OUSD Science

All OUSD students nurture curiosity and develop scientific understanding of our world in order to address personal, community, and global issues.

MISSION

To ensure all students have high quality science experiences that are relevant, engaging, rigorous and literacy-rich, the OUSD Science Department will:

- Develop and distribute high quality instructional materials, curriculum, and assessments.
- Provide learning opportunities for teachers responsible for science instruction.
- Build the capacity of teacher leaders, principals, and district leaders.
- Collaborate with internal and external partners to strengthen future work and celebrate accomplishments, and align district priorities.

Next Generation Science Standards (NGSS)

WHAT ARE THE NEW SCIENCE STANDARDS?

The Next Generation Science Standards (NGSS) are a new set of K–12 science standards that were developed by states, for states. The NGSS identify scientific and engineering practices, crosscutting concepts, and core ideas in science that all K–12 students should master in order to prepare for success in college and 21st-century careers.

WHY ARE THEY IMPORTANT?

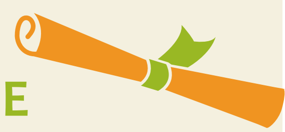
It has been more than 17 years since the National Research Council and the American Association for the Advancement of Science produced their reports from which most state science standards are based. Since then, there have been major advances in science and our understanding of how students learn science. Students need the kind of preparation that gives them the tools and skills necessary to succeed in a rapidly and continuously changing world.

When current students graduate from high school, more jobs will require skills in science, technology, engineering, and mathematics (STEM) than in the past. The NGSS provide a strong science education that equips students with the ability to think critically, analyze information, and solve complex problems — the skills needed to pursue opportunities within and beyond STEM fields.

HOW WERE THEY DEVELOPED?

The NGSS were developed through a collaborative state-led process. Science supervisors from 26 states worked with a 40-member writing team—which included teachers, working scientists, and education researchers—to develop the draft standards, based on the National Research Council's document *A Framework for K–12 Science Education*. Each of the 26 states established a broad-based committee to review draft standards and provide feedback. In addition to those reviews, a larger stakeholder team composed of hundreds of members representing K–12 educators, administrators, higher-education faculty, scientists, engineers, business leaders, policymakers, and key organizations provided feedback during five review periods. The draft standards went through two public review periods and received comments from more than 10,000 individuals.

HOW WILL THE NGSS SUPPORT COLLEGE AND CAREER READINESS FOR ALL STUDENTS AND PREPARE THEM TO SUCCEED IN THE GLOBAL ECONOMY?



A high-quality, robust science education means students will develop an in-depth understanding of content and will gain knowledge and develop skills—communication, collaboration, inquiry, problem solving, and flexibility—that will serve them throughout their educational and professional lives.

The NGSS were benchmarked against countries whose students perform well in science and engineering fields, including Finland, South Korea, China, Canada, England, Hungary, Ireland, Japan, and Singapore.

WHAT WILL THE NGSS LOOK LIKE IN THE CLASSROOM?

High-quality education standards allow educators to teach effectively, moving their practice toward how students learn best—in a hands-on, collaborative, and integrated environment rooted in inquiry and discovery. Teaching based on the NGSS calls for more student-centered learning that enables students to think on their own, problem solve, communicate, and collaborate—in addition to learning important scientific concepts.

THE NGSS OFFER FIVE INNOVATIONS FOR TEACHING

1. **Three Dimensional Learning:** There are three equally important, distinct dimensions to learning science included in the NGSS: Scientific and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. The NGSS connect all three dimensions. To prepare students for success in college and 21st century careers, the NGSS also connect scientific principles to real-world situations, allowing for more engaging and relevant instruction to explore complicated topics.

2. **All three dimensions build coherent learning progressions:** The NGSS provide students with continued opportunities to engage in and develop a deeper understanding of each of the three dimensions of science. Building on the knowledge and skills gained from each grade—from elementary through high school—students have multiple opportunities to revisit and expand their understanding of all three dimensions by the end of high school.

3. **Students engage with phenomena and design solutions:** In instructional systems aligned to the NGSS, the goal of instruction is for students to be able to explain real-world phenomena and to design solutions using their understanding of the Disciplinary Core Ideas. Students can achieve this goal by engaging in the Science and Engineering Practices and applying the Crosscutting Concepts.

4. **Engineering and the Nature of Science is integrated into science:** Some unique aspects of engineering (e.g., identifying problems) are incorporated throughout the NGSS. In addition, unique aspects of the nature of science (e.g., how theories are developed) are also included throughout the NGSS as practices and crosscutting concepts.

5. **Science is connected to math and literacy:** The NGSS not only provide for coherence in science instruction and learning but the standards also connect science with mathematics and English Language Arts. This meaningful and substantive overlapping of skills and knowledge affords all students equitable access to the learning standards.

COMMON MISCONCEPTIONS ABOUT THE NGSS

Myth: The NGSS were developed by the United States Department of Education.
FACT: The Next Generation Science Standards (NGSS) were developed through a collaborative state-led process. Twenty-six states volunteered to work with the 40 members of the writing team to lead the development of the standards, and each state formed broad-based committees to work on the standards.

Myth: The NGSS were developed without public input.
FACT: The draft standards received comments from more than 10,000 individuals during each of two public review periods. These comments came from teachers, school and school district discussion groups, scientific societies, parents, and students. In addition, an expert team composed of hundreds of members representing K–12 educators, administrators, higher education faculty, scientists, engineers, business leaders, policymakers, and key organizations provided confidential feedback during critical points of the development process.

Myth: The NGSS were developed without teacher input.
FACT: To develop the standards, the science supervisors in the 26 lead states worked with a 40-member writer team, all of whom were education experts and more than half of whom were practicing K–12 teachers. Thousands of teachers also provided comments to the draft standards during the two public review periods and as part of expert review panels.

Myth: The NGSS will force states and districts to adopt a uniform curriculum.
FACT: The NGSS are standards, not curricula. Local districts, schools, and classroom teachers will continue to determine their own curriculum, including what is taught throughout the year and how it is taught.

Myth: The NGSS are part of the Common Core.
FACT: The NGSS are not part of the Common Core State Standards (CCSS). The CCSS only cover mathematics and English Language Arts (ELA)/literacy whereas the NGSS are a separate set of K–12 science standards that were drafted through a distinctly different process.

Myth: The NGSS are funded with federal dollars.
FACT: No federal funding, grants, or formula funding is tied to the adoption of the NGSS nor was used to develop them. The Carnegie Corporation of New York, a foundation dedicated to improving science education in the U.S., provided funding support for the development of the NGSS.

Myth: The NGSS are too rigorous for students who have no intention of pursuing science after high school.
FACT: Science is a key factor in students' ability to think critically and innovate. All students need strong foundational knowledge in science to tackle long-term and difficult issues that face our generation and future generations. A strong science education equips students with skills that are necessary for lasting success in their postsecondary lives and careers.

Myth: The NGSS are not rigorous enough for students interested in advanced classes in high school and beyond.
FACT: The NGSS does not set a ceiling for student achievement. Students who wish to take advanced coursework will still have the opportunity to do so, and the NGSS will provide them with a solid academic foundation for college-level science courses.

New Vision for Science Education - NGSS Pedagogical Shifts

SCIENCE EDUCATION WILL INVOLVE LESS:		SCIENCE EDUCATION WILL INVOLVE MORE:
1. Rote memorization of facts and terminology	<-->	Facts and terminology learned as needed while developing explanations and designing solutions supported by evidence-based arguments and reasoning
2. Learning of ideas disconnected from questions about phenomena	<-->	Systems thinking and modeling to explain phenomena and to give a relevant context for the ideas to be learned
3. Teachers providing information to the whole class	<-->	Students conducting investigations, solving problems, and engaging in discussions with teachers' guidance
4. Teachers posing questions with only one right answer	<-->	Students discussing open-ended questions that focus on the strength of the evidence used to generate claims
5. Students reading textbooks and answering questions at the end of the chapter	<-->	Students reading multiple sources, including science-related magazine and journal articles and web-based resources; students reading for different purposes, including summarizing, evidence-building, etc.
6. Pre-planned outcome for "cookbook" laboratories or hands-on activities	<-->	Relevant task that drives multiple investigations and prompted by students' questions with a range of possible outcomes that collectively lead to a deep understanding of established core scientific ideas
7. Worksheets	<-->	Student writing of journals, reports, posters, and media presentations that explain and argue
8. Oversimplification of activities for students who are perceived to be less able to do science and engineering	<-->	Provision of supports so that all students can engage in sophisticated science and engineering practices, as well as opportunities to produce language that communicates their ideas and reasoning
9. Participation by a few students	<-->	All students are engaged in learning and choose appropriate scaffolds for learning
10. Assessment focused on content knowledge	<-->	Assessment focuses on learning of the three dimensions of NGSS that spirals throughout the grades
11. Unstructured group work focused on completion of the task	<-->	Students collaborate to build understanding and revise their thinking when presented with new evidence

Adapted from the OUSD Science Department's 5x8 Card and the National Research Council's Guide to Implementing the Next Generation Science Standards (pp. 8-9). Washington, DC: National Academies Press. 2015.
http://www.nap.edu/catalog/18802/guide-to-implementing-the-next-generation-science-standards

OUSD Science

Draft July 2016

Oakland Unified School District Science Department
High Quality Science Learning Indicators – *Work in Progress*

Categories & Definition		**Observable Student Indicators (high quality behaviors, actions, and outputs)**
Language for Learning The use of academic language to communicate information, ideas, concepts, and questions necessary for academic success.	1	Students **listen** actively, as indicated by non-verbal actions, such as eyes on speaker, leaning in, etc.
	2	Students **use language to communicate about science regardless of proficiency level** (safety, risk-taking)
	3	Students **demonstrate "eagerness" to use new words/phrases** to speak about content
	4	Students **reference resources** to help with oral/written output, such as anchor charts, sentence stems, notebooks, textbook, other students, teachers, technology, etc.
	5	Students **use specific vocabulary**, both orally and in writing, to convey ideas in a given context.
	6	Students **share their prior knowledge**, observations, and/or ideas about an observed phenomenon, video, or text, both orally and in writing.
	7	Students **use specific language functions** that match the task, e.g. using argumentation language to justify a design change.
	8	Students **write for various purposes** (e.g. procedural writing, observational writing, evidence-based arguments.)

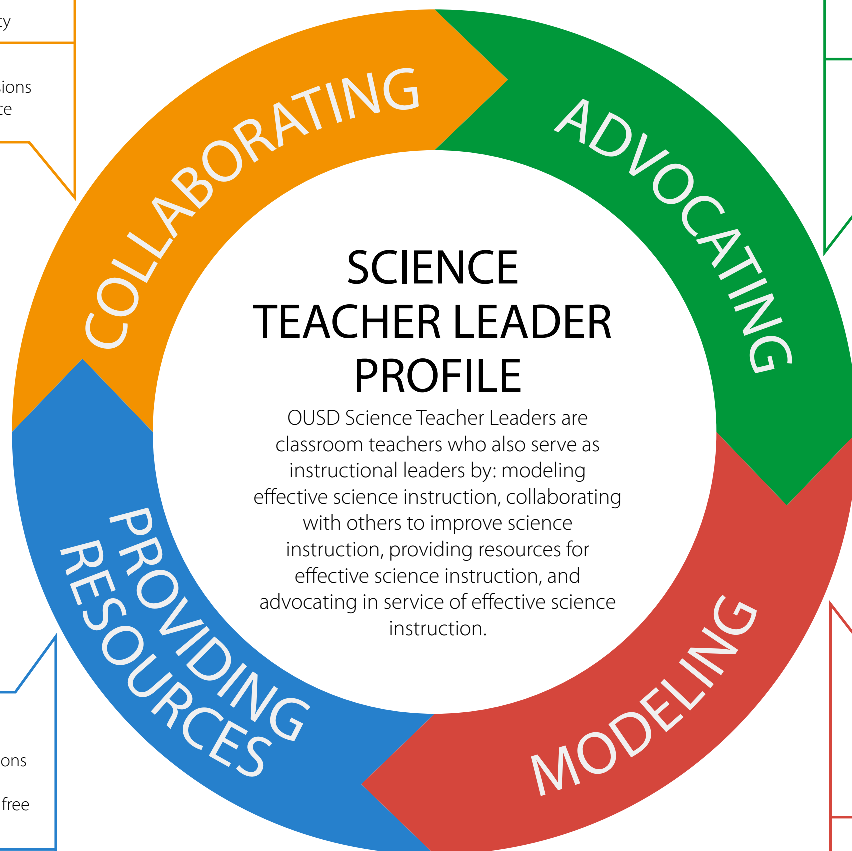
Sense-making for Learning The ability or attempt to understand ambiguous experiences or situations.	1	Students **activate and use prior knowledge and experiences** to make predictions. (Ex: personal connections, KWL, previous science activities) Students apply their thinking to new situations.
	2	Students critically **evaluate and question ideas, data, and possible explanations**. (Ex: by asking follow up questions, research and jigsaw from resources, engaging in open-ended inquiry)
	3	Students **construct and revise evidence-based explanations** (Ex: notebooking, warm up and cool down exercises (oral and written), observations and data and analysis)
	4	Students **engage in discussion and argumentation with others**. (Ex: to promote understanding (not just be correct), explore possible explanations, collect ideas from others, agree or disagree with an idea, ask for clarification)
	5	Students **represent and communicate ideas in multiple ways**, both orally and in writing. (Ex: creating models, posters, writing in notebooks, formal presentations, partner talks, small group talk, and whole group discussion.)
	6	Students **engage in reflection and revision of their ideas and learning process,** both written and orally, taking risks as needed.

