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

Brief 5 of 7

A CLASSROOM EXAMPLE

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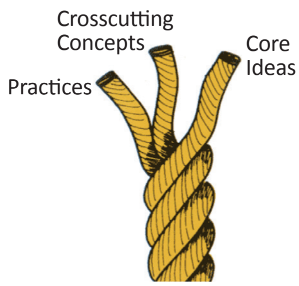
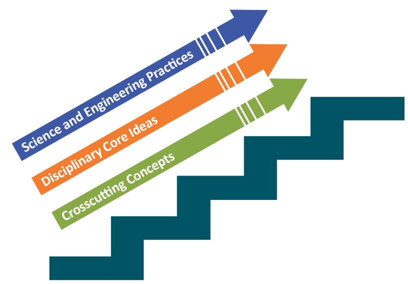
The New York State (NYS) P-12 Science Learning Standards call for changes in the way we teach, or shifts in instruction. The goal is not just for students to learn science facts and information but rather to make sense of phenomena by engaging in three-dimensional learning and building their understanding over time, or learning progressions.

Phenomenon

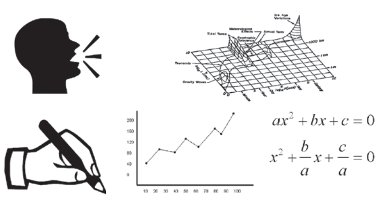


Three-dimensional Learning



Learning Progressions

To engage in this type of science learning, all students, and English language learners (ELLs) in particular, benefit from using multiple modalities, drawing from everyday and specialized registers, and engaging in different types of interactions in a community of practice.



Modalities

Registers

Interactions

In Brief 3, we described in detail the science instructional shifts (phenomena, three-dimensional learning, and learning progressions) and provided specific recommendations for implementing them in the classroom. In Brief 4, we described in detail the language instructional shifts (modalities, registers, and interactions) and provided specific recommendations for implementing them in the classroom. In this brief, we illustrate how both sets of recommendations can be enacted using examples of science instruction in a linguistically diverse classroom.

The recommendations are 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. The complete unit is available at nyusail.org for teachers to download and use.

Recommendations for Enacting the Science and Language Instructional Shifts

PHENOMENON

Anchor science learning in local phenomena that draw on students' everyday experiences and language.

Sustain the focus on the phenomenon over the course of a unit of instruction.

MODALITIES

Provide opportunities for students to engage in science practices using multiple modalities.

Guide students in using modalities strategically to communicate their ideas.

3-D LEARNING

Blend the science and engineering practices, disciplinary core ideas, and crosscutting concepts in instruction.

Leverage science and engineering practices to promote rich language use in a classroom community.

REGISTERS

Provide opportunities for students to engage in science practices using all of their linguistic resources.

Guide students in using specialized language to communicate their ideas with precision.

LEARNING PROGRESSIONS

Plan instruction so that each new understanding leads to a new question to investigate.

Scaffold increasingly sophisticated engagement with three-dimensional learning.

INTERACTIONS

Provide opportunities for students to engage in a range of meaningful and purpose-driven interactions.

Guide students in adapting their language use to meet varying communicative demands.

A Classroom Example: Part 1

On the first day of the garbage unit, students enter the classroom to find a pile of their school lunch garbage. The pile 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 of about four students per group. Students sort the garbage materials in different ways, based on things like color, texture, and reflectivity.

PHENOMENON

Anchoring science learning in a local phenomenon like garbage highlights the relevance of science to students' everyday lives. Because all students are familiar with this local phenomenon, they can participate meaningfully from the very beginning of instruction using their everyday experiences and language.

3-D LEARNING

When students sort their lunch garbage, they make observations, a subpractice of planning and carrying out investigations, about the properties of materials, a disciplinary core idea, and use patterns, a crosscutting concept, to identify similarities and differences in the garbage materials.

Students make observations of garbage using everyday language (e.g., "Let's put the hard stuff right here"). As students sort the garbage, the teacher introduces the idea of properties. The teacher also points out that students have been identifying similarities and differences, or patterns, between the different garbage materials to form their categories.

After students finish sorting their lunch garbage, they complete an entry in their science and engineering notebook where they record the categories they came up with and the properties of the garbage in each category.

