NGSS Instructional Shifts and Language Instructional Shifts Support Each Other with English Learners

Science Kickstart
Honolulu, Hawaii
July 17, 2017

Okhee Lee
New York University
Changing Student Demographics

ESSA four demographic groups for accountability measures:

1. Economically disadvantaged students
   • 51% of students were eligible for free and reduced price lunch in 2013 (Southern Education Foundation, 2015)

2. Students from major racial and ethnic groups
   • Racial and ethnic minority students made up 50% of students in fall 2013 (National Center for Education Statistics [NCES], 2016)

3. Children with disabilities
   • 13% of students received special education services in 2013–2014 (NCES, 2016)

4. English learners
   • 21% of children spoke a language other than English at home (U.S. Census Bureau, 2012)
   • English learners constituted 9.3% of public school students in 2013-2014, or an estimated 4.5 million students (NCES, 2016)
NGSS Diversity & Equity Team: All Standards, All Students

Bias Reviews
- Inclusive language
- Consistency of language
- Clarity of language

Appendix D
- NGSS learning opportunities and demands
- Effective strategies
- Context

Diversity and Equity Topic in Appendices

7 Case Studies
- Economically disadvantaged
- Racial and ethnic groups
- Students with disabilities
- English learners
- Girls
- Alternative ed
- Gifted and talented
NGSS Instructional Shifts and Language Instructional Shifts Support Each Other with All Students, Including English Learners (ELs)

1. Conceptual Framework
2. Classroom Video
3. Instructional Materials
NGSS Instructional Shifts and Language Instructional Shifts Support Each Other with ELs

**Shift 1:** Explaining phenomena or designing solutions to problems

**Shift 2:** Three-dimensional learning

**Shift 3:** Coherence (or Learning progression)

---

NGSS Science and Engineering Practices

1. Ask questions (for science) and define problems (for engineering)
2. Develop and use models
3. Plan and carry out investigations
4. Analyze and interpret data
5. Use mathematics and computational thinking
6. Construct explanations (for science) and design solutions (for engineering)
7. Engage in argument from evidence
8. Obtain, evaluate, and communicate information
1. Patterns
2. Cause and effect
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter
6. Structure and function
7. Stability and change
# NGSS Disciplinary Core Ideas

## Physical Sciences
- PS 1: Matter and its interactions
- PS 2: Motion and stability: Forces and interactions
- PS 3: Energy
- PS 4: Waves and their applications in technologies for information transfer

## Life Sciences
- LS 1: From molecules to organisms: Structures and processes
- LS 2: Ecosystems: Interactions, energy, and dynamics
- LS 3: Heredity: Inheritance and variation of traits
- LS 4: Biological Evolution: unity and diversity

## Earth and Space Sciences
- ESS 1: Earth’s place in the universe
- ESS 2: Earth’s systems
- ESS 3: Earth and human activity

## Engineering, Technology, and the Applications of Science
- ETS 1: Engineering design
- ETS 2: Links among engineering, technology, science, and society
Shift 1: Explaining a phenomenon or designing solutions to a problem. A phenomenon or problem in a local context of ELs’ home and community capitalizes on everyday language and experience.

Our school makes large amounts of garbage every day.

What happens to our garbage?

There is much concern over lead in the water in Flint, Michigan.

Can this problem happen in our community?

Rita Januszyk
Shift 1: A phenomenon or problem in a local context integrates equity through place-based learning with science through project-based learning.
Shift 1: Local phenomena or problems in Hawaii
Shift 2: Three-dimensional learning. The NGSS science and engineering practices are language intensive.
## Shift 2: Three-Dimensional Learning

