



EDUC267E

Development of Scientific Reasoning and Knowledge

Stanford University, PreFall/Fall Quarter 2025

Wednesday Aug 6, Aug 20, 2:15-5:15 pm, September 3, 10, 17 2:30-5:15 pm

Tuesdays Sept 23, Sept 30, Oct 7, Oct 14, Oct 21 3:15-6:00 pm

Instructors:

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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 and implementing the vision 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 wonder, 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 understanding 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. Analyze existing curriculum to understand the structure and content of popular science curriculum materials that you may be using in your classrooms in terms of alignment with the NGSS and opportunities to promote equity and justice.

2. Practice skills, strategies, and routines for teaching science (productive talk moves, literacy strategies, eliciting student ideas, leveraging phenomena and student questions to drive instruction, anchoring phenomenon routine, investigation routine) and include them in your plans.
3. Understand student's initial ideas about science topics and phenomena to inform teaching and instruction.
4. Customize 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. Students who miss class will be asked to complete an activity or meet with the instructors to review the materials. 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 instructors directly. We encourage you to ask for extensions in advance as needed.

Instructor Communication:

We utilize Canvas for all course information, including emails and announcements. Please make sure that you have your Canvas notifications set to send you emails.

Course Assignments:

Discussions: There will be an assigned discussion question for each session that will build on the readings. Please complete these discussions 24-48 hours before each class. Please answer for yourself and feel free to also build on other people's responses.

Assignment 1: Science Talk - Due September 30, 2025

The goal of this assignment is to (a) get to know your students; (b) see the “seeds” of science and scientific thinking in their everyday interests and activities; and (c) gain low-stakes practice facilitating a Science Talk that supports students in engaging deeply with their own and others’ science ideas.

This assignment includes three major activities:

1. Informal student “interview” or conversation with a small group of students
 - a. **Submit:** Reflection [aim to complete this between **Sept 4-10**]
2. Planning for and carrying out a Science Talk with a small group of students
 - a. **Submit:** Science Talk Plan [aim to complete this between **Sept 10-24**, at least 48 hours before you will do the Science Talk for feedback!]
3. Collectively analyzing student artifacts generated during the Science Talk
 - a. **Submit:** Student artifact(s) and Reflection [**Sept 30, in class**]

Parts 1 and 2 need to be completed by **Week 6 [Sept 23]** – you will bring your student artifacts to class on **Week 7 [Sept 30]** for our collective analysis of them. You will turn in your reflection and write-up about the Science Talk after this in-class activity.

Assignment 2: Lesson Customization - Oct 28, 2025

The focus of this assignment is on building out a specific lesson (i.e., day of instruction) from the OpenSciEd unit you selected for your Science Talk that follows directly from that Science Talk and is also customized to your particular students and contexts, based on what you learned from your Science Talk. Your lesson should align with the vision(s) for science teaching that we have addressed this semester.

Along with a lesson plan, you will submit a written justification for the lesson. This justification should include references to class readings, activities, and discussions.

We will have time in class during Weeks 8, 9, and 10 to work on your customization and justification. The complete assignment is due on **Oct 28**, one week after our final class session.

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 academic accommodations 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: What does it mean to be a scientist? - Wednesday August 6, 2025

Essential questions/Goals for the day: How do we motivate science units with questions that come from students?

Equity Focus: What are we bringing into the classroom and how can we dream toward science teaching for dignity and justice?

Science Focus: Pacifica cliffs

Tasks/In-Class Activities:

- Intros - Science journey
- Reading discussion: Our vision for science ed
- Review syllabus and assignments
- Science exploration: Pacifica cliffs

Reading:

- [Interactive Summary](https://doi.org/10.17226/26215) of: National Academies of Sciences, Engineering, and Medicine 2021. *Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators*. Washington, DC: The National Academies Press.
<https://doi.org/10.17226/26215>

Session 2: Frameworks, Standards, Curriculum, and Equity - Wednesday August 20, 2025, 2:15-5:15

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: What are some additional ways we can frame teaching science for justice?

Science Focus: Pacifica cliffs

Tasks/In Class Activities:

- Continue science exploration: Pacifica cliffs
- Reading and Using the Next Generation Science Standards
- Reading discussion: Equity approaches and applications to curriculum materials
- Introduce Assignment 1 - ***aim to complete Part 1 sometime in the next 2 weeks***

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*, pp. 33-58.
- Gholdy Muhammad. Chapter 2, pages 49-61. *Cultivating Genius. An equity framework for culturally and historically responsive literacy*.

