

EDUC267E

## **Development of Scientific Reasoning and Knowledge**

Stanford University, PreFall/Fall Quarter 2022

Mostly Tuesday, except Thursday Sept 15 and Oct 27, CERAS 204, August 30-November 1, 2022

### **Instructors**

Polly Diffenbaugh

Office: CERAS 313, 650-223-9421

pdiffenbaugh@stanford.edu

Office Hours: By appointment

Sami Chiang

Phone: 510-717-3914

scchiang@stanford.edu

Office Hours: By appointment

### **Course Description:**

In the Development of Scientific Reasoning and Knowledge II we will explore and investigate aspects of science in the elementary classroom. Our overarching goal is to develop your competence and confidence to teach science. We will be emphasizing: 1. The use of phenomena as a method of exploring the world around us, 2. Interpreting the practices of the NGSS and 3. Integrating child centered and culturally relevant content into our lessons. The course will help you integrate science into your teaching. We hope that you will see science as the wonderful, all encompassing, fascinating subject that it is and can be. Like us, our children are so interested in the world around them and they are fantastic question askers. We want to explore how we can facilitate this questioning and investigating of the world and to see what it looks like in our classrooms.

As we explore objects and phenomena, we will listen to ourselves describe, classify, explain, and predict in order to hear what scientific understanding sounds like. We will argue, use scientific models and write about our investigations as a model for what we can do with students. Our discussions will focus on how teaching can foster such understandings in children. We will also discuss how all children can wonder and think about the world we live in and the phenomena they experience every day. Unfortunately, there are many students who are marginalized in science despite their interest and creativity. Some of these learners are not given access to robust and rich science curriculum. Throughout this course, we will be focusing our lens on aspects of equity and how all students can engage in and access scientific content and practices.

In this class we will delve into the Next Generation Science Standards and their strong connections with the Common Core Standards in Math and Language Arts. The emphasis will be on thinking about how we can support literacy in science education. Additionally, we will focus on how you as teachers can build up your own content knowledge.

### **Fall Quarter Goals**

1. Analysis of existing curriculum to understand the structure and content of popular science curriculum materials that you may be using in your classrooms through the framework and structure of the NGSS.
2. Practice skills, strategies, and routines for teaching science (productive talk moves, literacy strategies, see it-do it-write it, applying practices and CCCs, using models, asking questions, navigation routine) and include them in your plans.
3. Understand student's ideas about science topics (pre-assessments) to inform teaching and instruction.
4. Develop a phenomenon-based lesson plan using a known curriculum and the needs of students, including special needs and linguistic / cultural resources.
5. Plan science instruction that promotes social justice by considering the roles of power, agency, and authority in the science classroom.

### **Course Requirements**

Students are required to attend classes regularly and to complete all readings prior to each class. The course will be highly collaborative and active participation is essential. Attendance is extremely important and is required at all class meetings. Students are expected to arrive on time, refrain from leaving prior to the end of the class, and participate actively in class activities and discussions. Classes will include mini-lectures, small group activities, presentations, and discussions of key themes from the assigned readings. We expect that people will remain off of their phones and social media during class and stay focused and engaged with your classmates.

### **Grading Policy:**

Our intention is that all teacher candidates will become more comfortable teaching science and in their own science understandings. Assignments which do not meet criteria will be returned for revision. Please communicate questions or concerns with Polly and Sami directly. We encourage you to ask for extensions in advance as needed.

### **Course Assignments:**

#### **Assignment 1: Curriculum Analysis and Presentation - Due September 20, 2022**

The goal of this assignment is for you to explore some of the main curriculums available in schools right now and to share them with your classmates. You will choose a curriculum you are interested in to analyze independently or with a partner and then create a slide for a shared presentation and jigsaw discussion we will do during week 4 (Sept 20).

#### **Assignment 2: Pre-assessment Design and Analysis - Part 1 Due October 4, Part 2 Due October 18**

For this assignment, you will modify a probe (from the series of books Uncovering Student Ideas in Science) and give it to your students. You will then analyze the data and think about what ideas your students are bringing into the content you plan to teach. Ideally, this assessment will also allow you to gather some data on what your students find interesting, joyful and thoughtful. You will need to plan a time to give this to your students in the weeks of Nov 1 or 8.

#### **Assignment 3: Unit Framework and Lesson Plan - Due November 1 or 8 (following our last week of class)**

Using any curriculum studied in our class or that is used in your school, take an existing lesson from that curriculum and modify it into a lesson plan that takes your students and their needs into account. Link your lesson plan to the NGSS and if possible, consider how you might also make it interdisciplinary. We will be using a lesson planning template that integrates the work of Dr. Gholdy Muhammed in her book Cultivating Genius.