NGSS practices afford rich language use

### NGSS Practice 7: Engage in argument from evidence

<table>
<thead>
<tr>
<th>Analytical Science Tasks</th>
<th>Receptive Language Functions</th>
<th>Productive Language Functions</th>
</tr>
</thead>
</table>
| • Distinguish between a claim and supporting evidence or explanation  
• Analyze whether evidence supports or contradicts a claim  
• Analyze how well a model and evidence are aligned  
• Construct an argument | • Comprehend arguments made by others orally  
• Comprehend arguments made by others in writing | Communicates (orally and in writing) ideas, concepts, and information related to the formation, defense, and critique of arguments  
• Structure and order written or verbal arguments for a position  
• Select and present key evidence to support or refute claims  
• Question or critique arguments of others |

---

Lee, O., Quinn, H., & Valdés, G. (2013)
Lessons often raise questions that motivate what we want to figure out in subsequent lessons.
### Shift 3: Learning Progression. Language use becomes more sophisticated over time

<table>
<thead>
<tr>
<th>Modalities</th>
<th>Registers</th>
<th>Interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Talk</td>
<td>Colloquial/everyday talk and text</td>
<td>• One-to-one</td>
</tr>
<tr>
<td>• Text</td>
<td>Specialized/disciplinary talk and text</td>
<td>• One-to-small group</td>
</tr>
<tr>
<td>• Diagram</td>
<td></td>
<td>• One-to-many</td>
</tr>
<tr>
<td>➢ Drawing</td>
<td></td>
<td>• Small group-to-many</td>
</tr>
<tr>
<td>➢ Table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Graph</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Chart</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Precision:** Is the language exact enough to communicate discipline-specific ideas (e.g., using discipline-specific terms)?
- **Explicitness:** Can someone who is not in the classroom understand?

Lee, O., Quinn, H., & Valdés, G. (2013)
The video shows a 4th grade science classroom at a Title I school with 64% economically disadvantaged and 34% ELs.

The teacher has been teaching NGSS-based instruction for the past couple of years. It takes time to implement NGSS-aligned science instruction.

https://vimeo.com/166410948
1. As you watch a video of science instruction, identify:
   1) NGSS science and engineering practices
   2) NGSS crosscutting concepts
   3) how the teacher demonstrates NGSS and language instructional shifts

2. Discuss with your partner

3. Share your ideas with the whole group
Question 1: Science and Engineering Practices
1. Ask questions (for science) and define problems (for engineering)
2. Develop and use models
3. Plan and carry out investigations
4. Analyze and interpret data
5. Use mathematics and computational thinking
6. Construct explanations (for science) and design solutions (for engineering)
7. Engage in argument from evidence
8. Obtain, evaluate, and communicate information

Question 2: Crosscutting Concepts
1. Patterns
2. Cause and effect
3. Scale, proportion and quantity
4. Systems and system models
5. Energy and matter
6. Structure and function
7. Stability and change

Question 3: NGSS Instructional Shifts
1. Explaining phenomena
2. Three-dimensional learning
3. Coherence (or learning progression) across time
Discussion

1. Identify:
   1) NGSS science & engineering practices
   2) NGSS crosscutting concepts

2. Discuss with your partner

3. Share your ideas with the whole group
Shift 1:
How does a phenomenon or problem in a local context support language development?

Shift 2:
How does three-dimensional learning support language use and development?

Shift 3:
How does science understanding support language development over time (i.e., learning progression)?
Discussion

Shift 1:
How does a phenomenon or problem in a local context support language development?
Shift 1:
Phenomenon-based science instruction provides students with a purpose to communicate and a compelling context in which to express their ideas.
Discussion

Shift 2:
How does three-dimensional learning support language use and development?
Shift 2:
As students “do” science, they use language
Discussion

Shift 3:
How does science understanding support language development over time (i.e., learning progression)?
Shift 3:
As three-dimensional learning becomes more sophisticated over time, language use becomes more sophisticated.
### Shift 3:
As three-dimensional learning becomes more sophisticated over time, language use becomes more sophisticated