Categories & Definition		Observable Student Indicators (high quality behaviors, actions, and outputs)
Engagement for Learning The connections to content and practices that results in an investment in learning.	1	Students **ask questions** of self, peers, teachers and secondary sources (text, experts, video) to probe for deeper understanding and challenge ideas.
	2	Students **share ideas**, **build on each other's ideas, agree or disagree, defend their ideas, and change their ideas** as they construct meaning verbally through structured dialogue. (Elaborating, paraphrasing, etc.)
	3	Students **build upon previous experiences** in and out of school.
	4	Students can **apply new learning** to themselves, their family and their community. Students recognize and can talk about connections to the world outside of their community.
	5	Students **develop and refine specific, short-term goals** that are both challenging and attainable, select appropriate scaffolds, note their progress, verbalize the next steps and recover quickly from setbacks.
	6	Students **participate in classroom routines and systems unprompted** (turning in work, accessing materials, cleaning, etc.), monitor themselves and peers, and make suggestions on how to improve.
	7	Students **take risks**, admit confusion, make and learn from mistakes, and embrace the "productive struggle" by showing a willingness to persevere and following-through.

Interpersonal Interactions The social attributes and behaviors enabling productive learning during collaboration with others.	1	Students **reflect** on their own participation and on group collaboration.
	2	Students **respectfully challenge and encourage** each other's thinking.
	3	Students **cite evidence and reasoning**, not source status, when evaluating peers' claims.
	4	Students **give each other meaningful feedback** on participation and process.
	5	Students **contribute to the task of the group** through discussion, thinking, writing, or drawing.
	6	Students **engage and contribute** to the scientific conversation using a variety of communication modalities for diverse tasks and audiences.
	7	Students **collaborate to design learning** to meet their needs in gaining understanding of the phenomena
	8	Students **work within the group** to cultivate relationships and respect emotions of others to complete the task.
	9	Students **share their own prior knowledge**, experiences, understanding, and/or claims with peers to contribute to the group.
	10	Students **ask clarifying questions**, **productively argue, agree and disagree, and/or build** on each other's thinking to deepen understanding.
	11	Students actively **listen to peers**, ask clarifying or probing questions, and/or paraphrase other's ideas or claims to increase their own learning.
	12	Students **participate in established protocols** including assigned roles.
	13	All students **participate in the generation of ideas**, **evidence, and solutions** for problems and explanation.
	14	Students and groups **revise thinking** and **explanations** based on inputs from other groups, individuals, and other sources.
	15	Students **self monitor** their participation in group discussions and norms by choosing the appropriate volume, discourse and frequency.
	16	Students **act as experts contributing evidence** from other sources to group work and discussion.

SCIENCE TEACHER LEADER PROFILE

OUSD Science Teacher Leaders are classroom teachers who also serve as instructional leaders by: modeling effective science instruction, collaborating with others to improve science instruction, providing resources for effective science instruction, and advocating in service of effective science instruction.



COLLABORATING
with others to improve science instruction

Self
- Participate in science professional development
- Value the power of collaboration and the conditions that support it
- Develop productive meeting formats and processes
- Understand how to mentor, support, and coach a variety of teachers
- Contribute to the science teacher leader community

With Others
- Initiate and facilitate peer collaboration
- Facilitate science focused professional learning sessions
- Mentor and coach teachers to improve their practice

ADVOCATING
in service of effective science instruction

Self
- Keep abreast of science related policies, expectations, and decisions
- Regularly communicate and remind administrators and teachers about science expectations and opportunities
- Identify opportunities to integrate science into the core instructional plan
- Ensure representation for science instruction in school governance
- Analyze the political climate and context of the school site for the purposes of supporting science instruction

With Others
- Identify and develop common pedagogies across subject areas such as academic discussions
- Advocate for the prioritization of science instruction in school-wide decision making
- Build alliances that advocate for improved science instruction

PROVIDING RESOURCES
for effective science instruction

Self
- Keep abreast of science related news and resources
- Access resources such as district provided materials
- Create and adapt instructional resources such as lessons and units
- Identify resources such as fieldtrips, speakers, grants, free or donated materials, and access to technology

With Others
- Share readings, lessons, and ideas
- Support regular access to district provided materials and supplies
- Share ideas for science events, field trips, speakers, free or donated materials, etc.

MODELING
effective science instruction

Self
- Make effective science instruction visible
- Commit to deep understanding of NGSS instruction
- Be open to improving teaching practices
- Regularly reflect on teaching practice
- Balance and integrate non-science commitments to maximize science instruction

With Others
- Open your door to being observed and collaboratively evaluating the lesson
- Analyze and discuss teaching practices utilizing the indicators of high quality science instruction

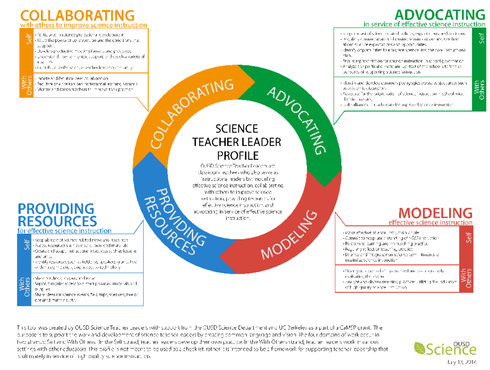
OUSD Science

This tool was created by Oakland Unified School District Science Teacher Leaders with support from the OUSD Science Department and UC Berkeley as a part of a CaMSP grant. The purpose is to support the work and development of science teacher leaders by creating common language and vision. The four domains of work occur in two strands: Self and With Others. In the Self strand, teacher leaders develop their own practice. In the With Others strand, teacher leaders work in various settings with other educators. This profile is not meant to be used as an evaluative checklist, rather it is intended to be a framework for supporting teacher leadership that is ultimately in service of high quality science instruction.

July 15, 2016

Science Teacher Leadership in OUSD
2016-2017 Roles, Responsibilities, & Benefits

Description



Science Teacher Leaders continue to serve as lead learners in their content, playing a critical role in the development of site-based leadership to support the transition to the Next Generation Science Standards. Science Teacher Leaders **collaborate** to improve science instruction, **advocate** in the service of effective science instruction, **model** effective science practices, and **provide resources**. They exercise their influence in formal and informal contexts, maintain a growth mindset, and support Professional Learning Community structures within their schools.

For 2016-2017, the instructional focus will be based on the NGSS pedagogical shifts, with particular attention to writing with evidence, quality lesson design and inquiry, small group instruction, and academic social emotional learning. Leaders will use the Student Indicators of High Quality Science Learning to gauge student learning.

Roles and Responsibilities

- Serve on the site Instructional Leadership Team (ILT), which meets a minimum of once a month.
- Support implementation and revision of the site plan with administration and ILT to improve instruction and student achievement.
- Work with ILT to facilitate site-based professional learning and site-based inquiry cycles. This can include department meetings, collaboration sessions, or lesson study focused on the implementation of NGSS.
- Serve as an advocate and point person for instructional shifts in science at school sites, and coordinate with other Teacher Leaders to support cross-content pedagogical shifts in the classroom.
- Support grade level teams of teachers as they engage in collaborative instructional planning cycles around the instructional shifts.
- Promote and foster a culture of collaboration and collective responsibility for teaching and learning.
- Open her/his classroom to colleagues and invite them to learn together. Model a disposition of continuous learning and reflection
- Communicate information shared and learned from Science TL meetings with school staff in a timely way.
- Use OUSD Google email/calendar/documents for communication.
- TK-5 Teacher Leaders also:
    - Coordinate the delivery and pickup of the FOSS kits
    - Submit inventory forms for missing materials at the start of each trimester
    - Order live organisms before the start of the life science rotation for the school

Activities

- All K-12 Science Teacher Leaders attend 6 professional learning sessions, from 4:00-6:00 pm on:
    - August 18, 2016 at the Oakland Zoo
    - September 22, 2016 at Chabot Space and Science center
    - November 3, 2016 at Chabot Space and Science Center
    - January 5, 2017 at the Oakland Zoo
    - March 2, 2017 at the Oakland Zoo
    - May 4, 2017 at the Oakland Zoo

- TK-5 Science Teacher Leaders attend one Live Organism meeting during their school's FOSS Life Science rotation, from 4:30-6:00 pm at the SMART Center on:
    - August 25, 2016 (fall)

- November 15, 2016
- March 7, 2017

- NGSS Early Implementation Initiative and California Math and Science Partnership (CaMSP BOLTS) Grant Teacher Leaders *also* participate in:
  - Two rounds of Lesson Study (4 release days total)
  - Summer Teacher Leadership Institute July 24-28, 2017, Dublin
  - End-of-Year Retreat on Saturday April 22, 2017, 9:00 am-3:30 pm at Chabot Space and Science Center.

- Attend 5 Principal/ILT Summit PDs* in lieu of the regular Teacher Leader meetings from 4:00-6:30 pm on:
  - October 6, 2016
  - December 1, 2016
  - February 2, 2017
  - April 13, 2017
  - June ILT Retreat, date TBD.

* if member of the ILT

Benefits

- Up to $1500 stipend (or OUSD Professional Growth Units) per school ** based on participation in all the professional development sessions, including the ILT Summits, and partnering to facilitate/coordinate site-based Professional Learning at school sites.
- Additional leadership stipend for participation in the Summer Leadership Institute ($1000) and Saturday Retreat ($250) (NGSS Early Implementation and CaMSP only).
- Develop skills in facilitation, team building, and leadership.
- Develop pedagogical skills and expertise for CCSS/NGSS, including the district instructional foci.
- Opportunity to deepen subject area content and pedagogical knowledge.
- Network with Teacher Leaders from other school sites.

** School sites may have additional Teacher Leaders as part of the NGSS Early Implementation/CaMSP programs

Recruitment Process (OUSD and OEA Agreement - February 2014)

1. Teachers and principals are informed about roles, responsibilities, and selection process.
2. Teachers download this Nomination Form to nominate oneself or a peer.
3. Teachers submit the nomination form to their principal and others involved in TL selection.
4. If there are no applicants in a content area, the Principal will make the nomination.
5. A peer-review process is recommended if there is more than one applicant. In moving towards shared decision-making, the department, ILT, or a Peer Review Committee can review nominees and make a recommendation to the principal.
6. The principal makes the final decision with considerations from the peer-review process.
7. The principal submits the final selection to the Elementary Teacher Leader Team using the Google form.

In nominating and selecting teacher leaders, we consider individuals who:

- Take a learning stance towards teaching practices
- Focus on equitable outcomes for students
- Demonstrate high quality instruction
- Demonstrate capacity to lead/facilitate colleagues in professional learning
- Have knowledge and experience with CCSS and NGSS
- Exhibit strong rapport with peers
- Are open to change and leading change

Funding for Teacher Leaders:
Subject Area Teacher Leaders will be funded through Teaching & Learning and the NGSS Early Implementation/CaMSP BOLTS program. If a school site would like to have additional teacher leaders, it will need to provide the funding.

