagrams and other representations in the public domain. What we teach in science is best seen as a set of 'crazy ideas' which are challenging for students to understand.

And

2. Build a more accurate understanding of the nature of science, i.e. of what science is, as a discipline, especially to re-understand the nature of inquiry and the fallacy of "The Scientific Method", and to connect the ways science is done to the outcomes of those activities, by:
   a) using approaches to the science in lesson plans that promote opportunities for students both to argue what they know, how they know it, and why they trust it (inquiry processes) and to build understandings of concepts (the products of the scientific enterprise).
   b) using approaches that ask and encourage students to figure something out, using evidence.
   c) helping students to build an understanding of science as an activity devoted to constructing explanatory models of the world and the cross-cutting concepts of patterns, scale, energy transfer that are common to all the sciences.
   d) understanding the issues surrounding current efforts to promote "Intelligent Design"/ Creationism in schools and/or to undercut the consensus understanding of biological evolution in schools around the nation,

The Nature of Learning:

We will examine the processes of learning in order for you to:

1. Comprehend that understanding can be neither given nor received, and to act on this understanding in your teaching.
2. Distinguish between information we can give and the understandings that students will construct.
3. Comprehend that scientific meaning of an event is first built not in specialized vocabulary, definitions and equations, but in ordinary everyday language and that when we add specialized vocabulary after such meaning making has occurred it is learned more successfully.
4. Understand that each of us makes deep meaning from two sources: what we already know of the objects, phenomena and domain to be learned, and new information and new phenomena.
5. Understand that we must find out what alternate conceptions our students bring to their learning that will interact with the new information we give them, using research literature and pre-assessment work.
7. Use ideas in your teaching that are based on a cognitive science view of human cognition, e.g. concept mapping, advance organizers, working memory overload, chunking, the pause principle, wait time, etc.
8. Begin seriously to question the notion that our students' capacity to learn is a fixed, unchangeable capacity (the legacy of I.Q.) in favor of the idea that useful, challenging cognitive work and effort will lead students to make real progress in the academic work that they do.

The Nature of Learners:

We will examine the question of who are your students, in order for you to:

1. Find out what your students have already experienced outside school about objects, events, behaviors to which a science topic is or could be connected.
2. Find out both the strengths they bring to class on which you can plan to build, and uncover any alternate conceptions about fundamental ideas they might bring to their studies.
3. Uncover what specific, prior knowledge they have from science classes and from their everyday experiences, including misconceptions.
4. Find out something about them as individuals re. their current academic functioning levels, about their English language fluency, what they do well, and what they need help with.
5. Become very aware of them as individual teenagers, especially re. language, culture, and gender, with rich lives outside of school, rather than lumping them together as a single unit e.g. "they don't want to …", or "my class is very …."
6. Create and set a plan in motion for their progress and achievement over a distinct time period.

The Nature of Teaching:

We will examine the work of effective teachers, in order for you to:

1. Construct an image of teaching different from that of teacher as deliverer of curriculum, sharer of knowledge, star performer, magician with a bag of tricks, etc.,

2. Construct new images of teaching the foci of which are both:
   a) teacher as designer, designing work for students to do in order to build understanding, and
   b) teacher as assessor, designing ways to constantly monitor/assess learning, so that you can help close the gaps between where a student is and where you want her to be.
3. Develop student engagement, learning, and your ownership of what happens in your class that good plans, made well ahead of time, have.
4. Create a well-integrated curriculum unit plan, based on the text "Understanding by Design", and through the process of 'Backwards Planning', and build a plan with your CT to teach it after C&I is over.
5. Know how to make effective lesson plans, in which the goals, strategies and assessments are aligned.
6. Constantly collect data (assess), during class time, about what students are understanding vis-à-vis your intentions so that you can make modifications to close learning gaps, on the spot, or asap,
7. Know that it is hugely valuable to work collaboratively with other teachers, other candidates, your supervisor and Jonathan and Stephanie on the details of your specific classes and your specific science topics in sponsoring your growth and progress as a science teacher, and act on this knowledge.