<table>
<thead>
<tr>
<th>Modalities</th>
<th>Registers</th>
<th>Interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Talk</td>
<td>Colloquial/everyday talk and text</td>
<td>• One-to-one</td>
</tr>
<tr>
<td>• Text</td>
<td></td>
<td>• One-to-small group</td>
</tr>
<tr>
<td>• Diagram</td>
<td>Specialized/disciplinary talk and text</td>
<td>• One-to-many</td>
</tr>
<tr>
<td>➢ Drawing</td>
<td>• Precision</td>
<td>• Small group-to-many</td>
</tr>
<tr>
<td>➢ Table</td>
<td>• Explicitness</td>
<td></td>
</tr>
<tr>
<td>➢ Graph</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➢ Chart</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lee, O., Quinn, H., & Valdés, G. (2013)
Science and Integrated Language

Development of Language-Focused Three-Dimensional Science Instructional Materials to Support English Learners in Fifth Grade

Okhee Lee
Lorena Llosa
(New Jersey Research Site)

Guadalupe Valdés
Helen Quinn
(California Research Site)

This work is supported by the National Science Foundation (NSF Grant DRL-1503330). Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the position, policy, or endorsement of the funding agency.
Perspective on Science and Language Integration with English Learners

- ELs participate in a classroom community of practice that offers continuous opportunities to “do” science
- ELs use language for purposeful communication, as they “do” science
- All ELs participate meaningfully in rigorous science learning, regardless of their English proficiency levels
Science (NGSS) and Language Design Principles Support Each Other with ELs:

- **Science Design Principles**
  - ELs explain phenomena and design solutions to problems
  - ELs engage in three-dimensional learning
  - ELs build understanding over time (learning progressions)

- **Language Design Principles**
  - ELs use multiple modalities strategically
  - ELs use increasingly specialized/disciplinary register of talk and text
  - ELs use multiple modalities and registers to meet communicative demands of different types of interactions
Content Framework for 5th Grade – 4 Units

**Unit 1**

AP: Garbage in school lunch

DQ: What happens to garbage?

What are the properties of matter? What is air made of? How do materials change? Do materials vanish?

5-PS1-1: DCI: Structure and Properties of Matter: Matter is made of tiny, invisible particles that are too small to see, but even the matter still exists and can be detected by other means. A model showing that gases are made from matter that is so small that it can be seen. 5th graders can explain how properties of matter change in response to changes in their environment. 5th graders can explain how forces between objects can cause materials to change or separate.

5-PS1-2: DCI: Structure and Properties of Matter: The amount of matter in an object or substance is called its mass. This mass can be measured with a balance or scale. The amount of space something occupies is called its volume. This volume can be measured with a container or by displacement. 5th graders can explain how forces between objects can cause materials to change or separate.

5-PS1-3: DCI: Structure and Properties of Matter: Changes in matter can be observed by changes in its properties and can be described in terms of measurable properties. Changes in matter can be classified as reversible or irreversible. 5th graders can explain how forces between objects can cause materials to change or separate.

5-PS1-4: DCI: Structure and Properties of Matter: Changes in matter can be observed by changes in its properties and can be described in terms of measurable properties. Changes in matter can be classified as reversible or irreversible. 5th graders can explain how forces between objects can cause materials to change or separate.

**Unit 2**

AP: The tiger salamander present in one vernal pool and missing from the another vernal pool

DQ: Why is the tiger salamander disappearing?

How do species in an ecosystem interact and meet their needs? How do matter and energy flow through an ecosystem? How do plants grow?

5-Li.8.3-1: DCI: Interdependent Relationships in Ecosystems: The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants and animals) and therefore operate as "decomposers." Decomposition eventually returns (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. Cycles of Matter and Energy Transfer in Ecosystems: Matter cycles between the air and soil and among plants, animals, and microorganisms as these organisms live and die. Organisms obtain energy, grow, and reproduce from the environment, and release waste materials (gas, liquid, or solid) back into the environment.

5-ESS3-1: DCI: Human Impacts on Earth Systems: Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

5-PB2-1: DCI: Types of Interactions: The provisional force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.

**Unit 3**

AP: People drink water from different sources

DQ: Why does it matter what water we drink?