Resources Used in Class:

- 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>
- NASEM Report from Week 1 - Using tables 1.1 and 1.2 in class

Additional Resources:

- Mindshift Podcast. Gholdy Muhammad: How do you cultivate genius in all students? (24 min) <https://www.kqed.org/mindshift/58492/how-do-you-cultivate-genius-in-all-students>
- Mensah, F. M. (2019). Teaching culturally and ethnically diverse learners in the science classroom.

Session 3: The Role of Talk in Science - Wednesday September 3, 2025, 2:30-5:15

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

Equity Focus: Ensuring equitable discussions

Science Focus: Pacifica cliffs; Elwha Dam

Tasks/In-Class Activities:

- Reading discussion: Talk in science
- Listening to students' science talk: Videos and vignettes
- Finish science explorations: Pacifica cliffs
- Introduce science explorations: Elwha Dam

Readings:

- Chapter 5: Children's Talk in Bloom, J. W. (2006). *Creating a classroom community of young scientists*. Routledge.
- [Talk Moves single page](#)
- Hudicourt-Barnes, [Conversational Styles](#)

Resources Used in Class:

- Video: [Maya's ideas about seed travel](#)
- Video: [Gyorgy's ideas about sound production](#) [transcript]
- Vignette: [Translanguaging when exploring electricity](#)

Additional Resources:

- Talk Science Primer
- Suárez, E., & Otero, V. (2024). Ting, tang, tong: Emergent bilingual students investigating and constructing evidence-based explanations about sound production. *Journal of Research in Science Teaching*, 61(1), 137-169.

Session 4: Science Phenomena - Wednesday September 10, 2025, 2:30-5:15

Essential questions/Goals for the day: What is the role of phenomena in science learning and curriculum materials?

Equity Focus: How can phenomena selection “de-settle” our assumptions about science and about students?

Science Focus: Elwha Dam

Tasks/In-Class Activities:

- Reading discussion
- Science explorations: Elwha Dam
- Curriculum review
- Discuss Assignment 1 Part 1 - ***aim to complete Part 2 some time between now and Sept 24***

Readings:

- Gallas, Karen. [Chapter 8. Building a Curriculum from Children's Questions](#). Pp. 69-81
- Types of phenomena for supporting equity [slides + “podcast”, coming soon]

Additional Resources:

- Lee, O. (2020). [Making everyday phenomena phenomenal](#). *Science and Children*, 58(1), 56-61.
- 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.](#)
- Penuel, W. R., & Bell, P. (2016, March). Qualities of a good anchor phenomenon for a coherent sequence of science lessons [Practice Brief No. 28]. STEM Teaching Tools, UW Institute for Science + Math Education. <https://stemteachingtools.org/brief/28>

Session 5: Anchoring Phenomenon Lesson Arcs - Wednesday September 17, 2025, 2:30-5:15

Essential questions/Goals for the day: How can we design a sequence of activities that meaningfully engage students in exploring a phenomenon?

Equity Focus: How can our instructional practices allow for heterogeneous experiences and cultural practices to be valuable assets for doing science?

Science Focus: Elwha Dam

Tasks/In-Class Activities:

- Continue science explorations: Elwha Dam
- Unpacking Pacifica cliffs and Elwha Dam using the Anchoring Phenomenon Routine

Required Readings:

- German, S. (2019). [Using the Anchoring Phenomenon Routine to Introduce a Science Unit](#). *Science Scope*, 42(5), 32-35.
- Supporting Discussions. [OpenSciEd Teacher Handbook](#) (pp. 36-40)

Resources Used in Class:

- [Anchoring Phenomenon Lesson element tracker](#)

Additional Resources:

- [OpenSciEd Teacher Handbook](#) - What is the role of phenomena in OpenSciEd? (p. 8)
- [OpenSciEd Teacher Handbook](#) - The Anchoring Phenomenon Lesson type (p. 14)

Session 6: Using Models to Explain Phenomena - Tuesday September 23, 2025, 3:15-6 pm

CLASS WILL BE HELD AT JASPER RIDGE

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

Equity Focus: How can modeling provide a range of entry points for students to show what they know and work with ideas?

