Integrating Science And Language For All Students With A Focus On English Language Learners

SCIENCE INSTRUCTIONAL SHIFTS

Produced for the New York State Education Department by
Alison Haas, PhD, Scott Grapin, PhD, Lorena Llosa, PhD, and Okhee Lee, PhD

Enacting instruction aligned to the New York State (NYS) P-12 Science Learning Standards with English language learners (ELLs) requires shifts in how teachers think about science teaching. This brief introduces science instructional shifts, which are new or different ways of thinking about teaching and learning science. We highlight how these science instructional shifts are beneficial for all students but especially ELLs.

The three science instructional shifts addressed in this brief are phenomena, three-dimensional learning, and learning progressions. For each shift, we will address (1) what is the shift, (2) what does the shift look like in science classrooms with ELLs, and (3) what can teachers do in their own classrooms to begin enacting the shift.

Each shift is illustrated in the context of a fifth-grade science unit aligned to the standards and designed with a specific focus on ELLs. In this unit, students explain the phenomenon of garbage in their home, school, and community while developing their understanding of key physical and life science ideas. Throughout this brief, we will refer to this unit as "the garbage unit." The complete unit is available at nyusail.org for teachers to download and use.

AT A GLANCE

PHENOMENON

A phenomenon is an observable event in the natural world that students need to explain. Local phenomena capitalize on ELLs' everyday experiences and language in their homes and communities.

THREE-DIMENSIONAL LEARNING

Three-dimensional learning blends science and engineering practices, crosscutting concepts, and disciplinary core ideas for the purpose of explaining phenomena. Engaging in three-dimensional learning promotes rich language use with ELLs in the classroom community.

LEARNING PROGRESSIONS

Learning progressions describe the increasingly sophisticated science understanding that students develop. Scaffolding student engagement with three-dimensional learning allows all students, including ELLs, to build and revise their science understanding over time.

PHENOMENON

Phenomena or problems are central to science and science learning. A phenomenon is an observable event in the natural world that students need to explain. As students make sense of phenomena or solve problems, they experience the work of scientists and engineers and have a purpose for learning science. There are countless examples of phenomena that can be used as the focal point for curricular units. For example, in the garbage unit, students engage with the phenomenon of garbage in their home, school, and community in order to answer the question, "What happens to our garbage?" Local phenomena such as garbage allow all students, including ELLs, to bring their everyday experiences into the science classroom.

What is the shift?

Traditionally, phenomena were used primarily to introduce investigations, lessons, or units. Phenomena were not always relevant to students' everyday lives and experiences. In the contemporary science classroom, phenomena that are local, meaningful, and relevant to all students are sustained over a unit. Some examples of local, meaningful, and relevant phenomena include:

- What happens to garbage in our home, school, and community
- Why an endangered animal disappeared from a local ecosystem
- Whether we should drink tap or bottled water in our community
- Why falling stars fall from the perspective of our position on Earth

Anchoring science learning in local phenomena capitalizes on students' everyday experiences in their homes and community.

What happens to our garbage?

Why did the tiger salamanders disappear?

Why does it matter if I drink tap or bottled water?

Why do falling stars fall?

TRADITIONAL THINKING

Phenomena were used to introduce science ideas but were not sustained over a unit.

CONTEMPORARY THINKING

Students explain phenomena that are local, meaningful, and relevant to them.

What does the shift look like in the classroom?

In the contemporary science classroom, instruction is anchored in phenomena that are local, meaningful, and relevant to students. In the garbage unit, students engage in the phenomenon of their own lunch garbage. The primary goal of the unit is to answer the driving question, "What happens to our garbage?" Students engage in investigations and learn science concepts and ideas for the purpose of answering the unit driving question. In this unit, the phenomenon is sustained over the entire 9 weeks of instruction. For example, students consider how the garbage produced in their school is transported through the community garbage system. Additionally, students develop "landfill bottles" to investigate what happens to garbage over time. Sustained engagement with the phenomenon over 9 weeks of instruction allows all students to develop deep science understanding. Additionally, science instruction anchored in a local phenomenon provides all students, and particularly ELLs, with a reason and a compelling context in which to communicate.

What can teachers do to enact the shift?

Recommendation 1: Anchor science learning in local phenomena that draw on students' everyday experiences and language. For example, students could study an ecosystem within or near their community. Students could also investigate questions about space from the perspective of their particular position on Earth. When phenomena are relevant to students' lives, all students, including ELLs, can participate meaningfully from the beginning of science instruction.