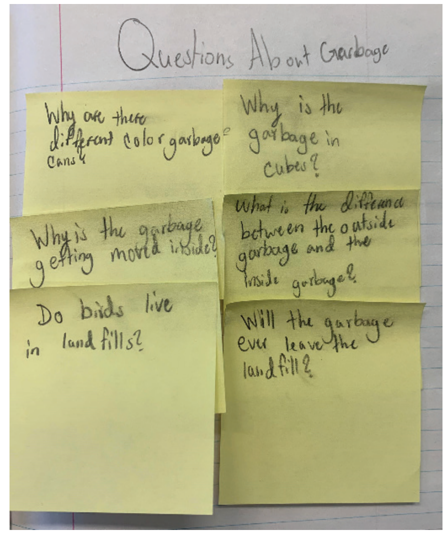
During the next class period, students take a virtual fieldtrip to the landfill in their local community. As students watch the video, they generate questions about garbage and the landfill system. For example, a student may ask, "Will the garbage ever leave the landfill?"

REGISTERS

Students use all of their linguistic resources, including everyday language, to participate meaningfully from the very beginning of instruction. It is not until students have already begun sorting the materials in terms of their color, texture, reflectivity, etc. that the teacher introduces the specialized terms "properties" and "patterns."

MODALITIES

Students use gesture and oral language to negotiate the sorting of the garbage with their group. They also use written language and drawings to record their observations in their science and engineering notebooks. By providing opportunities for students to use multiple modalities to communicate their ideas, teachers value all of the meaning-making resources that students bring to the science classroom.



For homework, students look through their garbage at home and sort the home garbage based on the categories they created in class with their group. The next day, students share their responses to the homework and write down any additional questions they have about garbage on sticky notes. Finally, students create a "Driving Question Board." Students add their questions to a board in the front of the room, and the teacher facilitates a discussion about how the questions are related to each other. Together, the class decides on one big driving question for the unit: "What happens to our garbage?" Over the next 9 or so weeks, students will answer many of their questions on this Driving Question Board as the class works toward answering the overarching driving question.

LEARNING PROGRESSIONS

Instruction is designed so that each new understanding leads to a new question to investigate. Students first experience the phenomenon of garbage and engage in three-dimensional learning by sorting their garbage into categories and asking questions about the landfill system. These three-dimensional experiences culminate in the creation of the Driving Question Board. The questions on the board become the springboard for additional three-dimensional learning for the purpose of making sense of the phenomenon and answering the driving question.

INTERACTIONS

Students engage in a range of meaningful and purpose-driven interactions. For example, when students are sorting their lunch garbage, they engage in one-to-small group interactions. When students are sharing their questions with the whole class to create the Driving Question Board, they engage in one-to-many interactions. In each of these interactions, students have a reason to communicate and work together with other members of their classroom community toward a common goal. This classroom community provides a rich context for both science learning and language use.

A Classroom Example: Part 2

To answer the driving question ("What happens to our garbage?"), students engage in an investigation where they put food and non-food materials in bottles and observe changes over time. The purpose of the investigation is to find out whether the properties of the food and non-food materials change. Also, students keep one landfill bottle open and the other closed to find out whether the amount of matter in each bottle changes over time.

Students make observations at the beginning of the investigation and then again after 1 week. They record the properties of the materials and the weight of the open and closed landfill bottle systems at each time point.

LEARNING PROGRESSIONS

As students investigate what happens to garbage materials in the landfill bottles, they notice a smell, which prompts them to ask questions such as, "What is that smell?" These questions lead to additional three-dimensional learning experiences, which in turn raise further questions to investigate. When teachers design instruction in this way, they guide students in building their science understanding coherently over time.

As one student weighs her landfill bottles, she says to her group, "It's the same as before" while pointing to the measurement scale. But when this student reports the results of the investigation to the class, she needs to transition to a more specialized register to make her meaning explicit, saying, "The weight didn't change from time point 1 to time point 2." By time point 2, students start to notice an unpleasant smell coming from the open landfill bottle systems and ask, "What is that smell?"

Material	Time Point	Properties			
		Smell	Color	Texture	Reflectivity
Orange 	Time Point 1	fruity	orange	smooth	shiny
	Time Point 2	bad-smelling	green/brown	some fuzz	dull
	Time Point 3	rotten	brown	fuzzy	dull

Time Point	System Weight	
	Open System Weight (grams)	Closed System Weight (grams)
Time Point 1	1,174	1,150
Time Point 2	1,022	1,153
Time Point 3	956	1,148

