ESCAPE

Exploring Science Collaboration at Pinole-family Elementaries

Strategies for promoting student skill development in the practices of science and engineering, and strategies for connecting science with Common Core language arts skill development (speaking and listening, reading, and writing).

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

BASP
BAY AREA SCIENCE PROJECT

WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT

West Contra Costa Unified
SCHOOL DISTRICT

Strategies to Develop Science and Engineering Practices

Encourage Curiosity and Questioning

- Pose mysteries or challenges, provide time and/or materials for open-ended exploring, and use tools (lens, frames, scales, rulers, plots/sections) to focus/facilitate observation
- Use board, posters or journals to record "I Notice, I Wonder". Ask students to develop and write investigation questions or challenge questions.
- Help students sort questions into categories and "Research, Observe over time, Investigate at school" and let students to choose " juicy questions" they want to answer *(Everyone's interested, no one knows the answer, we have materials and time needed)*
- Ask: What do we want to know? What do we think is happening? What problem do we want to solve? *to focus on a testable idea or design problem*

Prompt, Investigation Planning, Modeling, and Data Collection

- Ask: How can we find out whether our idea is right? Or is there a model that could help us test possible solutions or explore how something might work? What materials will we need? *To design experiment or develop testable model for design problem*
- How will we observe the results – what will change? *To define dependent variable or success criteria.*
- Ask: To make a fair test, what different factors could influence results? Which factor do we want to test? How shall we control the other factors so they will remain the same? *to help identify controlled variables and isolate test variable in experiments or design tests*
- How shall we record and organize our observations? Pictures? Numbers? Words?
- Progress from using instructions and provided data collection tools, to group development, to independent development of experiments, including: variables, procedures, and records.

Support Data Analysis and Using Math and Logic

- Compare and contrast data for whole class. Ask: Which data is most relevant to our question or challenge? What differences/similarities do you see in the relevant data? Can you think of any differences in methodology that might explain unusual data?
- Build analysis and communication skills. Ask: Do you see any patterns or trends in the data? How could we show your data so that this pattern is easier for others to see?
- Does this data or model support some explanations about what is happening? Sentence frames: "The data […] might support the idea that […]" ; That data could also mean […]; "This other data […] supports/opposes '
- Introduce and use different data analysis tools including tables, labeled drawings, descriptions and graphs, progressively asking students to develop and describe analysis approach

Foster Respect for Evidence-Based Explanation and Respectful Argumentation

- Which idea or design solution is supported by the most relevant evidence? Are there other sources that could help us answer our question? Other observations? Analogies? Research information?
- Help students distinguish claims, evidence, and reasoning leading to a conclusion. Claim sentence frame: **I think that ___** [*is the best solution, is caused by …, is related to …*] **because of the following evidence** [*observational data/test results/research information from text or media/ model of relationships*] **and reasoning** from available evidence.
- Facilitate respectful discussion with frames for argument, additions, and response. Sample frames: Can you say a little more about your idea….?; How does this result compare with …..?; Can you explain what evidence supports your reasoning?; Could this evidence also support another idea….?; Does anyone have a different idea…?

Building Students' Science Knowledge

Start from Student Ideas and Encourage Exploration

- Use open activities with varied results
- Give value to any speculation and investigate with real evidence
- Allow for and encourage unexpected results or wondering
- Follow up on all possibilities right or wrong
- Select productive questions appropriate to student skills and activity:
    - Focus attention *(Did you notice…)*
    - Improve observation *(How many? how long? How are they alike or different?)*
    - Prompt exploration *(What happens if? Can you find a way to determine..?)*

Foster Confidence and Participation

- Connect lessons to student experiences, relevant issues
- Make it easier with clear directions *(say it, write it, show it)*
- Answer questions with questions that promote thinking
- Expect everyone to think – somebody will share
- Be equitable in student selection (*class sticks, sharing stick)*
- Use 3-second wait time after questions, after sharing, after instruction
- Make clear distinction between presentation/instruction and sharing/discussion
- Facilitate students' responding to one another during sharing
- Listen and prompt during discussions as needed, to emphasize, redirect, clarify misconceptions