Recommendation 2: Sustain the focus on the phenomenon over the course of a unit of instruction. In this vision of the science classroom, phenomena are not simply used as a hook to engage students at the beginning of instruction. Instead, students' questions about phenomena drive instruction throughout the entire unit. Over the course of a unit of instruction, students develop increasingly sophisticated explanations of the phenomenon.

THREE-DIMENSIONAL LEARNING

Three-dimensional learning blends science and engineering practices (SEPs), crosscutting concepts (CCCs), and disciplinary core ideas (DCIs) for the purpose of explaining phenomena.

- SEPs refine and deepen science inquiry. Students engage in eight SEPs that reflect the work that professional scientists and engineers do.
- DCIs are organized into four disciplines: physical science; life science; Earth and space sciences; and engineering, technology, and applications of science. DCIs depart from the traditional notion of science content because they provide explanatory power to make sense of phenomena.
- CCCs apply across science disciplines and help students develop a coherent and scientifically based view of the world. Students engage in seven CCCs that apply across all science domains.

Science and Engineering Practices

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

Disciplinary Core Ideas

1. Physical science
2. Life science
3. Earth and space science
4. Engineering, technology, and applications of science

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

What is the shift?

In the previous generation of standards, science content and inquiry were the focus, while crosscutting concepts and science and engineering practices took a backseat. In the contemporary science classroom, students engage in three-dimensional learning that blend science and engineering practices, disciplinary core ideas, and crosscutting concepts. All three dimensions are equally important and work together to explain phenomena.

TRADITIONAL THINKING

Science content and inquiry were the focus.

CONTEMPORARY THINKING

Students engage in three-dimensional learning. All three dimensions are equally important and work together to explain phenomena.

What does the shift look like in the classroom?

On the first day of the garbage unit, students enter their classroom to find a pile of their lunch garbage (that has been carefully curated by the teacher to include only safe items). All students are immediately engaged. They have a range of reactions from amazement to disgust, and they start making observations. Ensuring that students are wearing appropriate safety gear, the teacher prompts students to sort the garbage into categories. Students work in small groups to sort the garbage materials in different ways, for example, based on color, texture, and reflectivity.

This is an example of how students engage in three-dimensional learning. Students make observations, which is part of the science and engineering practice of planning and carrying out investigations. Specifically, students make observations about the properties of garbage materials. The idea that materials can be identified by their properties is a disciplinary core idea in physical science. Finally, to sort the garbage materials into categories, students look for patterns of similarity and difference. Patterns is a crosscutting concept. So putting it all together, students make observations (the science and engineering practice) by looking for patterns (the crosscutting concept) in the properties of materials (the disciplinary core idea).

Science and Engineering Practices

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

Disciplinary Core Ideas

1. 5-PS1-1 (related to particle nature of matter)
2. 5-PS1-2 (related to conservation of matter)
3. **5-PS1-3 (related to properties of matter)**

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

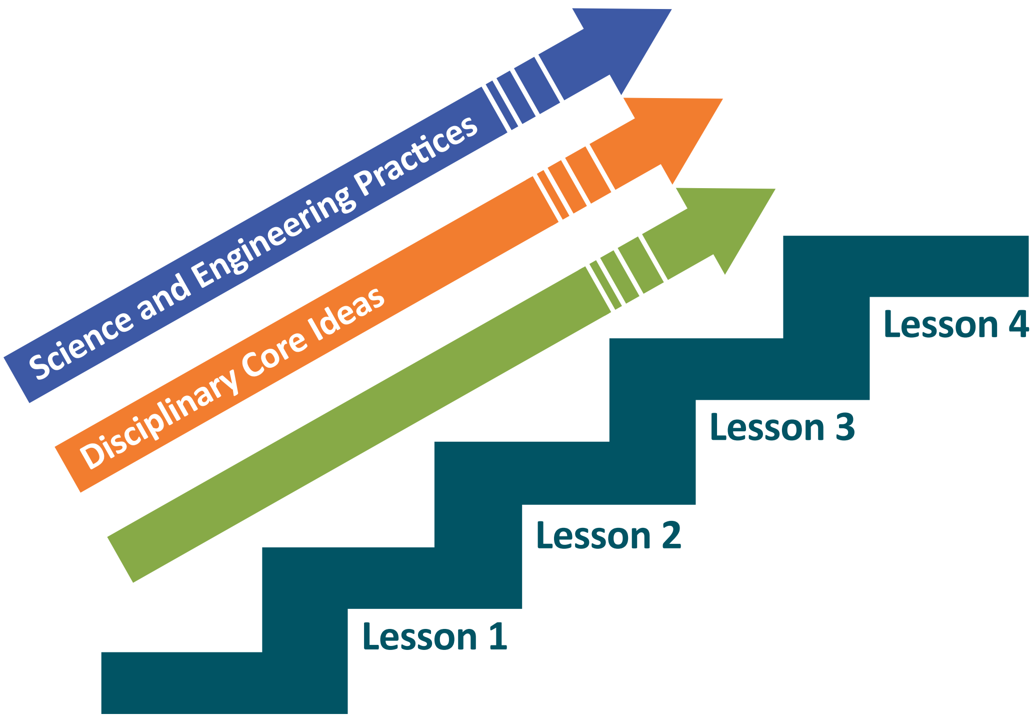
What can teachers do to enact the shift?