Questions? Please contact:

Claudio Vargas, claudio.vargas@ousd.org

Science Teacher Leadership Initiatives in OUSD 2016-17

Oakland Language Immersion Advancement in Science (OLAS), a California Elementary Mathematics and Science Professional Learning Initiative Grant

This new project will support a two-year program, from January 2016 through December 2017, focusing on leadership, Dual Language programs, and the Next Generation Science Standards.

Partners include:

- Oakland Unified School District (Science and ELLMA)
- UC Berkeley Principal Leadership Institute (PLI)
- UC Berkeley Multicultural Urban Secondary English Master's Program (MUSE)
- UC Museum of Paleontology
- Bay Area Writing Project

Goals:

1. Work with teams composed of 5 Teacher Leaders and their principal from 5 OUSD Spanish Dual Language Elementary Schools (Melrose leadership Academy, Esperanza, Global Family, Community United, and International Community School) to implement the Next Generation Science Standards (NGSS).
2. Strengthen each team's content, pedagogical, and collective knowledge and instructional leadership skills for the continued implementation of NGSS.
3. Focus on equity for all students.
4. Launch a professional development network of Spanish Dual Language Elementary Schools in the Bay Area that supports the implementation of NGSS.

Main activities include:

- Initial planning, assessment of needs, teacher recruitment, and an introduction to the project during the spring of 2016.
- Weeklong summer institutes during June 2016 and 2017. Professional development choices including Universal Design for Learning (UDL), science content, meeting needs of EL students, Professional Learning Communities, leadership development, Spanish language support, etc. Includes creating an instructional plan for each school related to the implementation of NGSS and curricular goals.
- On-site support to the ILTs to meet their instructional goals set at the summer institute during the 2016-17 school year. (10 hours of facilitation and coaching)
- Curricular work groups that are composed of members across school sites.
- Equity centered professional learning community for the school administrators. (5 x 1.5 hour meetings)

Participants:

- 5 Dual Language schools
- 5 Teacher Leaders from the ILT of each of these schools (25 teachers)
- 5 principals from these schools

NGSS Early Implementation Initiative, WestEd and Building Oakland Leadership for the Teaching of Science (BOLTS) Project, a California Math and Science Partnership Program (MSP) Grant.

The NGSS K-8 Early Implementation Initiative is a 4-year program designed to assist districts and charters as they "jump start" the implementation of the California NGSS. The CaMSP grant serves to build on this work by a deeper focus on Teacher Leadership in OUSD.

Partners include:

- Oakland Unified School District.
- K-12 Alliance at WestEd.
- Other selected California school districts (Palm Springs, Vista, San Diego, Tracy, Kings Canyon, Galt, Dublin, Lakeside; Aspire charter, and High School High charter).
- UC Berkeley College of Letters and Sciences (BOLTS)
- UC Berkeley School of Education (BOLTS)
- The Exploratorium (BOLTS)

Goals:

- Foster teacher expertise in content, skills and practices along a continuum aligned to the NGSS;
- Build NGSS instructional leadership for Teacher Leaders; Teaching and Learning Collaborative, Science Teacher Leadership Meetings, and a Yearend Educational Day.
- Develop instructional tools, curriculum, and resources for all K-12 teachers and classrooms aligned to the NGSS.

Main activities include:

- Summer Institute (40 hours) focused on NGSS awareness, change management, lesson study, formative assessments, literacy integration, equity in science education and lesson planning.
- Monthly follow-up meetings. (20 hours)
- Four 6-hour sessions (2 cycles) of Teacher and Learning Collaborative (TLC) Lesson Study. The TLC focuses on lesson study as a tool to plan and execute an intensive instructional sequence in small grade-level teams of 3-4 teachers. Each of the two rounds of TLC will consist of lesson study planning, team teaching, and reflection on NGSS lessons and assessment tasks. (30 hours)
- One year-end 6-hour Educational Day. The year-end Educational Day provides additional reflection and planning for school site NGSS implementation. (6 hours)

Participants:

- 34 elementary schools; 2 middle schools; 5 high schools.
- 78 Teacher Leaders

Total Teacher Leader Programs 2016-2017

- CaMPS: 56 teachers (47 elementary; 2 middle school; 5 high school)
- IEI: 22 teachers (18 elementary; 4 middle school)
- OUSD: 26 teachers (15 elementary; 9 middle school; 2 high school)
- **Total**: 104 Teacher Leaders

SIRA
Science Instructional Reflection and Assessment

Science Instructional Reflection and Assessment

The Science Instructional Reflection and Assessment (SIRA) was designed as a transition strategy to prepare OUSD elementary teachers and students for the upcoming shifts of the newly adopted Next Generation Science Standards (NGSS). The SIRA also better aligns our current FOSS science modules with the ELA Common Core State Standards. Developed by OUSD's Elementary Science Team in partnership with veteran OUSD teachers, the SIRA is an instructional sequence that helps focus and deepen the teaching of FOSS modules, while emphasizing the science practices and crosscutting concepts called for in NGSS. In addition, the SIRA increases opportunities for students to develop CCSS-aligned language and literacy skills as they make sense of the science they are experiencing. The SIRA defines clear learning goals, encourages frequent formative assessment, and leads to a concise summative assessment for FOSS science modules.

Why the SIRA?

The Elementary Science Team is driven by a vision that all Oakland students enter middle school with a solid understanding of key scientific principles and practices. This is a minimum requirement for participating in a democratic society, where science plays an important role around issues of health, safety, and the environment. Further, we strive to ensure that all Oakland students, regardless of race, ethnicity, socioeconomic status, or language learner status, gain access to and succeed in the highest levels of high school science offered here in OUSD, the Advanced Placement (AP) courses. To that end, the SIRA supports teachers and students by offering clear learning goals and a road map to ensure that students are meeting those goals, so that all students can succeed in classrooms, college, and career.

Assessment in science, as a tool for understanding whether instructional goals are met, is not a frequent practice in most OUSD elementary classrooms. There are a few reasons for this. First, FOSS provides summative assessments at each grade but these assessments are lengthy and considered impractical to administer and score by many teachers. Second, FOSS provides tips for formative assessment, though these are rarely followed because they are not always embedded in the lesson plans themselves. As a result, science instruction often occurs in OUSD classrooms without systematic assessment. Increasing the use of assessment to improve learning outcomes is a goal of the SIRA.

What is the SIRA?

Conceptual Framework. The SIRA begins with a conceptual framework that tightly outlines the most important concepts, science practices, and crosscutting concepts addressed in a particular FOSS module. This map serves as the anchor for subsequent sections of the SIRA.

Instructional Plan and Formative Assessment. With the conceptual framework as an anchor, a highly focused, lesson-by-lesson instructional roadmap outlines tightly connected focus questions, key concepts, and learning objectives (content language objectives for grades K-2). Suggestions for assessing each learning objective through writing or discussion prompts are offered, including optional scaffolds and expected student responses. The most commonly suggested forms of formative assessment are the 10-minute Reflective Assessment Protocol for work in science notebooks or a Science Talk Checklist for use during academic discussions. The Instructional Plan is to be used hand-in-hand with our current FOSS modules and FOSS Teacher Guides.

Summative End-of-Module Assessment. For grades 3-5, the Instructional Plan culminates in a written assessment designed from a pool of existing FOSS assessment items as well as some that were internally-developed. The assessment covers science concepts as well as crosscutting concepts and practices from NGSS, with a focus on higher-order thinking skills and evidence-based reasoning, as emphasized in the Common Core. Assessment items are mostly short-answer, with an occasional multiple choice item.

Who uses the SIRA?

The 3rd, 4th, and 5th grade SIRAs were piloted between 2013 and 2016. During the summer of 2016, versions of the SIRA for K-2, called SIRA Elements, were developed, and they will be piloted throughout the 2016-17 school year, while 3rd-5th grade SIRAs continue to be in use.

What are OUSD teachers saying about the SIRA?

“A concise, usable packet that incorporates important ‘stuff’ not in FOSS so that we don’t need to struggle through it.”
"Great revisions to FOSS. Excited to have real science assessments."
"It's good to know that OUSD is moving towards NGSS."
“Great assessment!”

OUSD Science

Science Instructional Reflection & Assessment (SIRA)
3rd Grade FOSS: *Structures of Life*

Conceptual Framework

The Big Idea: Adaptations in physical structure or behavior may improve an organism's chances for survival in its specific environment.

Supporting Concepts	Abbreviation
Organisms have structures and behaviors that serve different functions.	Structure/Behavior/Function
Organisms have needs that are met through their environment.	Organisms' Needs from Environment
Organisms can change their environments; changes in environments can affect organisms.	Environmental Change
There is a diversity of living organisms and environments.	Diversity of Organisms & Environments

NGSS Cross Cutting Concept
Form and Function

NGSS Science Practices	Abbreviation
Practice 3: *Planning and carrying out investigations*	P3
Practice 4: *Analyzing and interpreting data*	P4
Practice 6: *Constructing explanations*	P6
Practice 8: *Obtaining, evaluating, and communicating information*	P8

Sample from SIRA Structures of Life Instructional Plan:

Part 2: Adaptation (Sessions 15-18)

Focus Questions:

- What are adaptations?
- How do different organisms from different environments meet the same need?

Key Concepts:

- Behavior is what an animal does or how it responds. **(Supporting Concept: Behavior/Function)**
- Adaptations are structures and behaviors that improve an organism's chance for survival. **(Big Idea)**
- The diversity of organisms on earth is related to the diversity of environments on earth. **(Supporting Concept: Diversity of Organisms & Environments)**

Learning Objectives: *Through this lesson, students should be able to:*

1. Describe at least four adaptations of various organisms and how those adaptations meet the organisms' needs for survival. **(P6, P8)**
2. Identify how two different organisms from two different environments meet the same need. **(P8)**

How to teach and assess Learning Objective 1:

SESSION 15 (using FOSS Inv. 3, Part 2)

- Introduce and post the Focus Questions.
- Teach lesson steps 1-6 (beginning on p. 127 of the FOSS Teacher Guide).

SESSION 16 (using FOSS Inv. 3, Part 2)

- Teach lesson steps 7-11 (beginning on p. 128 of the FOSS Teacher Guide).
- During step 12, circulate and assess student progress on notebook sheet #10. (If you are short on time, it is acceptable to have students complete a minimum of 4 rows total.) Students will be using the data from notebook sheet #10 during their Science Talk, and so you will further assess their understanding then.

How to teach and assess Learning Objective 2 (continue Session 16):

- After Step 12, review and post a list of the needs of organisms (movement, getting food, protection or defense, caring for young, etc.).
- Guide a Science Talk, using the question: How do different organisms from different environments meet the same need? (Students should consult notebook sheet #10 during the Science Talk.) See Appendix B for more information about facilitating Science Talks. Science Talk data can be recorded on a class checklist (see Appendix B).
  - Start with one need, such as protection. Ask students to share an organism, its environment, and what adaptation it has to protect itself.
    - Optional Scaffold: A ____ lives in the ___ environment. To protect itself, it ____.
    - Expected Student Response: A turtle lives in the pond environment. To protect itself, it pulls itself inside its hard shell.
  - Ask a student to make a contrasting connection by describing how a different organism in a different environment meets the same need (of protection).
  - Students can continue making contrasting connections to the same need or can introduce a new need and make further connections from there.
  - For tips on using data from the Science Talk class checklist to inform future instruction, Appendix C: Next Step Strategies.
- Teach lesson steps 13-14.

Sample from SIRA Structures of Life End-of-Module Assessment:

6. These are some examples of different environments: **grassland, ocean, tundra, temperate forest, desert, wetland, rainforest,** and **pond.**

   A crayfish would probably **not** survive in the

   ____

   I think this because

   ____

   ____

   ____

   ____

Sample from SIRA Structures of Life End-of-Module Coding Guide:

Item 6 – Crayfish Survival

Science Concepts	There is a diversity of living organisms and environments. Adaptations in physical structure or behavior may improve an organism's chances for survival in its specific environment**.**
Science Practice	P6: Constructing explanations
Code	**If the student…**
3	writes an environment in which the crayfish would not survive *(such as grassland, ocean, tundra, temperate forest, desert, rainforest, or any other environment inhospitable to crayfish)* **AND** writes at least one plausible reason why it would not survive there.
2	writes an environment in which the crayfish would not survive but gives vague or incorrect explanation as to why it would not survive there.
1	writes anything else related to the module.
0	makes no attempt or writes words unrelated to the module.