**Extra Class Meeting (Optional):** Soup, Science and Salad - Sunday September 11, 2022, 5:30pm at Polly's house, address in canvas

### **Honor Code:**

Students are expected to adhere to Stanford's honor code. According to the Office of Judicial Affairs (OJA) website, "For purposes of the Stanford University Honor Code, plagiarism is defined as the use, without giving reasonable and appropriate credit to or acknowledging the author or source, of another person's original work, whether such work is made up of code, formulas, ideas, language, research, strategies, writing or other form(s)." For further information, please consult the OJA website:

<http://www.stanford.edu/dept/vpsa/judicialaffairs/students/plagiarism.sources.html>

### **Students with Documented Disabilities:**

Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is made. Students should contact the OAE as soon as possible since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk (phone: 723-1066, URL: <http://studentaffairs.stanford.edu/oae>).

### **Detailed Session Information (Also linked on our Canvas site)**

#### **Session 1: How do I think and behave like a scientist? - Tuesday August 30, 2022 3:15-6pm**

**Essential questions/Goals for the day:** How can we make scientific practices more authentic and inclusive?

**Equity Focus:** Access to science matters. What are we bringing into the classroom and how can we reframe science teaching into teaching for justice?

**Science Focus:** Using science practices (strategies)

#### **Tasks/In-Class Activities:**

- Review readings and consider positionality
- Review syllabus and assignments
- Use Gholdy Muhammad's equity framework to consider lesson planning and relation to curriculum
- Science

#### **Required Reading:**

- Patterson, A., & Gray, S. (2019). Teaching to Transform:(W) holistic Science Pedagogy. Theory Into Practice, 58(4), 328-337.

#### **Supplemental Readings:**

- Williams, A. P. & Gray S. (2021) “(W)holistic Science Pedagogy: Teaching for Justice” Science Teacher. August 2021. [Practitioner Version](#) (example is a high school lesson)
- Not required, but we will be using work from Gholdy Muhammad in class, if you would like a refresher, check out this mindshift episode on KQED, 24 minutes, <https://www.kqed.org/mindshift/58492/how-do-you-cultivate-genius-in-all-students>

#### **In class Resource (in case you would like to review in advance)**

- Muhammad, G. (2020) Cultivating Genius: An equity framework for culturally and historically responsive literacy. Portion of Chapter 2: What is Historically Responsive Literacy. pp 57-61.

#### **Session 2: Standards and Curriculum - Tuesday September 6, 2022 3:15-6pm**

**Essential Questions/Goals for the Day:** How do we read the NGSS standards and what is both in them and missing from them?

**Equity Focus:** How do we bring the Wholistic Science Pedagogy and 5 pursuits from Gholdy Muhammad's work into the standards? Who are our kids and what do they need?

**Science Focus:**

#### **Tasks/In Class Activities:**

- Unpacking the Scientific Practices (differences from the Scientific Method)
- Introduction to the frameworks we will use in class (?)
- Using nature journals as a practice of observation
- Review curriculum choices and sign up for curriculums to review

### Readings:

- Bang, M., Brown, B., Calabrese-Barton, A., Rosebery, A. and Warren, B. (2017) Chapter 3: Towards a more Equitable Learning in Science: Expanding Relationships Among Students, Teachers and Science Practices. *Helping students make sense of the world using next generation science and engineering practices*, 33-58. Focus on pages 33-39, the rest of the chapter is 3 vignettes and then concluding thoughts, they are helpful in seeing examples, pick one to focus on or skim all
- Banks, James. Approaches to Multicultural Curriculum Reform.  
[https://www.teachingforchange.org/wp-content/uploads/2015/11/Banks\\_James.pdf](https://www.teachingforchange.org/wp-content/uploads/2015/11/Banks_James.pdf)

### Additional Resources:

- California Science Framework. <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>
- California Science Standards. <https://www.cde.ca.gov/pd/ca/sc/ngssstandards.asp>
- [John Muir Laws Nature Journaling Curriculum](#), available as a free download. Please download and check out this wonderful resource.
- Osborne, J., & Quinn, H. (2017). Chapter 2: The framework, the NGSS, and the practices of science. *Helping students make sense of the world using next generation science and engineering practices*, 23-32. Skim this, and focus on Figure 2.1 on page 26. How is this different from how you might have learned science?