Recommendation 1: Blend the science and engineering practices, disciplinary core ideas, and crosscutting concepts in instruction. By engaging students in three-dimensional learning, teachers provide opportunities for students to do the work of scientists and engineers. All three hold equal importance. Each lesson should blend the three dimensions for the purpose of explaining a phenomenon.

Recommendation 2: Leverage science and engineering practices to promote rich language use in a classroom community. Science and engineering practices are particularly important for ELLs, as these practices afford opportunities for using language and other meaning-making resources, such as symbols and graphs. As ELLs develop and use models, plan and carry out investigations, and engage in argument from evidence, they work together with others members of their classroom community toward a common purpose.

LEARNING PROGRESSIONS

Learning progressions describe the increasingly sophisticated science understanding that students develop over the course of instruction. When science instruction is designed coherently, students are supported in developing deep science understanding over time. Learning progressions can occur over multiple timeframes. First, learning progressions occur across the P-2, 3-5, 6-8, and 9-12 grade bands articulated in the standards. Second, learning progressions occur within a unit and over a year. As students, and ELLs in particular, develop more sophisticated science understanding, they also develop the language to communicate that understanding with increasing precision and explicitness.



What is the shift?

Traditionally, science was taught through individual activities or investigations that were not always connected. Students learned a concept, were expected to master that concept, and then the class moved on to the next concept to be learned. In the contemporary science classroom, students engage in coherent learning experiences and develop increasingly sophisticated science understanding as they build and revise their understanding over time.

TRADITIONAL THINKING

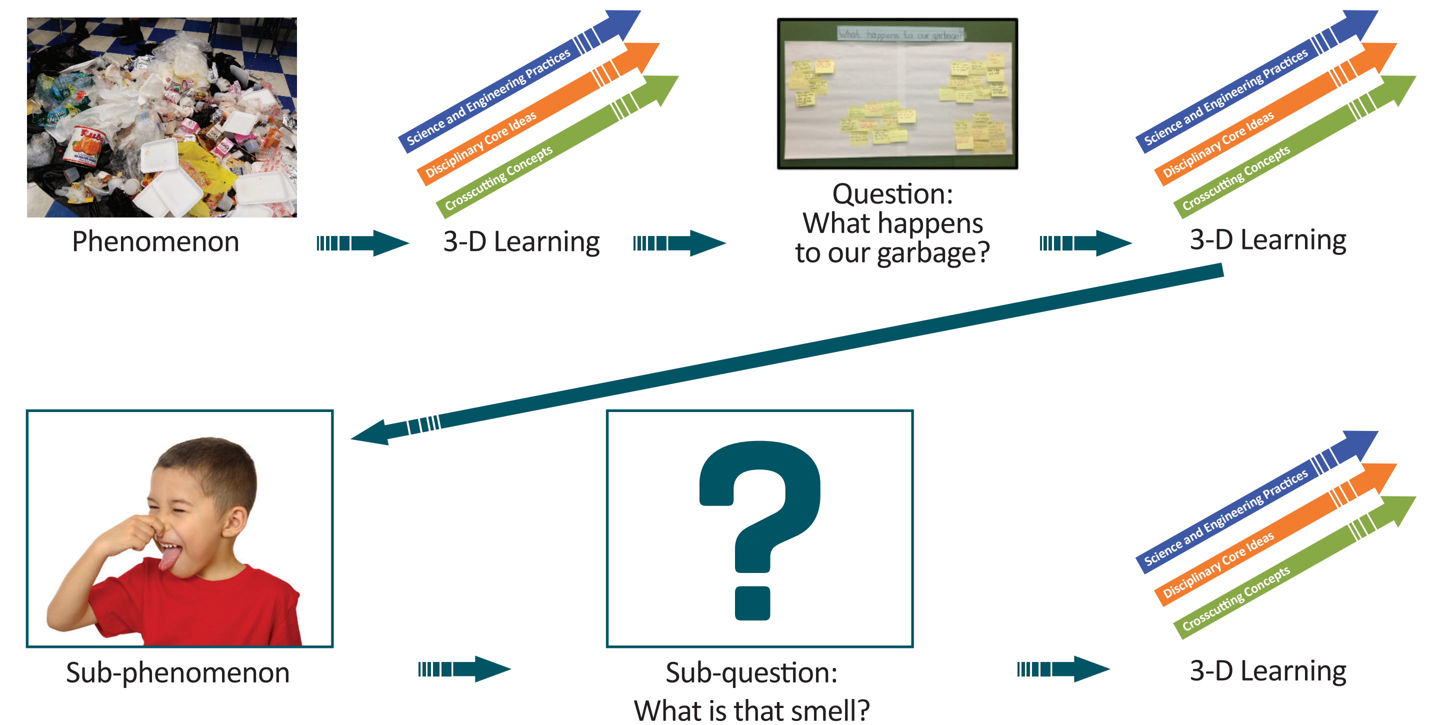
Individual activities or investigations were not always connected. Students were expected to "master" a science concept and then move on to the next concept.