Build Science and Communication skills

- Provide multiple opportunities to share results
- Introduce the idea of making educated guesses to predict what might happen
- Teach how to give and receive constructive questioning and feedback,
- Grow skills by building up to group conversation *(think, pair, share)*
- Ask students to write down observations and thoughts; use science notebooks to write & draw
- Use science process words consistently
- Teach all new vocabulary (tools, concepts, and science process words) in context and with visual support, including pictures, videos, diagrams, and graphic organizers
- **Make new science vocabulary a tool rather than a barrier *(don't use "science" words until they're needed)***

Help Students Connect Experiences to Ideas

- Conclude every activity with a discussion
- Build ideas from direct experiences with questions that reveal meaning
- Allow all students to participate in higher level thinking
- Provide opportunities to apply ideas to new situation*. Experiences are fixed memories, but ideas evolve with information and experience.*
- Connect back to original thinking and hypothesis to build memory pathway
- Refer to experiences and vocabulary in later lessons where possible
- Map ideas; use graphic organizers and diagrams to illustrate all relationships Record all big ideas from individual lessons in overall concept map for the unit and leave on the wall

Common Core – Science Connections

Strengthening Science Speaking & Listening Skills

Science provides key opportunities for developing speaking and listening skills, including: small group work and discussions during investigations, large group discussions of data and explanations, possible conclusions, and occasional individual presentations of research, such as Science Investigation Posters. Several tactics can improve student performance in these tasks.

- Review guidelines for small group discussion (respectful, equitable, "I" statements) and use teaching structures like timed sharing as necessary to develop respectful, equal discussion habits.

- Use structures to develop large collaborative discussion skills, including basic discussion rules, practicing listening postures, and providing sentence frame support for
  - sharing observations (I noticed that ___)
  - presenting conclusions (I think that _____ because during the experiment I noticed ____)
  - commenting on previous statements (I agree/disagree with the idea that ___ because ____) (Another way to look at that observation might be ____)

- **Individual and small group oral presentations** on investigations or research topics, with visual display (clear & logical arrangement of main idea, supporting facts, appropriate vocabulary)

- Review discussion support and structure to address performance expectations in CCELA Speaking and Listening Standards**.** Applicable performance guidelines for students and possible prompts include:

Common Core ELA Performance Guidelines	**Possible Instruction Prompts**
Follow agreed-upon rules for discussion	What are our rules for discussion?
Are able to state their own observations and ideas	What did you notice? What do you think might be happening? What evidence from your observations supports that idea?
Answer questions with observations and reasoning related to the discussion	If off topic: Can you think of another observation or interpretation to add to our list? Or Which of these observations did you see? If encyclopedic answer: Can you choose one important thing that supports or contradicts our observations/reasoning?)
Summarize the points that the last speaker (or teacher) made	Who can tell me what ____ just said in their own words? [Ask routinely and select speakers at random]
Make a comment that elaborates on the remarks of others	Can anyone explain more about what ____ just said? Who has something to add to that …
Identify the evidence that the speaker provided to support their idea	What evidence did __ provide to support this idea? Can you think of any other evidence that supports or contradicts this idea? Can you think of any other ways to look at that evidence?
Draw conclusions using information from discussion	Who can sum up the shared results of our experiment?

Common Core-Science Connections**: Strengthening Science Writing Skills**

Common Core Standards require students to produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose and audience. There are several science-specific writing formats, including:

- **Background information, pre-investigation research on topic**
- **Experimental Procedure notes and Experimental Data Records**
- **Learning Notes, Conclusions**
- **Research Reports**
- **Science Investigation Posters.**

Several tactics can improve student performance in science and writing.