Science Focus: Elwha Dam; Jasper Ridge

Tasks/In-Class Activities:

- Continue science explorations: Elwha Dam & Jasper Ridge
- Role of models in science learning

Readings:

- [Jasper Ridge Story Map](#). This story map about Jasper Ridge was created by Stanford undergraduate Katherine Nolan for her [Bio 105/Esys 105](#) project.
- 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](#)

Resources Used in Class:

- Ms. Sheridan and Ms. Lee vignettes

Session 7: Designing Investigations/Collecting Data - Tuesday September 30, 2025, 3:15-6 pm

Essential questions/Goals for the day: How do we design investigations to support student learning?

Equity Focus: Engaging students in productive uncertainty around designing investigations

Science Focus: Seed travel

Tasks/In-Class Activities:

- Discuss Science Talks (Assignment 1); **submit Part 3 after class**
- Science explorations: Seeds
- Planning to involve students in investigation design

Required Readings:

- Manz, E. (2025). *Productive Uncertainty in Science Education: Engaging Students in Meaningful Science Practice*. NSTA Press. [Chapter 1](#) and [Chapter 2](#)

Resources Used in Class:

- Investigations Project case: [Resourceful Decision-Making: Supporting Children's Engagement in Planning Investigations](#)

Additional Resources:

- 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 8: Literacy Integration and Adapting for Equity - Tuesday October 7, 2025, 3:15-6 pm

Essential questions/Goals for the day: How can science lessons support literacy?

Equity Focus: What are our strategies for adapting existing lessons to better support equity?

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

Tasks/In-Class Activities:

- Explore literacy integration strategies in existing materials
- Begin next lesson adaptations (Assignment 2)

Required Readings:

- Suárez, E., & Sousa, K. (2023). "What did you learn?" [Emergent Bilingual Students Write Their Understandings about Sinking and Floating](#). *Language Arts*, 100(4), 323-328.
- McCourt, S., & Kelley, S. S. (2016). Assessing the unseen: Using music and literature to access and develop first graders' knowledge of sound waves. *Science and Children*, 53(5), 54-59.

Resources Used in Class:

- Curriculum material examples [Investigations Project; OpenSciEd; TBD]
- Find the common core standards for reading. Look under "Reading Informational Texts" for your grade level. [Link to Common Core ELA.](#)

Additional Resources:

- Chapter 7 from Kober, N., Carlone, H., Davis, E.A., Dominguez, X., Manz, E., & Zembal-Saul, C. 2023. *Rise and Thrive with Science: Teaching PK-5 Science and Engineering*. Washington, DC: The National Academies Press.
<https://nap.nationalacademies.org/catalog/26853/rise-and-thrive-with-science-teaching-pk-5-science-and>

- Ward, A. E., Manz, E., & Salgado, M. (2023). [Project-Based Learning: A Justice-Oriented Pathway for Meaningful Science and Literacy Integration](#). *Language Arts*, 100(4), 317-322.
- 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.

Session 9: AI, Ethics, and Lesson Planning - Tuesday October 14, 2025, 3:15-6 pm

Essential questions/Goals for the day: How might we use AI, or not, to help customize lessons for our students?

Equity Focus: Can AI be used to support equity in science learning?

Science Focus: Your focal lesson subjects

Tasks/In-Class Activities:

- Using AI to teach yourself about science content
- Using AI to adapt/customize your lessons - *guest teacher doctoral student Kevin Hall*
- Work on Assignment 2 in class

Required Readings:

- NYT article - [Teachers worry about students using AI, but they love it for themselves](#). PDF or gift article
- Practices of Refusal (under review)

Session 10: Engineering and Wrapping Up - Tuesday October 21, 2025, 3:15-6 pm

Essential questions/Goals for the day: What have we learned about science teaching and equity?

Equity Focus: How will you make decisions about how you apply what you have learned to your teaching?

Science Focus: Engineering

Tasks/In-Class Activities:

- Engineering Design Process
- Equity Reflection
- Concept mapping and applying what we have learned to our teaching
- Work on Assignment 2 in class

Required Readings:

- Lee, S., Russell, J., Campbell, T., & Lee, O. (2022). [Student Agency Through Engineering](#). *Science and Children*, 59(3), 44-51.

Additional Resources

Science and Engineering in Preschool Through Elementary Grades: The Brilliance of Children and the Strengths of Educators (2022)

<https://nap.nationalacademies.org/catalog/26215/science-and-engineering-in-preschool-through-elementary-grades-the-brilliance>

[John Muir Laws Nature Journaling Curriculum](#), available as a free download. Please download and check out this wonderful resource.

And the recent report on equity in preK-12 STEM education expands the four listed in the elementary report to 5: <https://www.nationalacademies.org/our-work/equity-in-prek-12-stem-education>