ENGINEERING EXTRAVAGANZA
Family Science Night

11 Hands-on Engineering Stations in English & Spanish

- Spinning Tops
- Lego Cities
- Catapult Launching
- Parachute Design
- Designing Boxes
- Recycling
- Marble Run
- Earthquake Engineering
- Designing Circuits
- Cars & Ramps
- Dowel Construction

Seeking OUSD Elementary Schools to Participate in 2015-2016!

- Free of charge
- One-week kit check-out *(Online reservation system coming soon!)*
- Lead Science Teachers pick up and drop off materials at the SMART Center
- **Teachers/Organizer must complete and return activity evaluations**

Activity Stations Include:

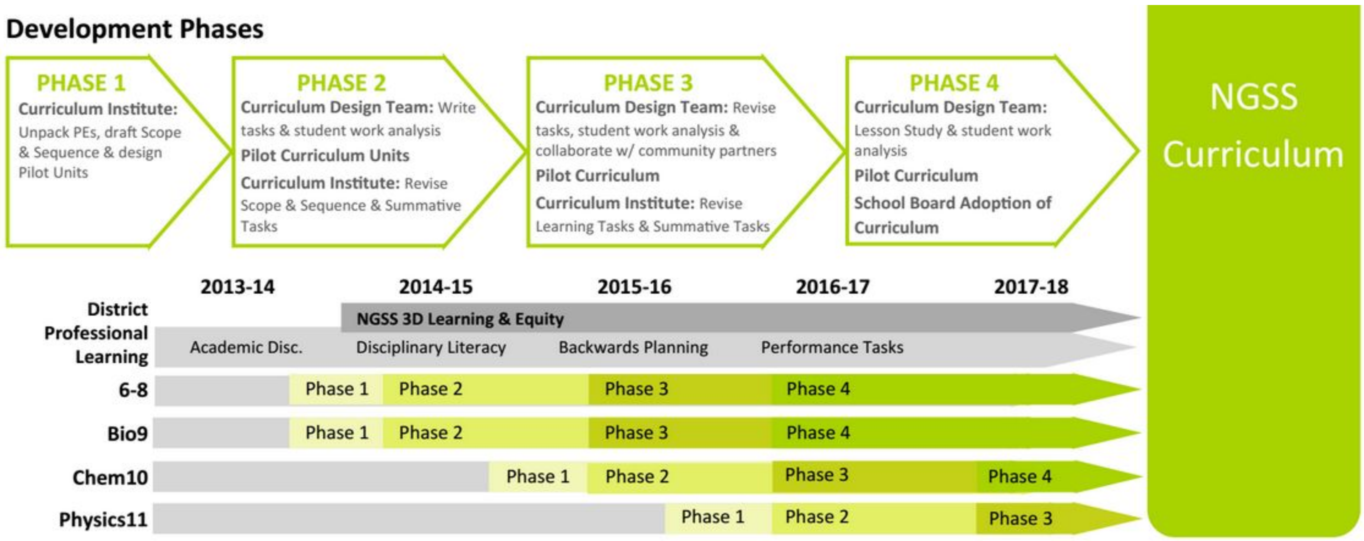
- Hands-on Materials
- Bilingual Instruction Cards for Participants
- Color Images for Making Real Life Connections
- Background Information for Station Facilitators

Planning Tools Include:

- Organizer's Guide
- Volunteer Sign-up Sheet
- Bilingual Customizable Flyers & Announcement Script
- Activity Passport
- Event Signs

OUSD Secondary Science NGSS Implementation Plan

In September 2013, California adopted the Next Generation Science Standards (NGSS). The new science standards, represent a major shift in science instruction that focuses on scientific sense-making, language use, and scientific and engineering practices. These practices overlap with Common Core (CCSS) by placing significance on developing explanations and argumentation from evidence. In support, the OUSD Science Department has been actively preparing teachers to engage and utilize NGSS to make the necessary shifts in their classrooms since the adoption.



In order to implement a system-wide plan for this transition in OUSD, the Science Department has focused on three major areas of work:

1. The development of curriculum and instructional resources that align to NGSS

Teams of experienced teachers and science specialists work together to create a relevant, authentic, and engaging integrated NGSS curriculum. Summative tasks and formative assessments are embedded in the curriculum. All curriculum is accessible online and is linked to teaching resources. Essential equipment/materials are provided to sites using the curriculum. All OUSD teachers using the curriculum and receiving materials must share resources, samples of student work, and provide ongoing feedback for revisions.

2. Foster teacher expertise in content, skills, and practices to align with NGSS

The professional learning calendar begins in August with the Curriculum Institute. During this week long institute, teachers work to backwards designed 3D-NGSS-aligned lessons to build students' skills and content knowledge on a path to success on the OUSD summative assessments. Participants gained valuable skills and knowledge of NGSS implementation. Skills and knowledge building of NGSS implementation are continued throughout the year with monthly 2nd Wednesday PDs and two Buy Back Days.

3. Build science instructional leadership for science teacher leaders

Science teacher leaders participant in monthly workshops to develop leadership skills around NGSS advocacy and implementation. Through a grant and application process, some of the science teacher leaders participant in lesson study. During the summer, lesson study teachers participant in a week long institute to strengthen their pedagogical and content knowledge in implementing NGSS. For two cycles during the year, lesson study teachers collaboratively plan 3D-NGSS-aligned lessons, implement those lessons and reflect on student learning.

Unit 8.1 Force and Motion - 6 Weeks - Table of Contents

Essential Question: How can we air drop delicate materials to land safely on the ground?

UNIT OVERVIEW

This 6 week unit investigates force and the motion of objects. The unit culminates with a design challenge, team storyboard, and an individual model. Teams design a prototype to reduce the amount of energy transfer through iterative testing that meets the criteria using evidence based reasoning in an annotated model.

Individuals will describe and model the effects distance has on the prototype's potential energy using sequence words to recount the investigation and data to justify changes to the prototype in a storyboard format.

Student Storyline: You are an engineering designing a drop delivery system. The application of your system could be used to drop food and/or equipment to remote locations around the world or in space.

Unit Resources

- **Unit Rubric** **-** The Unit Rubric assesses the 3-dimensions in the summative. Strands of the Unit Rubric will be pulled out and used to assess each task. The goal is to assess the 3-dimensions throughout the unit rather than just at the end of the unit.

- **RRR Log/Sheet** - The phenomena is a someone jumping on a skateboard. The person makes the jump the first attempt but falls during the second attempt. How can we explain this phenomena with our knowledge of force and motion? How can this phenomena help us with our summative?

- **Anchor Texts -**

  Anchor Text 1: Ornes, S. (2013, August 21). *Baseball: From pitch to hits The ballpark brings home plenty of science* [Scholarly project]. In *Science Student*. Retrieved June 28, 2016, from https://student.societyforscience.org/article/baseball-pitch-hits
  Anchor Text 2: *Combining Forces* [Scholarly project]. (2016). In *CK-12*. Retrieved June 28, 2016, from http://www.ck12.org/physical-science/Combining-Forces-in-Physical-Science/lesson/Combining-Forces-MS-PS/

  District Textbook*: CPO Focus on Physical Science
  - Chapter 12: Distance, Time, and Speed
  - Chapter 13: Forces
  - Chapter 14: Forces and Motion

  *The District Textbook was adopted in 2007 and is not NGSS-aligned. However, students may reference these chapters to support their understanding of the unit phenomena and essential questions.

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Unit 8.1 Force and Motion - 6 Weeks - Table of Contents

Essential Question: How can we air drop delicate materials to land safely on the ground?

- **Vocabulary** A list of scientific concepts covered in the Unit. Students can use the vocabulary list to develop a glossary to refer to throughout the unit.

- **Materials List** A list of materials needed for each task - designates which materials are provided by the district, site, and/or teacher.

- **Teacher Shared Resources**
  - Share your ideas and materials by filling out Teacher Shared Resources Log Form
  - Check out what your fellow teachers have shared by viewing the Teacher Shared Resources Log Spreadsheet.

- **Feedback** - As we refine the curriculum, we depend on an ongoing, collaborative dialog with you. Please take the time to share your thoughts on this unit and how it can be improved to better serve our students and promote high quality science learning.
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Unit 8.1 Force and Motion - 6 Weeks - Table of Contents

Essential Question: How can we air drop delicate materials to land safely on the ground?

TASK LIST

Unit Tasks	Unit NGSS Foci									
	SEP #2	SEP #5	SEP #6	DCI # PS2.A	DCI # PS3.A	DCI # PS3.C	DCI # ETS1.B	CCC #1	CCC #2	SEL #4
Entry Task - Tablecloth Challenge Content Language Objective(s): - I can model the sum of forces acting on an object using observational descriptions of forces and symbols, such as arrows. Teacher Overview	x		x	x					x	
Task 1 - Car Crashes Content Language Objective(s): - I can demonstrate how kinetic energy is proportional to mass using data and mathematical reasoning to support a claim. - I can model potential energy relative to a position using mathematical reasoning in a storyboard format Teacher Overview		x		x	x				x	
Task 2 - Craters Content Language Objective(s): - I can model the sum of forces acting on an object using sequence words to recount the investigation in a storyboard format - I can model potential energy relative to a position using mathematical reasoning. Teacher Overview	x	x	x	x	x			x		
Task 3 - Kinetic Energy Graphs Content Language Objective(s): - In pairs, we can describe the relationship between mass, speed, and kinetic energy using a graphical displays highlighting patterns over time. Teacher Overview	x	x	x		x	X		x		
Summative Task - Airdrop Delivery System Content Language Objective(s): - As a team, we can design a prototype to reduce the amount of energy transfer through iterative testing that meets the criteria using evidence based reasoning in a storyboard format. - I can model the effects distance has on the prototype's potential energy using sequence words to recount the investigation and data to support a claim. Teacher Overview	x	x	x	x	x	x	x	x	x	x

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Unit 8.1 Force and Motion - 6 Weeks - Table of Contents

Essential Question: How can we air drop delicate materials to land safely on the ground?

UNIT CALENDAR (suggested)

	Monday	Tuesday	Wednesday (Minimum Day)	Thursday	Friday
Week 1	**X-X** Start of Marking Period **Entry Task: Tablecloth Challenge**	**X-X** **Entry Task: Tablecloth Challenge** Anchor Phenomenon RRR Introduce Summative	**X-X** **1st Anchor Text** 1st Read	**X-X** **2nd Anchor Text** 1st Read	**X-X** FLEX DAY ***Suggested:*** *Practice reading and making Force Arrow Diagrams*
Week 2	**X-X** **Task 1: Car Collisions**	**X-X** FLEX DAY ***Suggested:***	**X-X** **Task 1: Car Collisions**	**X-X** **Task 1: Car Collisions**	**X-X** FLEX DAY ***Suggested:*** *x*
Week 3	**X-X** FLEX DAY ***Suggested:*** *Probably need to finish the CER from Task 1: Car Collisions* *Revisit the graphs and CER with Technical Writing Tools to add Force Arrow Diagrams*	**X-X** **Task 2: Craters Investigation**	**X-X** FLEX DAY ***Suggested:*** *x*	**X-X** **Task 2: Craters Investigation**	**X-X** **Task 2: Craters Investigation**
Week 4	**X-X** FLEX DAY ***Suggested:*** *x*	**X-X** FLEX DAY ***Suggested:*** *x*	**X-X** **Anchor Texts** 2nd Read	**X-X** **Task 3: Kinetic Energy Graphs**	**X-X** **Task 3: Kinetic Energy Graphs**
Week 5	**X-X** FLEX DAY ***Suggested:*** *x*	**X-X** FLEX DAY ***Suggested:*** *x*	**X-X** **Anchor Texts** 3rd Read	**X-X** FLEX DAY ***Suggested:*** *x*	**X-X** ***Return to*** Anchor Phenomenon RRR
Week 6	**X-X** **Summative Task: Airdrop Delivery System**	**X-X** **Summative Task: Airdrop Delivery System**	**X-X** **Summative Task: Airdrop Delivery System**	FLEX DAY ***Suggested:*** *x*	FLEX DAY ***Suggested:*** *x*

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NGSS FOCI

PEs Performance Expectations	Physical Science: - **MS-PS2-2** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. - **MS P 2-1** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. - **MS-PS3-2** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system - **MS-PS3-1** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object - **MS-PS2-4** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. Engineering Design: - **ETS 1-4** Engineering Design: Develop a model to generate data through iterative testing
SEPs Science & Engineering Practices	- 2. Developing and Using Models - 4. Analyzing and Interpreting Data - 5. Using Mathematics and Computational Thinking
DCIs Disciplinary Core Ideas	Physical Science: **PS2.A: Forces and Motion** - For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1) - The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2) - All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2) **PS2.B: Types of Interactions** - Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4) **PS3.A: Definitions of Energy** - Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1) - A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)

Essential Question: How can we air drop delicate materials to land safely on the ground?