### Assignment 1 work for today:

Share and explore curriculum - Form curriculum groups using the following curriculum choices: FOSS, Engineering is Elementary, CEEI, Amplify (grade 3), Mystery Science, NGSS Storylines, Learning in Places, Open Sci Ed, Twig

Week 3: Some class time to work on presentations

Week 4: Presentations in class

### Session 3: Asking Questions About Phenomena -Thursday September 15, 2022 3:15-6pm

**Essential questions/Goals for the day:** What is phenomenon based teaching and how do we go about it?

**Equity Focus:** How does using a phenomenon-based approach help to support all learners? What does sensemaking look like in culturally relevant teaching? How can I support culturally and linguistically diverse students in my science classroom?

**Science Focus:** Light and sound (content), Modeling (strategies), anchoring phenomenon routine (strategies)

### Tasks/In-Class Activities:

- Finding and evaluating phenomenon
- Anchoring Phenomenon Routine
- Looking at phenomenon: Notice, Wonder, Remind me of?
- Some time to work on Assignment 1 in groups

### Required Readings:

- McGill, T., Housman, G. and Reiser, B. (September/October 2021) [Motivating three-dimensional learning from students' questions](#). Science and Children.
- Focus on Pages 3-4. Types of Questions. [Learning in Places Collaborative. \(2020\). Framework: Wonderings, "Should We", and Investigation Questions in FieldBased Science](#). Bothell, Seattle, WA

[& Evanston, IL: Learning in Places.](#)

#### **Additional Resources:**

- OpenSciEd Teacher Handbook - What is the role of phenomena in OpenSciEd? (p.8)
- OpenSciEd Teacher Handbook - The Anchoring Phenomenon Routine (pp. 12-14)

Gallas, Karen. Chapter 8. Building a Curriculum from Children's Questions. Pp. 69-81 (optional)

#### **Session 4: Valuing Prior Knowledge - Tuesday September 20, 2022 3:15-6pm**

**Essential questions/Goals for the day:** How do we know what our students know? Where did they develop that knowledge? How can we use pre assessment and children's questions to assess what they are already bringing to the classroom? How can we as teachers ask better questions? How do we develop objectives based on pre-assessment?

**Equity Focus:** How does prior knowledge influence the way students react to new content?

**Science Focus:** Moon phases and seasons (content), challenges and benefits of using modeling in the classroom (strategies)

#### **Tasks/In-Class Activities:**

- Assignment 1, curriculum analysis due
- Find and begin to plan for your pre assessment assignment/talk with your CT about your lesson plan topic
- Analysis of student work or videos (Exploratorium)
- Prior Knowledge using NSTA Probes

#### **Required Readings:**

- Larkin, Douglas. (2019) [Chapter 2: Eliciting Student Ideas. Chapter 3: Every Misconception a Shiny Pebble.](#) Teaching Science in Diverse Classrooms. As a reading or as a [podcast](#). (You can listen to the whole book!)
- Article about pre assessment - maybe the one from the NSTA probes

#### **Optional Reading:**

- Short Summary about [Funds of Knowledge](#), based on the paper by Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory into practice*, 31(2), 132-141.
- Focus on page 1 and 3 of this document. [Learning in Places Collaborative. \(2020\). Framework: Culture, Learning, and Identity. Bothell, Seattle, WA & Evanston, Il: Learning in Places.](#)

#### **Session 5: Designing Investigations/Collecting & Interpreting Data - Tuesday September 27, 2022 3:30-6pm**

**Essential questions/Goals for the day:** How can I support the practice of engaging in data collection practices and conversations? How language and science learning can occur simultaneously?

**Equity Focus:** Engaging students in scientific discourse around data collection

**Science Focus:** ramps and momentum (content) and data collection conversations (strategies), navigation routine (strategies)

#### **Tasks/In-Class Activities:**

- Planning an investigation using available materials

- Connections to observations

### Required Readings:

Jigsaw readings: **½ read Chapter 7 and ½ read Chapter 8**

- Windschitl, Mark, C. (2017). Chapter 7. Planning and carrying out investigations. *Helping students make sense of the world through next generation science and engineering practices*, 135-158.
- Rivet, A., & Ingber, J. (2017). Chapter 8. Analyzing and interpreting data. *Helping students make sense of the world using next generation science and engineering practices*, 159-180.
- Focus on Page 1 and 3: Scaffolding Observations and Data collection [Learning in Places Collaborative. \(2020\). Framework: Observations and Data Collection for Making Sense of Phenomena. Bothell, Seattle, WA & Evanston, IL: Learning in Places.](#)

**Session 6: Tuesday October 4, 2022 3:15-6pm**

**TODAY WE HAVE A FIELD TRIP! We will be meeting at Jasper Ridge at 3:30pm. We will talk more in class to set our details.**

**Essential questions/Goals for the day:** How do we take students out in the field? What are the important ways we need to prepare ourselves and them for out of class activities?