CONTEMPORARY THINKING

Students engage in coherent science learning experiences and develop increasingly sophisticated understanding over time.

What does the shift look like in the classroom?

To support students in developing their science understanding over the course of instruction, lessons and units are connected and build on each other. Within the garbage unit, instruction is designed so that each new understanding leads to a new question to investigate. For example, students engage in three-dimensional learning when sorting their garbage materials into categories. This three-dimensional learning leads students to ask questions about garbage and then organize those questions on a board. The class decides that the driving question for the unit will be, "What happens to our garbage?" Throughout the unit, students continue to engage in three-dimensional learning as they answer their questions on the Driving Question Board. As students investigate what happens to garbage materials in landfill bottles, they notice a smell, which prompts them to ask questions like, "What is that smell?" and "Is smell something or nothing?" These questions lead to a number of three-dimensional learning experiences, which in turn raise further questions to investigate. This is different from the traditional approach of stand-alone lessons that may be only loosely connected to each other. When instruction is organized in this way, students build their science understanding over time.



What can teachers do to enact the shift?

Recommendation 1: Plan instruction so that each new understanding leads to a new question to investigate. This means creating a coherent unit storyline in which lessons work together and build on each other to answer an overarching driving question. By organizing instruction in this way, teachers provide opportunities for students to develop increasingly sophisticated science understanding over the course of instruction.

Recommendation 2: Scaffold increasingly sophisticated engagement with three-dimensional learning. This scaffolding can happen over several lessons within a unit and over multiple units in the school year. This scaffolding also supports students, and ELLs in particular, in developing not only their science understanding but also the language for communicating that understanding in increasingly precise and explicit ways.

Map of webinar and brief series on integrating science and language with ELLs

Webinar & Brief 1
Unpacking the NYS P-12 Science Learning Standards

Webinar & Brief 2
Science and Language with English Language Learners

Webinar & Brief 3
Science Instructional Shifts
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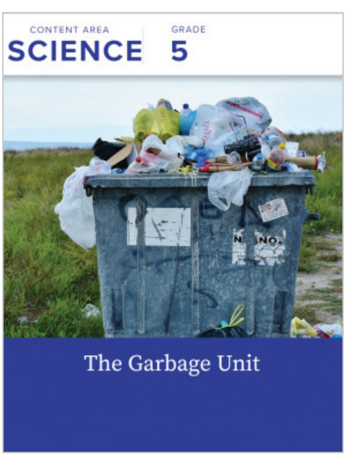
Webinar & Brief 4
Language Instructional Shifts

Webinar & Brief 5
A Classroom Example

Webinar & Brief 6
Science and Language Assessment Shifts

Webinar & Brief 7
Formative Assessment in the Science Classroom

Additional Resources



Science And Integrated Language (SAIL)

NYU

Visit our research team's website and access the unit: *www.nyusail.org*

NYS P-12 Science Learning Standards:
http://www.nysed.gov/curriculum-instruction/science

NYSED Office of Curriculum and Instruction:
http://www.nysed.gov/curriculum-instruction

Office of Bilingual Education and English as a New Language:
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