	PS3.C: Relationship Between Energy and Forces - When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2) Engineering Design: **ETS1.B: Developing Possible Solutions** - A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) - Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** - The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)
CCCs **Crosscutting Concepts**	- 2. Cause and Effect - 4. Systems and Systems Models - 7. Stability and Change

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References

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Core Instruction Strategies

Inspired by the OUSD Math Department, we created a collection of strategies to support the use of the MS/HS OUSD NGSS curriculum. By highlighting these strategies in both the middle and high school science curriculum, we hope students become increasingly comfortable using the strategies throughout their academic experience in OUSD. The collection of strategies support sense-making, literacy, writing, argumentation, discussions, gathering feedback, and developing questions.

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Refine-Revise-Reflect (RRR)

Purpose: To support constructivism when studying an essential question or scientific phenomena by integrating learning from multiple inputs to refine understanding.

GENERAL DESCRIPTION:

Refine-Revise-Reflect (RRR) is a thinking strategy designed to allow students to construct an understanding and integrate various inputs of information into a holistic understanding of a phenomenon. By taking the time to reflect on how an input (reading, peer share, video, demo, activity, etc.) relates to a larger phenomenon students focus on the enduring understandings of the discipline.

The RRR strategy begins with a question that needs to be answers or a phenomenon that needs to be explained. Students write or model their answer of the question or their understanding of the phenomenon and share their ideas with their group. Students then engage with a variety (3+) "inputs" designed to reveal new information about the question or phenomenon. During each input students make note of new, significant data to **refine** answer to the question or understanding of the phenomenon. Students synthesize this data and make note of it in their notebook by filling in a table dedicated to the RRR or using technical writing tools to highlight their work related to the input. Before revising their answer to the question or understanding of the phenomenon students discuss how each input helps further their understanding. Students then return to their original response/representation and **revise**. In the final stage of an RRR students reflect on the learning progress and how their understanding has deepened.

The RRR is a structured way to give the ownership of sense-making and metacognition to the students and connect discrete pieces of information into a larger conceptual framework that will lead to an understanding of a core scientific principle. The emphasis on revision of understanding promotes the nature of science as an ongoing endeavor that constantly changes in light of new evidence.

WHEN AND WHY IS THIS USEFUL?

A Refine-Revise-Reflect is useful:
- To frame and return to throughout entire unit or guide an independent lesson with multiple "inputs"
- For emphasizing the importance of having a variety of sources ("inputs")
- For promoting revision of ideas
- For modeling the scientific process and development of scientific theories
- For connecting discrete knowledge into a conceptual framework
- For focusing student learning around an essential question, enduring understanding. and/or phenomenon.
- As a framework for an entire unit, series of lessons, or single day lesson.
- For assigning meaningful homework to review the day's learning in relation to understanding a phenomenon

HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?

A Refine-Revise-Reflect will promote:
- Abstraction and application of discrete knowledge
- Making connections between concepts
- Internalizing science as a process rather than a body of knowledge
- Investment in the learning process/"productive struggle"
- Investment in the classroom as "inputs" are related towards a larger understanding
- Viewing a variety of "inputs" (including peers) as valuable sources of information
- Metacognitive ability to identify information that promotes understanding
- Documenting learning through meticulous note-taking
- Citation of evidence
- Investment in the classroom as peers' thinking is viewed as valuable scientific "input"

HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM?

The Refine-Revise-Reflect strategy takes the form of an "Interactive Table of Contents" for each unit so that students can make connections and metacognitively track their learning and thinking around the essential question over the course of the unit.

WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?

2 - Developing and Using Models
6 - Constructing Explanations and Designing Solutions
7 - Engaging in Argument from Evidence

8 - Obtaining, Evaluating, and Communicating Information
1 - Asking Questions and Defining Problems*
*When students ask their own questions or work to solve problems they've identified they can use the RRRs to organize their thinking

Planning to Use Refine-Revise-Reflect: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Identify a major scientific concept of the unit of student. Transfer the concept into a thought-provoking question or find an engaging phenomenon related to the concept.

2. Gather a variety of inputs (readings, videos, data sets, images, demos, labs) that relate to the question or phenomenon. Evaluating the inputs by determining what new understanding is revealed by engaging with the input. Consider: Does the input provide the type of understanding desired in the student product? What understanding does the input provide that other inputs don't? Is the input developmentally appropriate? How long will it take for students to engage with the input?

3. Identify 3+ inputs that best support understanding of the question or phenomenon. When possible choose inputs that support multiple modalities and learning styles. The number of inputs you ultimately select will likely be restricted by the allotted time for the learning objective.

4. Determine the order, format, and way in which students will engage with each input. Note that you may use some of the other strategies from this toolkit to engage students with each individual input. For example, if the input is a reading students might "Talk to the Text". Regardless of how students engage with the input they must identify the key information that helps refine their understanding and be held accountable to share their learning. Having a "peer", "group", or "whole-class" be an input is a great way to uplift the expertise of the students and help students view one another as a valuable source and member of the intellectual community.

5. Anticipate the initial student response or representations that will arise when the question or phenomenon is first introduced. Identify aspects of the concept that will be challenging for students or misconceptions that arise may be difficult to overcome. Consider how these cognitive challenges or misconceptions relate to the 3 inputs. Develop a list of questions for each input that you will discuss with groups as you circulate or to run a whole-class debrief after each input. The questions may be general such as "Which information from this input is irrelevant to our understanding of the question/phenomenon?" or they may be specific to particular inputs.

6. Identify 3-5 metacognitive questions to ask during the reflect stage, such as: How has your understanding changed? Which input was most effective in refining your understanding? In what way may your understanding still be lacking?

Refine-Revise-Reflect - Teacher Moves & Impact

The table below outlines some of the teacher moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Frame the RRR before introducing the question or phenomenon by emphasizing the refinement and revision of understanding over a final "correct" product	Stu dents embrace learning as a process, not a product Students internalize the nature of science, particularly that science is a way of knowing and that scientific knowledge is open to revision in light of new evidence.
Chart initial student ideas, including misunderstandings, to keep a public record of class thinking and address misconceptions about what the question is asking or what the phenomenon encompasses	Students see that student ideas are valued and contribute to scientific understanding Students work to clarify their understanding of prompts and tasks and practice their metacognition, understanding that realizing what you know and don't know helps prime the brain for learning
Ask questions to student groups prompting them to connect back to the essential question or phenomenon as they engage with the inputs	Students are challenged to evaluate evidence for its relevancy and focus on the enduring understandings of science
Debrief each input as a class by visually displaying the input and having different individual students or groups point out the key piece of evidence that refined their thinking about the question or phenomenon.	Students articulate their reasoning and make connections from discrete facts to enduring understandings.
Return to the original charted ideas and hold a discussion around what thinking has been confirmed by the inputs, what thinking needs to be revised.	Students see that student ideas are valued and contribute to scientific understanding, as well as that address misunderstandings often leads to the deepest learning Students embrace learning as a process, not a product
Prompt students to use technical writing tools to identify ideas that have been confirmed by evidence and thinking that needs to be revised from their original response to the question or explanation/representation of the phenomenon.	Students make their thinking visible and practice metacognition
Prompt students to do a quiet brainstorm to share their revised work with their group members and cite their peers as an "input" for their RRR.	Students see that student ideas are valuable and contribute to scientific understanding Students notice their are multiple and diverse ways that scientific understanding can be written or represented
Prompt students to turn and talk sharing the key evidence that refined their understanding and how they incorporated this understanding into their revised work.	Students have the opportunity to share their thinking and articulate their learning process as well as hear and learn from their peers' work/process.
Identify (or have groups identify) examples of revised work and go over (or have groups present) what makes it a strong piece of work highlighting the scientific understanding/representation and key revisions the student made.	Students embrace learning as a process, not a product Students notice their are multiple and diverse ways that scientific understanding can be written or represented

Reference(s):

Zwiers, O'Hara, & Pritchard. (2014). *Common Core Standards in diverse classrooms: Essential practices for developing academic language & disciplinary literacy.* Stenhouse.

San Lorenzo Unified School District

Technical Writing Tools

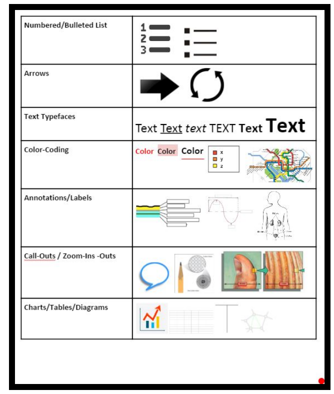
Purpose: To provide visual tools to communicate and justify thinking as well as show connections between ideas.

GENERAL DESCRIPTION:

The amount of time for making/using Technical Writing Tools varies.

Technical Writing Tools (TWT's) begins with students exploring a document that has information (i.e. text, diagram, image). Students make meaning of the information provided on the document by choosing the Technical Writing Tool they feel will best communicate their thinking about the information. Students have a variety of tools to select from.

The TWT's on the document provide a quick visual of student sense-making of the document.



WHEN AND WHY IS THIS USEFUL?

Technical Writing Tools are useful:
- For organizing and synthesizing information
- Promoting student choice
- For following a train of thought

HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?

Technical Writing Tools promote:
- Abstraction and application of discrete knowledge
- Making connections between concepts
- Metacognitive ability to identify information that promotes understanding

HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM? (This section can be deleted if n/a)

TWT's are used by individuals, pairs, and/or teams to communicate thinking and connections throughout a unit. TWT's are paired with an anchor text and another instructional tool, Talking to the Text.

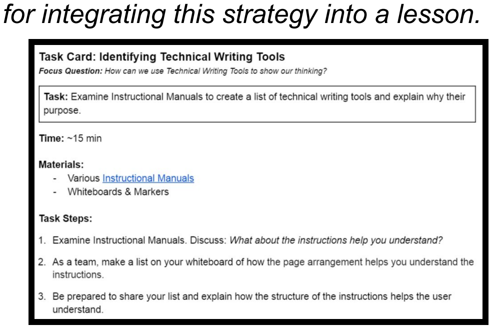
WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?

1 - Asking Questions and Defining Problems
2 - Developing and Using Models
6 - Constructing Explanations and Designing Solutions
8 - Obtaining, Evaluating, and Communication Information

Planning to Use Technical Writing Tools: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Before students make their own Technical Writing Tools (TWT's), students must know what the tools are and why they are used. Teams are given a task card, various instructional manuals, and something to capture their thinking (i.e. whiteboards and markers)
2. Teams examine the instructional manuals to identify what features in the instruction manuals helped them understand the information.


Task Card: Identifying Technical Writing Tools
Focus Question: *How can we use Technical Writing Tools to show our thinking?*

Task: Examine Instructional Manuals to create a list of technical writing tools and explain why their purpose.

Time: ~15 min

Materials:
- Various Instructional Manuals
- Whiteboards & Markers

Task Steps:
1. Examine Instructional Manuals. Discuss: *What about the instructions help you understand?*
2. As a team, make a list on your whiteboard of how the page arrangement helps you understand the instructions.
3. Be prepared to share your list and explain how the structure of the instructions helps the user understand.

3. Teams make a list and prepare to share out.
4. As teams share out, generate a list that can be posted in the room. A student scribes while the teacher facilitates.
5. If the team generated lists do not have every possible TWT, the teacher must question student thinking further. For example, “Other than words, what helps you understand the information?” “What about the arrangement of the page helps you understand the information?”
6. Give teams time to regroup to name some more TWT’s. Add the additional TWT’s to your class list. Students can refer to this list throughout the year. Students could also be given this reference sheet to glue into their notebooks to reference.

