Science Learning and Language Learners

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Framework and NGSS: Three Dimensions

- Scientific and engineering practices
- Crosscutting concepts
- Disciplinary core ideas
- NGSS – standards as performance tasks that involve all 3

Example (grade 3 PS – forces and motion)
Plan and conduct an investigation (practice) to provide evidence of the effects of balanced and unbalanced forces (ccc) on the motion of an object (dci)
Le savant doit ordonner ; on fait la science avec des faits comme une maison avec des pierres ; mais une accumulation de faits n'est pas plus une science qu'un tas de pierres n'est une maison.

The knower must organize (the knowledge); one builds science with the facts (data), as (one builds) a house with the stones. But a collection of facts is no more a science than a heap of stones is a house.

Jules Henri Poincaré (29 April 1854 – 17 July 1912)
Students must build 3D science knowledge structures.

Make conceptual changes from their pre-conceptions.
To build a house

• Need building materials—stones, planks, bricks, ….

  Disciplinary core ideas

• Need tools and experience using them

  Science and Engineering practices

• Need some idea of what you are trying to build, some big ideas about the nature of houses

  Crosscutting Concepts
**Scientific and Engineering Practices**

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Developing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

**Discourse intensive!**
Crosscutting Concepts

1. Patterns
2. Cause and effect: mechanism and explanation
3. Scale, proportion and quantity
4. Systems and system models
5. Energy and matter: flows, cycles and conservation
6. Structure and function
7. Stability and change

All suggest ways to approach a problem, questions to ask
How science understanding develops

• Multiple opportunities to hear and use science ideas and practices

• Rich contexts (phenomena and materials) create desire and opportunity to engage and contribute

• Appropriate supports

• Acceptance of flawed (non-scientific) language and incomplete ideas
How language develops

• Multiple opportunities to hear and use language
• Rich contexts (experiences) to create desire and opportunity to engage and contribute

• Appropriate supports

• Acceptance of flawed language (while still supporting language development)
Science class is a language development opportunity

IF

Classroom discourse

is managed for inclusion

Appropriate and varied

language development supports

for all students
Some science specific language challenges

• Technical terminology (word redefinitions or inventions)
• “academic” usage (analyze, consequently …)
• Multi-phrase sentence structure, many referents (it, that…)
• Nominalization (whole concepts turned into single words such as respiration, adaptation…)
• Need for precision
Every student is a science language learner

• Attention to language challenges benefits all students

• What additional supports ELL students need depends on their language level

• Priority given to participation and science meaning making over correctness
Science specific language opportunities

- Diagrams, graphs and tables augment text
- Manipulation of real objects and phenomena
- Diversity of topics and associated language to be explored
- Design opportunities that connect to real world problems
Engagement in practices

As a tool to learn science and engineering

As a way to understand the nature of science (with reflection)

As a language development opportunity

CCSSO Resources: A Framework for ELPD Standards Development -- Tables
<table>
<thead>
<tr>
<th>Key NGSS Practice 2: Develop models</th>
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**Analytical Tasks**
- Develop and represent an explicit model of a phenomenon or system
- Use a model to support an explanation of a phenomenon or system
- Make revisions to a model based on either suggestions of others or conflicts between a model and observation

**Receptive Language Functions**
- Comprehend others’ oral and written descriptions, discussions, and justifications of models of phenomena or systems
- Interpret the meaning of models presented in texts and diagrams

**Productive Language Functions**
- Communicate (orally and in writing) ideas, concepts, and information related to a phenomenon or system using a model developed for this purpose:
  - Label diagrams of a model and make lists of parts
  - Describe a model using oral and/or written language as well as illustrations
  - Describe how a model relates to a phenomenon or system
  - Discuss limitations of a model
  - Ask questions about others’ models
IQWST Assessment: Modeling Smell

Your teacher opened a jar that contained a substance that had an odor. Imagine you had a very powerful microscope that allowed you to see the odor up really, really close. What would you see?

• Lesson 15: student models
  – 75% of students create a particle model, 25% a mixed model
  – 68% of students include odor particles that are moving in straight lines until they collide into each other; 32% include both odor and air

2. Label what the parts in your drawing (in the magnifier) represent.
   * - Ammonia Molecules
   0 - Tissue soaked in Ammonia in a Jar
   → - Movement

3. Now, imagine that a friend of yours from a different science class was looking at...
What do teachers need to know how to do to?

• Support science discourse (in the context of science practices)

• Support science literacy development

• Ensure that process is inclusive, for students at all levels of language development and science knowledge
Supporting science discourse

• Set up *science problem situations* that prompt rich discourse
• Support productive discourse in varying group arrangements from whole class to paired students
• Prompt and question students to build on and extend science ideas and language usage (their own and that of others)
Support literacy in and for science

• Understand what makes science text different (discipline specific variants)
• Help students develop science-specific reading strategies
• Support students to keep and use science journals
• Assign formal science writing and verbal presentation opportunities
Teacher challenge

Be aware of both the **language learning** needs and the **science learning** needs and progress of each student

Formative assessment during learning tasks, (not just separate assessment tasks)

How can teachers record and analyze progress?

(eg through photos, and audio or video clips of activity in the classroom, as well as written student products)
Integrated Professional Development for

- 3d science learning
- language and literacy development in the science classroom
- assessment strategies that support meaningful science and language learning and inform subsequent teaching

All are unfamiliar to many science teachers