- Provide progressive learning experiences to strengthen writing in specific science formats Instruction can develop over time, moving from showing models of good writing of this type, providing structures and sentence frames for student content, and then moving to more independent writing with ongoing access to a word bank. Teacher comments on writing are an important part of this process: *pointers* about elements that are missing or unfocused and *positive affirmations* of writing that meets the key goals.

- Use science notebooks to help students develop skills to write (or draw). The overall notebook can contain several components that fall into the Experimental Record, Learning Notes, Observations and Data, and References. Younger grades may use more drawing; older grades can use Experimental Records that use *accepted format* and *science vocabulary*, including: a focus topic question, testable hypothesis, clear procedure, organized data, analysis of shared data linking opinions and reasons, and a concluding statement.

- Use sentence frames to support the development of science writing, such as prompts to structure the experiment record format or personal learning reflection. Post sentence frames in classroom for reference.

- Use glossaries in student notebooks, word banks on wall or student-made flashcards to support vocabulary acquisition. Student involvement can vary from looking up needed words in pre-printed glossaries to asking students to create their own content dictionary or flashcards with words, definitions, drawings and using words in their own sentences. In deciding the number to words to introduce and the level of student involvement balance the need to conserve time for critical hands-on experiences, monitoring for accuracy and completeness, and the benefits to student retention of vocabulary.

- Whole class, small group, or individual short research project that draws on multiple sources to develop an explanatory text (or poster), with a clear topic introduction, organized development of topic with facts or examples, appropriate science vocabulary, and a clear concluding statement.

Common Core – Science Connections: **Strengthening Science Reading Skills**

Science reading should be used to support the process of hands-on experimentation critical to science study:

- **reading procedures for experiments**
- **reading experiment records or investigation posters that summarize hands-on experiences**
- **reading science texts after the completion of hands-on experiences to connect personal observations with vocabulary and reinforce academic language**
- **reading informational texts for research projects to develop deeper knowledge on specific subjects.**

In schools with separated time for science and English instruction, reading science texts and longer research projects are typically part of the English Language Instruction time, ideally connected with science content and investigations done during science instruction time.

In Science Instructional Time: (*adapted as appropriate for grade level reading skills*)

- Provide all instructions and procedures in writing, as well as verbally and by demonstration, to build reading skills and vocabulary related to science materials and techniques. Strengthen reading skills by asking students to:
  - verbally "*describe the steps in a procedure*" and eventually write up their own procedures for an investigation.

- Provide models of good experiment records and investigation posters for students to read as background and to foster writing skills in these formats. Strengthen science reading by asking students to perform the following CCELA performance skills when reading and discussing material:
  - "*describe the connection between steps in the technical procedures*"
  - "*determine two or more main ideas of text and explain how they are supported by key details*"
  - *"Explain how images contribute to and clarify the text"*
  - *Summarize* what the report or poster says *explicitly or by inference, using accurate quotes*

- Ask students to ***read and compare experiment records or descriptions of the same event*** *to note important similarities and differences* in conclusions and ideas.

- Ask students to ***determine meaning*** of all science phrases and words using glossaries (provided or constructed by students) or other tools.

- Summarize units with a review of experiment records and/or other text passages related to the topic. Strengthen science reading by asking students to perform the following CCELA performance skills:
  - *"Describe the connection between (a series of scientific ideas)…"*
  - "*Explain relationships or interactions between (two or more events or ideas in the written material based on specific information in the text)…*"
  - Determine the meaning of science phrases and words

- **(In English Language instructional time)** Short research project (individual or class, as appropriate for grade level) related to science topics, providing support with lists of credible and accessible science resources in print and on-line. Strengthen science reading by asking students to perform the following CCELA performance skills:
  - Find information from multiple print or digital sources using valid search and selection techniques
  - Integrate information from several text to write or speak about subject knowledgeably
- Coordinate informational text reading (science curriculum materials, additional recommended science information texts) with ongoing investigations to strengthen vocabulary understanding and retention.