Technical Writing Tools - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Capture TWT’s generated by teams on chart paper and post this list up in the classroom.	Students can refer to this list throughout the year. Students see that student ideas are valued and contribute to scientific understanding.
Frame the informational document (i.e. reading, diagram, image, problem) with a focus question.	Students explore the informational document with purpose. Before exploring the informational document, students can take inventory of what they already know, what they don’t know, and what they might possibly learn from this document.
Provide color pencils and markers.	Allows students to highlight what information stands out to them and/or follows a train of thought - makes their thinking visible
Give time for students to make multiple passes through an informational document.	Students can read and making meaning, and then apply a TWT they select to organize and synthesize the information.
Ask probing questions on the selected TWT’s.	Students have to explain their reasoning for using a particular TWT and how it answers the focus question.
Timed pair reviews	Students review peers’ TWT’s to provide input on how clearly they communicate student thinking.

Reference(s):

OUSD Math Department’s Instructional Tool Kit

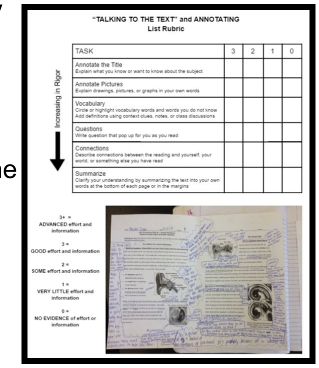
Talking to the Text

Purpose: To make meaning of an informational document by focusing on students metacognitive process.

GENERAL DESCRIPTION:

The Talking to the Text is a 15-20 minute individual activity. Students read a text and frequently stop to make meaning the information provided.

Students explore a document that has information (i.e. text, diagram, image) and engage with the rubric. Students annotate the title, pictures, and vocabulary. They develop questions and connections as they read. Students work to increase the rigor of their annotations throughout the unit and year. Talking to the Text is a process.



WHEN AND WHY IS THIS USEFUL?	HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?
Talking to the Text is useful: ● Reinforcing student voice ● Student independence ● Generating questions about an input ● Showing students thinking ● Following a train of thought	Taking to the Text will promote: ● Building on thinking through multiple reads ● Making connection between concepts

HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM? (This section can be deleted if n/a)

Talking to the Text is used by individuals as they interact with an anchor text. This strategy is paired with another instructional tool, Technical Writing Tools (TWT's).

Here is an example of students using Talking to the Text at the beginning of a unit with an anchor text. Video: Intro to Chemistry in an Oakland high school

WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?

1 - Asking Questions and Defining Problems
2 - Developing and Using Models
6 - Constructing Explanations and Designing Solutions
8 - Obtaining, Evaluating, and Communication Information

Planning to Use Talking to the Text: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Before students Talk to the Text, ask students to generate a list of all the ways in which they interact with a reading, image, or diagram.
2. Students pair share their lists and prepare to share out to the class.

3. As teams share out, generate a list that can be posted in the room. A student scribes while the teacher facilitates.
4. Student are given their own copy of the Talking to the Text Rubric. Students in pairs compare what they already do with what's listed on the rubric and share out.
5. Students practice annotating a text using the rubric.
6. Pairs discuss how they approached annotating a text using the rubric and then share out. This is an opportunity to gain clarity around expectations and how students can use what they already know. The teacher could model how they would approach a text using this rubric. At this time, Technical Writing Tools should be referenced and how they support to Talking to the Text.
7. Students individually rate themselves on the rubric, discuss ratings in pairs, and share out.
8. After sharing out and hearing their peers, students identify an area they would like to improve in.
9. Student revisit and revise their annotations as they return to the text later in the unit. A different color writing utensil should be used for future annotations.

Talking to the Text - Teacher Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Capture current annotation strategies used by students on chart paper and post this list up in the classroom.	Students see that student ideas are valued and contribute to scientific understanding.
Frame the informational document (i.e. reading, diagram, image, problem) with a focus question.	Students explore the informational document with purpose. Before exploring the informational document, students can take inventory of what they already know, what they don't know, and what they might possibly learn from this document.
Provide color pencils and markers.	Allows students to highlight what information stands out to them and/or follows a train of thought - makes their thinking visible.
Model (through a Think Aloud) Talking to the Text and the use of Technical Writing Tools.	Provides clarity around expectations and possible approaches to a text.
Ask probing questions on student annotations.	Students have to explain their current thinking/understanding and how it answers the focus question.
Give time for students to make multiple passes through a text.	Students can document their initial thinking and revised their thinking during multiple reads.
Prompt students to use evidence from an informational document.	Students are critically annotating the text for information that could be used in the future.

Reference(s):

Reading Apprenticeship

1st Read - Questioning Stance

Purpose: Reading Introduction is the first of three reading strategies used to engage students in the text by getting them to generate questions and conversation.

GENERAL DESCRIPTION:	
During a 1st Read, students are prompted to talk to the text and ask questions. This encourages them to engage in a reading for the first time and embrace a "questioning stance". While reading students look for signposts in the reading and think of questions. Following the first close reading, students participate in a discussion of the text revolving around 3 "big questions": 1) What surprised me?, 2) What did the author think I already knew?, 3) What challenged, changed, or confirmed what I already knew?.	
WHEN AND WHY IS THIS USEFUL?	**HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?**
A 1st Read - Questioning Stance is useful: ● The first time a text is read in class ● To encourage student thinking about the reading ● To encourage in depth discussion about the reading	A 1st Read - Questioning Stance will promote: ● Discussion of the text rather than regurgitation of facts in the text. ● Students will make connections to their own thinking and experience.
HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM? (This section can be deleted if n/a)	
This strategy should be used at the beginning of instructional units with the anchor texts and any other reading material introduced by the teacher.	
WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?	
1 - Asking Questions and Defining Problems 7 - Engaging in Argument from Evidence 8 - Obtaining, Evaluating, and Communication Information	

Planning to Use A 1st Read - Questioning Stance: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Select an anchor text or other meaningful, relevant and engaging reading.
2. Instruct students to talk to the text paying particular attention to facts, figures, quotes, and interesting or extreme points by writing questions.
3. Allow ample time for student reading.
4. Group students for discussion.
5. Ask one or more of the following three "big questions" for group discussion: What surprised me? What did the author think I already knew? What challenged, changed, or confirmed what I knew?
6. Encourage students to discuss questions they have for the author and/or questions they have about the topic.

A 1st Read - Questioning Stance - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Adjust text complexity without changing main messages.	Allows students to engage in conversations with peers despite gaps in reading skill.
Encourage the use of pairs and short conversations (3 minutes maximum) at the beginning of the year.	Helps students develop stamina and interest in conversations.
Provide sentence stems for group conversations.	Helps some students articulate their thoughts while teaching some academic vocabulary.
Time discussion segments.	Ensures all questions are answered.
Use discussion protocols.	Ensure all students are heard during discussion.
Chart sample responses on the board.	Encourages whole class participation and acknowledges the discussions of peers.
Follow up with a short summary activity, such as contributing to an RRR sheet.	Allows for individual thinking and metacognition.

Reference(s):

Beers, K. and R. E. Probst. (2016). Reading Nonfiction: Notice & Note Stances, Signposts, and Strategies. Heinemann. Portsmouth, NH.

2nd Read - Text-Dependent Questions

Purpose: Used as a scaffold for students to drive close reading and help clarify the purpose for reading a text. These text-dependent questions should continually push students to deepen their analysis.

GENERAL DESCRIPTION:	
Based on discussion and analysis of a text, students address text-dependent questions that should "be answered by careful scrutiny of the text… and do not require information or evidence from outside the text(s)" (Lapp, Grant, et al., 2013). As opposed to students reading and analyzing a text with no purpose, the text-dependent questions provide a path for students to engage meaningfully with the teacher's purpose for reading a text.	
WHEN AND WHY IS THIS USEFUL?	**HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?**
Text-dependent questions are useful: ● For breaking down short, complex science texts with multiple reads ● To give a purpose for reading, especially when students struggle getting what the instructor envisioned from the text	Text-dependent questions will promote: ● Students citing text as evidence ● Motivation and focus for approaching a text ● Evaluating text claims, inferring meaning and "using text structures to facilitate comprehension"
HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM? (This section can be deleted if n/a)	
This strategy should be used with the anchor texts and any other reading material introduced by the teacher. The questions can then focus students reading for evidence in solidifying an argument, informing design solutions, or help support their revision of a model.	
WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?	
2 - Developing and Using Models 6 - Constructing Explanations and Designing Solutions 7 - Engaging in Argument from Evidence 8 - Obtaining, Evaluating, and Communicating Information	

Planning to Use Text-Dependent Questions: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

Prior to Instruction...

1. Select short,complex texts that are rich enough for rereads.
2. Identify the purpose for close reading of the text.
3. Prepare the text for presentation by numbering lines or paragraphs to support referencing and discussing the text. (this can also be done through annotations by the student)
4. Ensure students have tools to talk to the text/annotate in order to fulfill their purpose for reading.
5. Write text-dependent questions and prompts to regularly incentivize going back to the text for further and deeper analysis through searching, synthesizing, inferring and supporting their claims with text.

In the classroom...

1. First reading—Teacher shares purpose and process. Students engage in the first reading and annotating, prompted by a posed question (e.g., What is the general information the author is sharing about...?).

2. Chatting and charting—Students share responses and annotations with a partner. If students cannot write in the text, annotations and information can be written on sticky notes or a graphic organizer.
3. Reading again—Based on insights from the conversation, the teacher asks additional text-dependent questions that return students to the text multiple times to accomplish the lesson purpose.
4. Chatting and charting— Conversation occurs after each return to the text. Responses should deepen after each reading and conversation.
5. Independence—At the conclusion of the reading, students, independently or with others, engage in a task illustrating their understanding of the text (e.g. writing text- supported arguments, a multimedia project, an opinion paper that uses text-based evidence, a collaborative poster, etc.). (Lapp, Grant, Moss, and Johnson, 2013).

Text-Dependent Questions - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Draw text-dependent questions (with possible revision) from student-generated questions during an initial read.	Incentivizes student inquiry and meaning making.
Encourage the use of pairs and short conversations (3 minutes maximum) at the beginning of the year.	Helps students develop stamina and interest in conversations.
Provide sentence stems for group conversations.	Helps some students articulate their thoughts while teaching some academic vocabulary. Sentence stems can also guide students to reference evidence from the text.
Time discussion segments.	Ensures all questions are answered.
Use discussion protocols.	Ensure all students are heard during discussion.
Model annotating a text by numbering lines/paragraphs.	Easier reference during discussions.
Pose targeted text-dependent questions when students don't provide expected responses.	Provides opportunity for assessment and differentiated support during student conversations.
Connect reading to real world applications.	Motivates students to "review text with attention to detail, language, and background knowledge."

Reference(s):

Coleman, D., & Pimentel, S. (2012). *Revised publisher' criteria for the common core state standards in English language arts and literacy, grades 3-12.* National Association of State Boards of Education. Retrieved from http://www.corestandards.org/assets/Publishers_Criteria_for_K-2.pdf

Lapp, D., Grant, M., Moss, B., & Johnson, K. (2013). Students' Close Reading of Science Texts: What's Now? What's Next? *The Reading Teacher. 67(2)*, 109-119.

Text-Dependent Questions Planning Tool

Text-Dependent Question Worksheet with Checklists for Determining Text Dependence by teacher David Pook

The 4 As

Purpose: The 4 A's is a text analysis protocol that encourages students to engage with a text as a point of discussion or argumentation, rather than solely for knowledge acquisition.

GENERAL DESCRIPTION:	
The 4 A's is a useful protocol for the third time through a reading. Students read and annotate a text through the lens of agreeing with and confronting ideas presented by the author. Following reading, students engage in sharing their ideas in a small group discussion.	
WHEN AND WHY IS THIS USEFUL?	**HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?**
The 4 A's is useful: ● After different inputs and experiences ● When returning to a text for a third time ● To engage the readers in a critique of a text	The 4 A's will promote: ● Deeper academic discussion informed by class input and experience. ● Teaching students to question and critique sources.
HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM? (This section can be deleted if n/a)	
Near the end of a unit, when interested in how students have revised their thinking, this protocol helps students critique and argue with an author's point of view. It should lift signs of their learning up into conversation.	
WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?	
1 - Asking Questions and Defining Problems 7 - Engaging in Argument from Evidence 8 - Obtaining, Evaluating, and Communication Information	

Planning to Use The 4 A's: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Assign students to read an anchor text or other engaging text.
2. Have student talk to the text by identifying 1) A point of agreement they have with the author, 2) Something they would like to argue with the author about, 3) assumptions made by the author and 4) something you aspire to or aspire to learn more about in the text.
3. In small groups, students take turns sharing their agreements and citing the page and paragraph. This continues through the remaining A's.
4. End the discussion with an open-ended question such as, "What did our discussions help us realize about the topic?"
5. Prompt students to return to their unit reflection sheet with additions from what they have learned.

