EDUC267E
Development of Scientific Reasoning and Knowledge
Stanford University, PreFall/Fall Quarter 2024

Tuesdays Sept 3, Sept 10, Sept 17 4:00-6:00 pm,
Sept 24, Oct 1, Oct 8, Oct 15, Oct 22, Oct 29 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. Analysis of 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 (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. 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.

Course Assignments:

Assignment 1: Curriculum Analysis and Presentation - Due September 24, 2024

In this assignment, you will learn more about science curricula that are commonly used in the Bay Area and evaluate their strengths and weaknesses. You will work in teams of 3 to explore your assigned curriculum. In week 4, we will create 3 jigsaw groups of 6 to explore themes and variations of the different curriculums.

Assignment 2: Pre-assessment Design and Analysis - Part 1 Due Oct 8, Part 2 Due Oct 22, 2024

For this assignment you will use a pre-assessment to collect information about students' existing knowledge on a scientific topic. Then, you will give the pre-assessment to your students and analyze the data. The data you collect during this assignment will be used to guide your unit plan in Assignment 3. 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 between October 14-18.

Assignment 3: Unit Framework and Lesson Plan - Due November 12, 2024 (after our last week of class)

In this assignment, you will build on the work you completed in Assignment 2 to plan instruction for your students. You will create a loose unit framework about the topic, as well as write a detailed lesson plan for ONE learning segment in your unit.

Extra Class Meeting (Optional): Soup, Science and Salad and Jasper Ridge Biological Preserve

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: How do I think and behave like a scientist? - Tuesday September 3, 4-6pm
Essential questions/Goals for the day: How do we motivate science units with questions that come from students?
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: Light and Shadows: Using anchoring phenomenon to set up science lessons

Tasks/In-Class Activities:
- Anchoring phenomenon
- Use NGSS Unit Crosswalk to brainstorm possible ideas and phenomena
- Science - https://www.opensciedelemfieldtest.org/grade-1-1
- Review syllabus and assignments

Reading
- German, S. (2019). Using the Anchoring Phenomenon Routine to Introduce a Science Unit. *Science Scope*, *42*(5), 32-35.
- Mensah, F. M. (2019). Teaching culturally and ethnically diverse learners in the science classroom.

Session 2: Standards and Curriculum - Tuesday September 10, 4-6pm
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: What are some additional ways we can we frame teaching science for justice?
Science Focus: Light

Tasks/In Class Activities:
- Developing investigative questions/Driving Question Board
- Unpack the anchoring phenomenon routine - how was our activity "5 dimensional"?
- Introducing 4 approaches to equity (NASEM report)
- Start curriculum 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
- Gholdy Muhammad. Chapter 2, pages 49-61. Cultivating Genius. An equity framework for culturally and historically responsive literacy.
- 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

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
- NASEM Report - Using tables 1.1 and 1.2 in class

Assignment 1 work for today:
Investigate curriculum - Assign curriculum groups in groups of 3: FOSS, Engineering is Elementary, Amplify (grade 3), Mystery Science, Open Sci Ed, Twig
Week 3: Some class time to work on presentations
Week 4: Presentations in class

Session 3: Sensemaking About Phenomena - Tuesday September 17 4-6pm

Essential questions/Goals for the day: How does thinking about phenomenon help us build core science ideas?
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:
- Video: explorations of sound production with multilingual learners
- Science talk
- Class work time: Assignment 1 in groups
- Finding and evaluating phenomenon: Reading discussion

Required Readings:
- Gallas, Karen. Chapter 8. Building a Curriculum from Children's Questions. Pp. 69-81
- 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.

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)
- Phenomenon Finder: (from Southern Nevada Regional Professional Development Program) https://sites.google.com/rpdp.net/snrpdp-science-site/snrpdp-sec-sci-home/phenomena-in-science
- McGill, T., Housman, G. and Reiser, B. (September/October 2021) Motivating three-dimensional learning from students' questions. Science and Children.

- 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
- Chapter 3 in 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

Session 4: Valuing Prior Knowledge - Tuesday September 24, 3:15-6:00pm

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

Tasks/In-Class Activities:

- Assignment 1, curriculum analysis due, working in jigsaw groups
- Prior Knowledge using NSTA Probes, Create driving question board
- Find and begin to plan for your pre assessment assignment/talk with your CT about your lesson plan topic

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!)
- Uncovering Student Ideas: using pre assessment to support student learning

Support Reading:

- 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 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 Data - Tuesday October 1, 3:15-6pm

Essential questions/Goals for the day: How do we design investigations to support student learning?
Equity Focus: Engaging students in scientific discourse around designing investigations
Science Focus: Changing landscapes

Tasks/In-Class Activities:

- Planning an investigation using available materials with an anchoring phenomenon
- Connections to observations
- Work on assignment 2 part 1 in class - questions?

Required Readings:

- Manz, E. (2019). Methods & Strategies: Getting a Grip. *Science and Children*, *56*(8), 80-87.
- 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.
- 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.

Additional Resources:

- possible video (https://ambitiousscienceteaching.org/tools-to-support-model-based-claims-evidence-and-reasoning/)
- https://www.csmonitor.com/USA/2016/0211/Living-on-the-edge-Residents-of-crumbling-Pacifica-cliffs-are-fighting-time

Session 6: Using Models to Explain Phenomena - Tuesday October 8, 3:15-6 pm

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 prior knowledge may influence the way students react to new content?
Science Focus: Return to light and investigating based on our consensus model

Tasks/In-Class Activities:

- What role do models play in promoting collective development of science ideas?
- Continue investigating light

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

Assignment 2 Part 1 due today. Look ahead and plan when you can give your probe to your students.

Session 7: Talking Science - Tuesday October 15, 3:15-6pm
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 small group discussions
Science Focus: Sound

Tasks/In-Class Activities:

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

Required 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

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 8: Reading and Writing Science - Tuesday October 22, 3:15-6pm
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
- Claim evidence reasoning
- Framework for teaching reading in science
- Layered texts and choosing texts for science classrooms

Required Readings:

- 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
- 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. (Link author talk)

Additional Resources:

- Find the common core standards for reading. Look under "Reading Informational Texts" for your grade level. Link to Common Core ELA.
- Patterson, A., & Gray, S. (2019). Teaching to Transform: (W)holistic Science Pedagogy. Theory Into Practice, 58(4), 328-337. This is the full paper discussed briefly in the previous

Session 9: Wrapping Up - Tuesday October 29, 3:15-6pm
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: Engineering

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:

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

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