How do Earth systems interact? How can we engineer solutions to problems in Earth systems?

5-ESS3-2: DCI: The Roles of Water in Earth's Surface Processes: Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground, only a tiny fraction of it is in streams, lakes, wetlands, and the atmosphere.

5-ESS3-3: DCI: Human Impacts on Earth Systems: Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

**Unit 4**

AP: Video of "falling stars" during a meteor shower

DQ: Why do "falling star" fall?

What models of Earth's movement can explain the patterns of the shadows, and the position of stars and the moon? How is the sun a star?

5-ESS1-1: DCI: The Universe and Its Stars: The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distances from Earth.

5-ESS1-2: DCI: Earth and the Solar System: The activity of Earth around the sun and around Earth, together with the rotation of Earth about its axis results in the fact that the time of day varies throughout the year. The time of day varies throughout the year. The time of day varies throughout the year.

5-ESS2-3: DCI: Energy in Chemical Processes and Everyday Life: The energy released from fossil fuel was once energy from the sun. This energy was trapped by plants in the chemical process that forms plant matter (from air and water). Organisms that eat plants must obtain energy from the food they eat. Organisms that eat only plants must obtain energy from the food they eat. Organisms that eat only plants must obtain energy from the food they eat. Organisms that eat only plants must obtain energy from the food they eat.

5-ESS3-1: DCI: Human Impacts on Earth Systems: Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.
Unit 1: What Happens to Our Garbage? – Performance Expectations (PEs)

Grade 5 PEs Topical Arrangements

5. Structure and Properties of Matter
   5-PS1-1   5-PS1-2   5-PS1-3   5-PS1-4

5. Matter and Energy in Organisms and Ecosystems
   5-PS3-1   5-LS1-1   5-LS2-1 (introduced)

5. Earth’s Systems
   5-ESS2-1   5-ESS2-2   5-ESS3-1 (introduced)

5. Space Systems: Stars and the Solar System
   5-PS2-1   5-ESS1-1   5-ESS1-2

3-5. Engineering Design
   3-5-ETS1-1   3-5-ETS1-2   3-5-ETS1-3
5-PS1-1: Develop a model to describe that matter is made of particles too small to be seen

5-PS1-2: Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved

5-PS1-3: Make observations and measurements to identify materials based on their properties

5-PS1-4: Conduct an investigation to determine whether the mixing of two or more substances results in new substances

5-LS2-1: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment

5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment

3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost
**Shift 1:** A phenomenon or problem in a local context of ELs’ home and community capitalizes on everyday language and experience

**Phenomenon:** Our school makes large amounts of garbage every day.

**Driving question:** What happens to our garbage?
Shift 1: Phenomenon and Driving Question
Write down your questions about the garbage on sticky notes, one question per note. See how I wrote on my sticky note: “Why does the trash stink?”
Shift 2: The NGSS science and engineering practices are language-intensive

What happens to our garbage (in the real world)?

What happens to our garbage (in the classroom)?
Shift 3: Three-dimensional learning becomes more sophisticated over time

Cluster 1: What do we want to know about our garbage? (phenomenon and driving question of the unit)

Cluster 2: What happens to materials of garbage? (properties of matter)

Cluster 3: How do we smell garbage? (particle nature of matter)

Cluster 4: What causes changes in the garbage? (chemical reactions, conservation of matter)

Cluster 5: How can we help the environment with engineering solutions to problems caused by garbage? (human impacts and solutions)
**Shift 3:** Language use becomes more sophisticated over time

<table>
<thead>
<tr>
<th><strong>Over the Course of the Unit</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modalities</strong></td>
</tr>
<tr>
<td>Increasingly strategic use of multiple modalities</td>
</tr>
<tr>
<td><strong>Registers</strong></td>
</tr>
<tr>
<td>Increasingly specialized / disciplinary registers</td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
</tr>
<tr>
<td>Increasingly strategic use of multiple modalities and registers in different interactions</td>
</tr>
</tbody>
</table>
Thank You!