The 4 A's - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Consider pair discussions for the beginning of the year.	Reduced pressure to speak in larger groups encourages

	participation by all.
Consider shorter discussion lengths at the beginning of the year.	Students need to build up stamina and interest in longer discussions.

Reference(s): http://www.nsrfharmony.org/system/files/protocols/4_a_text_0.pdf

Concept Mapping

Purpose: To show non-linear connections between scientific concepts and guide the construction or visually display one's conceptual framework.

GENERAL DESCRIPTION:

A Concept Map is a visual representation for showing relationships between concepts. As a process, Concept Mapping, helps individuals refine their conceptual framework. Science is an incredibly demanding discipline in terms of the amount of discipline-specific vocabulary required to access the content. Knowing definitions of the myriad of scientific concepts related to a phenomena does not lead to an understanding of the phenomena as a whole. "As students are introduced to new science concepts, they embark on a cognitive process of constructing meaning and making sense by consciously or subconsciously integrated these new ideas with their existing knowledge. Concept maps provide a uinque graphical view of how students organize, connect, and synthesize information" (Vanides, Yin, Tomita, & Ruiz-Primo, 2005).

Concept Mapping should be structured to ensure the meaningful thinking is displayed. Concept Mapping should follow the following basic sequence (**GOM** Phases): 1) **G**enerate Ideas, 2) **O**rganize Ideas, 3) **M**ap Ideas. The main concept is introduced and students start by generating a list of all the things that come to their mind when they hear the concept - using their previous work and peers as a resource. Students then organize their ideas by sorting/grouping and/or categorizing their list. Students might distinguishing main or central ideas from specific details/facts or make groupings of related concepts and assign labels to different categories. After students have a strong list of concepts to begin with and done some of the heavy conceptual work in organizing their list, they write the main concept in the center of a blank page and begin adding the other ideas by drawing arrows between ideas and adding linking words or phrases on the line in the direction of the arrow. Finally students "publish" their concept maps by sharing them with their peers, using them to orally defend their understanding of the concept, or write a summary explaining the concept.

Concept Mapping can be adapted in many ways to engage students in particular types of thinking. Concept Mapping can be extended by having students refine their concept map into a new graphic format that best represents the scientific phenomena or to further revise the organization of the concepts or they can complete a formal writing exercise using their referencing map to construct their writing. Concept Mapping is a powerful tool in science because of the quantity of new concepts introduced. Concept Mapping requires students to create a concrete visualization of their thinking and challenges them to justify connections between concepts, and while a structured process it also provides the freedom and flexibility for students to represent their conceptual framework in a way that makes sense to them.

WHEN AND WHY IS THIS USEFUL?	HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?
Concept Mapping is useful: ● For revealing misconceptions or misunderstandings about how scientific concepts are related ● As meaningful "vocabulary work" ● To review major concepts in a unit ● To organize ideas before formal writing ● As a formative assessment of major concepts throughout a unit	Concept Mapping will promote: ● Distinguishing between components and processes that are part of a scientific phenomena ● Visualization of thinking ● Systematic thinking and stronger conceptual frameworks of scientific ideas ● Justifying relationships between ideas ● Metacognitive awareness of preferred note-taking/studying methods

HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM?

Concept Maps are used as a final engagement with and assessment of concepts included in the unit glossary and as a way to uproot lingering misconceptions before the summative task.

WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?

2 - Developing and Using Models

6 - Constructing Explanations and Designing Solutions 8 - Obtaining, Evaluating, and Communicating Information

Planning to Use Concept Mapping: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Identify a phenomenon or concept that is large in scope and has been or will be thoroughly explored.

2. Generate a list of ideas you hope students will include in their concept map and develop an exemplar concept map to use as a model with students and/or to plan a think-aloud to go through with students. Develop a set of criteria for the concept map so students have a guiding framework and meet minimal requirements: What is the minimum number concepts students include? Are there certain concepts that "must be" included? What types of linking words or phrases are expected between concepts? Are their concepts that absolutely should be connected for students to demonstrate understanding? How many connections should each concept have? Do they need to have a key organizing the concepts? Should they use technical writing tools? See (Vanides, Yin, Tomita, & Ruiz-Primo, 2005) for suggestions on how to evaluate students concepts maps.

3. Based on the learning objective and purpose of implementing the concept mapping strategy, decide whether students will create their concept map independently, as a group, or some combination of the two.

4. Considering students experience with concept mapping plan out how to guide students through the GOM phases of concept mapping: 1) Generate Ideas, 2) Organize Ideas, 3) Map Ideas. Plan out 3-5 key points during the concept mapping to have the class, student groups, pairs of students, or individual students pause and reflect on the process and articulate their understanding of the scientific phenomena.

5. Determine how students/groups will "publish" their concept map and develop a structured protocol or use a strategy from this Instructional Toolkit to facilitate the sharing of their concept maps.

Concept Mapping - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Cut up essential concepts (generated by you or students) on separate sheets/strips of paper along with blank sheets/strips and provide to student groups or individual students to make the concept map.	Students can physically move and sort concepts to visually see grouping and make changes to representation. Students view revising and refining understanding as a natural and helpful process.
Encourage, model, or assign the use of technical writing tools.	Students add another layer of understanding by visually showing and justifying their thinking. Students internalize an arsenal of visual tools to use in future note-taking.
Circulate to notice which concepts students have linked and which concepts are unlinked as well as the words/phrases used to connect the concepts. Ask students to verbally explain/justify some of the links in their concept map.	Students practice using scientific vocabulary to articulate understanding and in the process may gain new insight or self-correct misunderstandings.
Facilitate a Quiet Brainstorm in the middle of or end of concept mapping.	Students learn from peers and have a chance to contribute their expertise to impact classmate's learning.
Post questions (or refer to class generated list of questions) for students to use their concept map to construct an answer.	Students refer to their own work to articulate or construct an understand and find value in work done.

Reference(s):

Ritchhart, R., Church, M., & Morrison, K. (2011). *Making Thinking Visible: How to Promote Engagement, Understanding, and Independence for All Learners.* San Francisco: Jossey-Bass.

Vanides, J., Yin, Y., Tomita, M., & Ruiz-Primo, M. (2005). Using Concept Maps in the Science Classroom. *Science Scope,* 28(8), 27-31.

Academic Discussions Scaffolds

Purpose: To provide scaffolds for academic discussions

GENERAL DESCRIPTION:	
The amount of time using academic discussion scaffolds varies. Academic discussion scaffolds focus on what is said and how its said. Table Tents are placed in between students during a discussion. Both sides of the tent have sentence starters. One side has prompts for initiating the discussion, while the other side has prompts for responding. Students should use at least 2 prompts on each side of the tent before switching roles (flipping the tent around). While students are conducting an academic discussion, student follow a participation protocol: 1. Looking at your partner/teammates 2. Lean towards your partner/teammates 3. Lower your voice 4. Listen attentively 5. Use evidence and examples The academic discussion scaffolds provide structure to the discussion.	
WHEN AND WHY IS THIS USEFUL?	**HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?**
Academic Discussion Scaffolds are useful: ● When coming to consensus ● Following a close reading ● For investigation conclusions ● Before a CERR ● With open-ended questions	Academic discussion Scaffolds will promote: ● Structure conversations ● Deep understanding of the content ● Building off of other's ideas ● Developing reasoning ● The use of evidence to generate claims
HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM? (This section can be deleted if n/a)	
Here are examples of students using sentence starters and participation protocol in academic discussions. These examples are not from science classrooms but are from Oakland classrooms.	
WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?	
1. Asking Questions and Defining Problems 6. Constructing Explanations and Designing Solution 7. Engaging in Argument from Evidence 8. Obtaining, Evaluating, and Communicating Information	

Planning to Use Academic Discussion Scaffolds: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Before students use Academic Discussion Scaffolds, gather a variety of inputs (readings, videos, data sets, images, demos, labs, activity, or task) that relate to the guiding question or phenomena.
2. Students interact with the input(s) to develop a stance.
3. In pairs or as a group, students use the sentence starters on the table tents to discuss the input(s).

4. The result of the discussions vary depending on the desired product.
5. While students are conducting an academic discussion, they follow the participation protocol.
6. The teacher walks around the room to document what was said and who followed the protocol.
7. The teacher highlights points made and who made them to class.

Academic Discussion Scaffolds - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Provide 2 copies of the table tents per group	All students can lean on the sentence starters to engage in scientific language to communicate their ideas and reasoning
Model use of sentence starters and participation protocol	Provides clarity around expectations and use of the scaffolds
Walk around the room and listen to the discussions to take notes on what was said	Students see that the teacher is listening. What students have to say is valuable and can influence others. This highlights the importance of listening to eachother to build off of ideas.

Reference(s):
- Edna Brewer Science Department
- Teaching Channel - Engaging ELLs in Academic Conversations
- OUSD Math Department's Instructional Tool Kit

Claim - Evidence - Reasoning - Rebuttal (CERR)

Purpose: To support evidence-based writing and argumentation.

GENERAL DESCRIPTION:	
The CERR framework simplifies the complex practice of scientific argumentation/explanation into four key parts–claim, evidence, reasoning, and rebuttal. The framework can be used to support student's evidence-based scientific writing and discourse.	
WHEN AND WHY IS THIS USEFUL?	**HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?**
CERR is useful: ● When students engage in argument to prove/disprove/evaluate a claim ● For supporting student growth to communicate and think more scientifically ● In deciding variables to manipulate, revising a model, or making engineering design decisions	CERR will promote: ● Students analyzing evidence and backing up their claim ● Critical thinking and evaluation skills ● A support for struggling writers to structure their arguments and engage in discourse to build science knowledge
HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM? (This section can be deleted if n/a)	
The curriculum offers multiple opportunities for students to use CERR in evidence-based writing as well as in scientific discourse. The framework can be used to support the individual component of many of the curriculum's learning tasks.	
WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?	
2 - Developing and Using Models 4 - Analyzing and Interpreting Data 6 - Constructing Explanations and Designing Solutions 7 - Engaging in Argument from Evidence	

Planning to Use CERR: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Introduce the instructional framework to students by breaking down its components and providing examples.
2. Identify opportunities to engage in argumentation and scientific explanation in the curriculum's tasks.
3. Give or help students develop a clear question for students to make claims for.
4. Design use of the framework that aligns to the complexity of the learning task, depending on the levels and needs of the students. Some examples from McNeill and Krajcik include:
    a. Variation #1: Claim, Evidence and Reasoning
    b. Variation #2: Claim, Appropriate and Sufficient Evidence, and Reasoning
    c. Variation #3: Claim, Appropriate and Sufficient Evidence, and Multiple Components of Reasoning
    d. Variation #4: Claim, Appropriate and Sufficient Evidence, Multiple Components of Reasoning, and Rebuttal (McNeill & Krajcik, 2012)
5. Provide appropriate scaffolds for students to develop/evaluate an argument, e.g. a CERR graphic organizer.
6. Students use the framework to discuss their argument with others and/or write an argument.