**Equity Focus:** Access to out-of-class spaces

**Science Focus:** Ecosystems and plant communities, mapping and journaling

### Tasks/In-Class Activities:

- Hiking (about 1.5 hours) flat, need water, closed toed shoes and journal
- We will set up carpools to the ridge. It is about 15 minutes from CERAS.

### Required Reading

- Review the conservation pages on the Jasper Ridge Website (<https://jrbp.stanford.edu/conservation>) focus on one aspect of management at the preserve (Fire, Watershed or Wildlife + the biodiversity at the preserve)

**Session 7: Using Models to Explain Phenomena - Tuesday October 11, 2022 3:30-6pm**

**Essential questions/Goals for the day:** How can students use models to explain phenomenon and how can we employ them effectively in our classrooms?

**Equity Focus:** How prior knowledge may influence the way students react to new content?

**Science Focus:** TBD

### Tasks/In-Class Activities:

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### Required Readings:

- Passmore, C., Schwarz, C. and Mankowski, J. (2017) Chapter 6: Developing and Using Models. *Helping students make sense of the world using next generation science and engineering practices*, 109-134
- Focus on pages 1-3. [Learning in Places Collaborative. \(2020\). Framework: Modeling and Forming Explanations. Bothell, Seattle, WA & Evanston, IL: Learning in Places](#)

**Session 8: Talking Science - Tuesday October 18, 2022 3:30-6pm**

**Essential questions/Goals for the day:** What does academically productive talk look like in science? How can I create a learning environment where students can engage in academically productive talk?

**Equity Focus:** Ensuring equitable small group discussions

**Science Focus:** TBA

**Tasks/In-Class Activities:**

- Scientific Practices: Argumentation
- Productive talk moves, setting discussion norms, and equitable small group discussions
- Individual meetings on your final project (set up outside of class)

**Required Readings:**

- Talk Moves single page
- Brown, Bryan. (2019) Science in the City. Chapter 4. Disaggregate Instruction.
- Hudicourt-Barnes, [Conversational Styles](#)

**Additional Resources:**

- Talk Science Primer
- Types of Discussion Resource from OpenSciEd

**Session 9: Reading and Writing Science - Tuesday October 25, 2022 3:30-6pm**

**Essential questions/Goals for the day:** Why is it important to support and focus on literacy during science?

**Equity Focus:** Teaching students how to read science texts *is* equitable science instruction.

**Science Focus:** Content (TBA), Obtaining, Evaluating and Communicating information (strategies)

**Tasks/In-Class Activities:**

- Difficulties of science texts
- Framework for teaching reading in science
- Layered texts and choosing texts for science classrooms

**Required Readings: (Both of these readings are available as an author talk or a paper, choose your modality)**

- Patterson Williams, Alexis, Higgs, JM, Athanases, SZ. Noticing for Equity to Sustain Multilingual Literacies. *Journal of Adolescent and Adult Literacy*, 63(4), 2020, <https://escholarship.org/uc/item/8vm9s55k>
- Patterson Williams, A. D. (2020). Sustaining Disciplinary Literacy in Science: A Transformative, Just Model for Teaching the Language of Science. *Journal of Adolescent & Adult Literacy*, 64(3), 333-336.

**Additional Resources:**

- Lee, Quinn and Valdez. 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*, Vol 42, No 4, pp 223-233.
- Find the common core standards for reading. Look under "Reading Informational Texts" for your grade level. Link to Common Core ELA.

**Session 10: Wrapping Up - Tuesday November 1, 2022 3:30-6pm**

**Essential questions/Goals for the day:** What have we learned about scientific literacy (integrating reading, writing, talking, and doing science) and equity? How will you apply what you have learned to your teaching?

**Equity Focus:** What barriers exist in your classroom for science participation?

**Science Focus:**

**Tasks/In-Class Activities:**

- Equity Reflection
- Concept mapping and applying what we have learned to our teaching
- **Work on Assignment 3 in class (goal to finish unit overview and learning goals by today)**

**Required Readings:**

- TBD