CERR - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

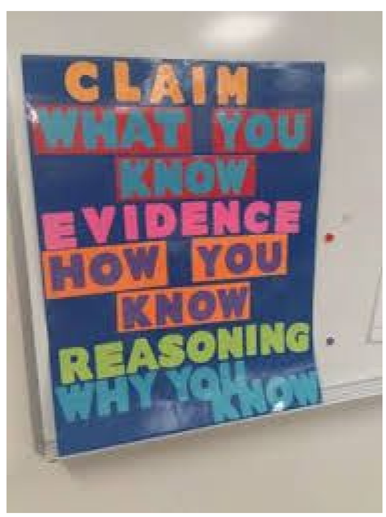
TEACHER MOVE	IMPACT ON STUDENT LEARNING
Use the CERR framework to annotate text and evaluate claims in a science text.	Students develop proficiency in identifying claims in a text and evaluating claims through the use of evidence.
Debate student examples.	Students evaluate the appropriateness and strength of various claims, evidence, reasoning, and rebuttal.
Model and critique teacher provided examples.	Critiquing examples according to their strengths and weaknesses helps students develop their own argumentation skills using the framework.
Facilitate a science seminar for students to apply their science knowledge as they practice their argumentation.	Students gain a greater understanding of the evidence presented and make sense of complex phenomenon.
Connect the framework to everyday examples.	Emphasizes that students use evidence and reasoning already to answer a question or convince others, e.g. who is the greatest singer of all time?
Connect to other content areas.	Students understand the similarities of argument across content areas as well as the nuances that make scientific argumentation unique.

Reference(s):

McNeill, Katherine & Krajcik, Joseph. *Supporting Grade 5-8 Students in Constructing Explanations in Science: The Claim, Evidence, and Reasoning Framework for Talk and Writing.* Boston, MA: Pearson Education, Inc., 2012.

Argumentation Toolkit from Lawrence Hall of Science's Learning Design Group

CER Poster from site.stedwards.edu



CERR Formative Assessment Strategies

Graphic organizers:

- CER - basic
- CERR more comprehensive

Quiet Brainstorm

Purpose: To provide individual time for students to formulate their ideas before creating a group product.

GENERAL DESCRIPTION:

The Quiet Brainstorm take about 17-20 minutes.

This strategy gives students an opportunity to individually capture their ideas, add to other's, and revise their initial thinking before the team comes to a consensus to produce a group-worthy product. A group-worthy task or product: "*provides opportunity for students to access the instructions and the information required to engage in the task, facilitates equal-status participation, and allows students to demonstrate the multiple intellectual abilities and the difference academic and social skills they use to complete the task successfully.*" - Cohen, Elizabeth G., and Rachel A. Lotan. *Designing Groupwork: Strategies for the Heterogeneous*. 2014.

WHEN AND WHY IS THIS USEFUL?	HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?
The Quiet Brainstorm is useful: ● When the task/product is open ended but has clear criteria for group and individual evaluation ● Requires problem solving ● Requires interdependence and individual accountability ● Getting and receiving feedback ● Coming to consensus	The Quiet Brainstorm will promote: ● Equity of voice ● Clear and effective communication ● Sharing, learning, and building off of others' ideas

HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM? (This section can be deleted if n/a)

This strategy is used in the engineering design process, designing an investigation, developing a model or argument. Really, this strategy can be used at the beginning of most group-worthy task.

WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?

2. Developing and Using Models
3. Planning and Carrying Out Investigations
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

Planning to Use Quiet Brainstorm: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Prior to using this strategy, identify a group-worthy task/product.
2. Each team member has 5-minutes to draw a model/write about the product they think their team should create.

The following is written for teams of 4-students. Reduce the number of rounds/rotations for teams with fewer people.

3. Teams rotate models/writing to the left. Team members write clarifying question(s) and/or add comment(s) to the model/writing. This round last for 2-minutes.
4. Again, teams rotate the models/writing to the left. Team members write clarifying question(s) and/or add comment(s) to the model/writing. This round last for 2-minutes.
5. Teams rotate models/writing to the left for the last 2-minutes. Team members write clarifying question(s) and/or add comment(s) to the model/writing.
6. Team members pass the models/writing back to their owners. Team members have 1-minute to review the question(s) and/or comment(s) and make revisions to their model/writing.

7. Teams take turns discussing how they will develop their group product using group roles and Academic Discussion Scaffolds.

Quiet Brainstorm - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Identify a group-worthy task for students.	Students rely on the interdependence of the team.
Define the criteria for the group product	Students have a clear understanding of the parameter in which they can work within.
Define the protocols, including how much time is allotted for each segment.	Students understand the process.
Define group roles.	Students understand their role in process.

Reference(s):

Expert Carousel

Purpose: This strategy allows group ideas and products to be strengthened through peer feedback.

GENERAL DESCRIPTION:

During an expert carousel, one group member remains with a visible presentation of the group's thinking. The student work could be an engineering design, argument supported by evidence, a lab summary, or many other groupworthy task products. Learning to provide and receive useful and nonjudgmental feedback is crucial to scientific processes

The group member who stays with the product explains the group's ideas to a set of peers who have rotated from another group. Depending on the type of product and purpose of peer feedback, the teacher should scaffold each rotation with a feedback protocol that would typically involve a brief presentation by the expert, clarifying questions, probing questions and general feedback. It may also be useful to set role expectations, such as a timer and note taker who captures ideas for the expert.

WHEN AND WHY IS THIS USEFUL?	HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?
An expert carousel is useful: ● When a key piece of groupwork is produced. ● When the group work would benefit from peer feedback. ● When individuals need fresh ideas from other groups. ● Before a revision or iteration of an investigation or engineering project. ● Because it encourages thought sharing. ● Because it strengthens leadership and presentation of the expert. ● Because it teaches how to give and receive low inference, technical, and nonjudgmental feedback.	An expert carousel will promote: ● Students revising their group work following an input of ideas. ● Students learning from the ideas of other groups. ● Increased ability to provide feedback and ask probing questions. ● Increased ability to evaluate work products.

HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM?

This strategy is often used after lab investigation when groups formulate arguments. Additionally, this strategy is found when groups are asked to revise designs, such as engineering products or investigation designs.

WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?

1 - Asking Questions and Defining Problems
3 - Planning Investigations
6 - Constructing Explanations and Designing Solutions
7 - Engaging in Argument from Evidence
8 - Obtaining, Evaluating, and Communication Information

Planning to Use Expert Carousel: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Design or identify a group product that would benefit from revisions following peer feedback.
2. Students, working in groups, create a visible work product to be presented.
3. Establish the protocols to get desired results. Include: times for each section, expert presentation component, clarifying and probing question stems, feedback structure, roles for feedback participants.
4. Choose an expert and determine a rotation path and schedule.
5. Determine number of rotations needed to maximize feedback.

Expert Carousel - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Choose experts	Potential to give some group members practice presenting or appoint experts who will represent the ideas most clearly.
Monitor feedback cycles and intervene	Determine if some groups are struggling with feedback or committing to protocols and roles. Redirect groups to maximize benefits.

Reference(s):

Question Sort

Purpose: To uplift the investigative nature of science and emphasize that science addresses questions about the natural and material world while acknowledging all questions.

GENERAL DESCRIPTION:

The Question Sort is a strategy that helps students identify questions that can answered by science. When students write their own questions we engage their curiosity. By having them sort their questions we deepen their understanding of the nature of science. Students should not simply ask and answer questions, but consider which types of questions we ask can be investigated scientifically; a Question Sort helps structure this process and uplift the scientific discipline, without constricting student questions.

A Question Sort begins with engaging students in a scientific phenomena. A phenomena may be introduced through any appropriate modality (i.e. demo, investigation, video, reading, etc.). Students individually generate as many questions as possible about the phenomena. Students then work in their groups to share their questions and combine questions that are similar. After all questions have been shared teams work to group them into 3 categories: 1) Investigatable via Experimentation or Observation (Primary Research), 2) Investigatable via Literature Review (Secondary Research), 3) Not Answerable by Science. What follows the question sort depends on the learning objective and students understanding of the nature of science. After sorting questions the class may discuss what distinguishes “investigatable questions” from non-scientific questions, student groups may be challenged to “turn” a non-scientific question into an investigatable one or student groups may be assigned or select questions to discuss, investigate, or research.

The Question Sort can be quick metacognitive exercise or a more involved process to guide students to select an investigable question as they conduct their own research. While the Question Sort helps students think scientifically and ask empirical questions it also stresses the importance of background research and encourages connections to and considerations of how different disciplines “investigate” the world.

WHEN AND WHY IS THIS USEFUL?	HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?
A Question Sort is useful: ● When starting a long-term project/investigation ● As a quick warm-up exercise (the types of questions students ask can reveal prior knowledge and misconceptions) ● For emphasizing the nature of science ● For refining students questioning skills ● For generating a list of questions to guide student-led investigation and research	A Question Sort will promote: ● An inquiry stance ● Curiosity and the asking of a richer variety of questions ● Questioning as a way to deepen understanding ● Investment in learning and value in sharing of ideas ● A deeper understanding of the nature of science ● Distinguishing scientific inquires from non-scientific questions

HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM?

A Question Sort is used during the entry task and/or first reading of the unit’s anchor text(s) to ground the unit of study in student-driven questions while uplifting the question the discipline of science attempts to answer.

WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?

1 - Asking Questions and Defining Problems
3 - Planning and Carrying Out Investigations

Planning to Use a Question Sort: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. Identify the phenomena students will ask questions about.

2. Select the appropriate input to share the phenomena with students (i.e. demo, investigation, video, reading, etc.). Generating your own questions be reviewing the input and completing the question sort yourself will help you anticipate difficult concepts and will prime you to support students as they try to sort questions into the different groups.

3. Consider the questioning skills of your students and overall learning objective - this will determine what will be done with questions once they are sorted. For example:
   - If it is students first time sorting questions, the question sort can be followed by a discussion and development of criteria to determine what makes a question “investigatable” or appropriate for primary research.
   - If it is students first time sorting questions, a random sample of questions can be taken from each group and posted for the class. Groups can then spend time sorting the posted questions and classifications can be reviewed as a class as students share their justification for classifying a questions as experimental, literature-based, or not-answerable by science.
   - If the question sort is done at the beginning of a unit of study student groups can share out their top question(s) from each category and the questions can be visually posted and returned to throughout the unit to guide discussions
   - If students are preparing to conduct an experiment the groups could select one of their experimental questions and develop a investigation plan

Question Sort - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING
Model thinking process behind developing questions.	Students get insight to "snowball" effect of asking questions and gain confidence in asking a variety of questions.
Engage students in phenomena input multiple times.	Students have multiple chances to ask questions. Students generate more complex questions and improve comprehension.
Provide Post-Its for generating questions.	Students can physically move and sort questions to visually see grouping and compare/contrast questions.
Model thinking process behind sorting questions.	Students get insight to metacognitive process when considering types of questions scientists ask and answer.
Have groups share questions that were difficult to classify and go through the questions as a class.	Students articulate metacognitive challenges and hear reasoning from teachers and peers. Students deepen their understanding of the nature of science and the essence of scientific questions.
Introduce or co-develop with students a key (sample below) to sort and code questions: - **PR** - Primary Research = Investigatable through experimentation or observation - **SR** - Secondary Research - **N/A** - Not answerable by science	Students begin to build a metacognitive framework around investigatable questions. Students use technical writing tools to visually organize their brainstorming/thinking.
Model, work as a class, or have groups "turn" a non-investigable question (literature-based or not answerable by science) into an investigable one.	Students see the value in embracing curiosity and taking on an inquiry stance as it leads to new ways to study phenomena or approach to a problem.

Reference(s):

Blosser, P. (2000). How to Ask the Right Questions. *NSTA Press Book*.

Sharkawy, A. (2010, December). A Quest to Improve: Helping students learn to pose investigatable questions. *Science and Children,* 33-35.

Simpson, P. (2010, December). Personalized Inquiry: Helping your students classify, generate, and answer questions based on their own interests or common materials. *Science and Children,* 36-39.

[Name of Core Instructional Strategy]

Purpose:

GENERAL DESCRIPTION:	
WHEN AND WHY IS THIS USEFUL?	**HOW DOES THIS STRATEGY IMPACT STUDENT LEARNING?**
A [name of strategy] is useful: •	A [name of strategy] will promote: •
HOW IS THIS STRATEGY EMBEDDED INTO THE CURRICULUM?	
WHICH SCIENCE AND ENGINEERING PRACTICES (SEPs) ARE SUPPORTED BY THIS STRATEGY?	

Planning to Use [Name of Strategy]: A Step-by-Step Guide

Ready to use this strategy in your classroom? Here are step-by-step instructions for integrating this strategy into a lesson.

1. x
2. x

[Name of Strategy] - Facilitation Moves & Impact

The table below outlines some of the facilitation moves implicit in this strategy and the impact on student learning.

TEACHER MOVE	IMPACT ON STUDENT LEARNING

Reference(s):