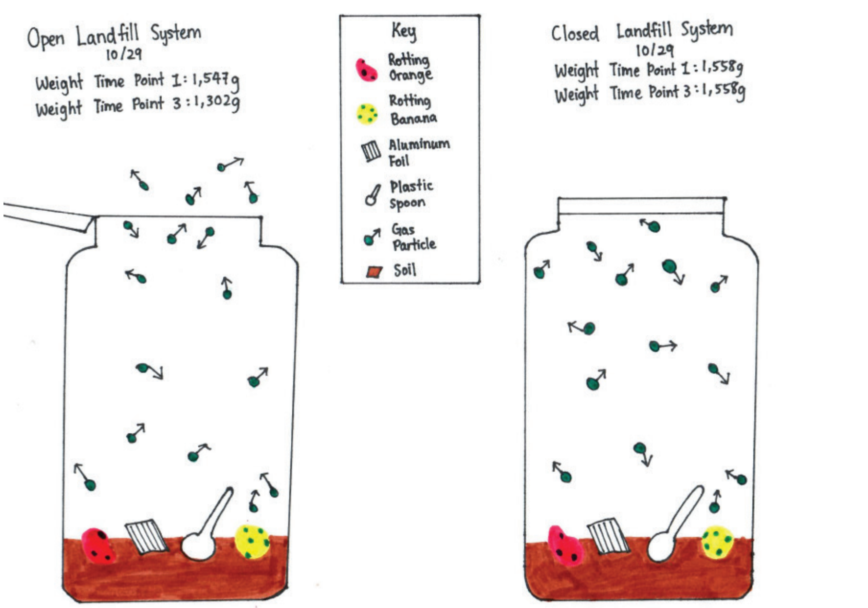
INTERACTIONS

As students engage in a range of interactions, the teacher guides students in adapting their language use to meet different communicative demands. For example, as students move from one-to-small group to one-to-many interactions, the teacher may ask clarifying questions such as, "What's the same?" or "What do you mean 'before'?" What's important is not that students always use the specialized register but that they learn to adapt their language use in different contexts and for different purposes.

Next, students develop models in small groups to represent what they observe happening in the landfill bottles. In this model of the open system, students represent their initial ideas about smell using wavy lines flowing out of the bottle. As students develop their models, they begin to wonder, "Is this smell something or nothing? Does it weigh anything?"

To answer their questions about smell, students engage in a series of investigations. They smell air freshener as it spreads to different parts of the classroom. They watch a video of a balloon that pops and loses its weight. They compress air in a syringe and then engage with a computer simulation that shows what is happening inside the syringe when air particles get pushed together. Collectively, these investigations produce evidence that smell is in fact something and, specifically, that it is a gas made of particles too small to see moving around freely. The particle nature of gas is a key disciplinary core idea in fifth grade.

Based on evidence from their investigations, students revise their landfill bottle models. This time, instead of using wavy lines, students represent how solid food materials become gas particles that move freely out of the open system but stay inside the closed system.



MODALITIES

Students develop models of the landfill bottle systems using a combination of drawings, symbols, and text. As students' science understanding becomes more sophisticated, the teacher guides students in using modalities more strategically to communicate their ideas. For example, as students figure out that smell is made of gas particles too small to see, the teacher invites students to consider how they could revise their models to represent that idea. Instead of wavy lines, students decide to use dots to represent gas particles and arrows to represent how those particles move freely out of the open landfill bottle system.

Beginning of instruction	**Something is coming out.**	**It's going everywhere!**	**You can't see it.**
Later in instruction	Smell travels frely and the wind helps it get more spread out, you cant see smell becavse it's particals are to Small to see.		

Another week passes, and students return to their landfill bottles to make their final observations. They notice that, while the weight of the closed system has stayed the same during the investigation, the weight of the open system decreased at each time point.

Next, students write arguments using data from their investigations. One of the questions they address is: "Did the amount of matter change in the landfill bottles?" For example, students argue that the amount of matter in the closed system stayed the same even though the properties of the food materials changed. However, the amount of matter in the open system decreased because the food materials left the system in the form of a gas.

Arguing from Evidence

Question: Does the amount of matter change in a landfill bottle?	
Claim: The amount of matter changes in the open system but it stays the same in the close system.	
Evidence:	**Why did you use these data?**
According to my system weight table the open system was 2.38 in time point 1 and in time point 3 was 0.877. My closed system weigh in time point 1 was 1.2 and in time point 3 was 1.2.	I chose this data because the open system kept losing weight and the closed system stayed the same
Reasoning: Since our open system lost weight and our close system stay the same then whe know the amount of matter changes only in the open system.	

REGISTERS

As the unit progresses and students develop more sophisticated science understanding, the teacher guides students in using more specialized language to communicate their ideas with precision. For example, the teacher guides students to be precise about the scale at which gas particles can be observed and how those particles move around. Especially with ELLs, it is important for teachers to keep the focus on the meaning that students are attempting to communicate, not only their linguistic accuracy.

3-D LEARNING

By engaging students in three-dimensional learning throughout the unit, teachers create an environment that promotes rich language use. As students develop models, analyze and interpret data, and argue from evidence with peers and their teacher, they use language to accomplish specific goals.

PHENOMENON

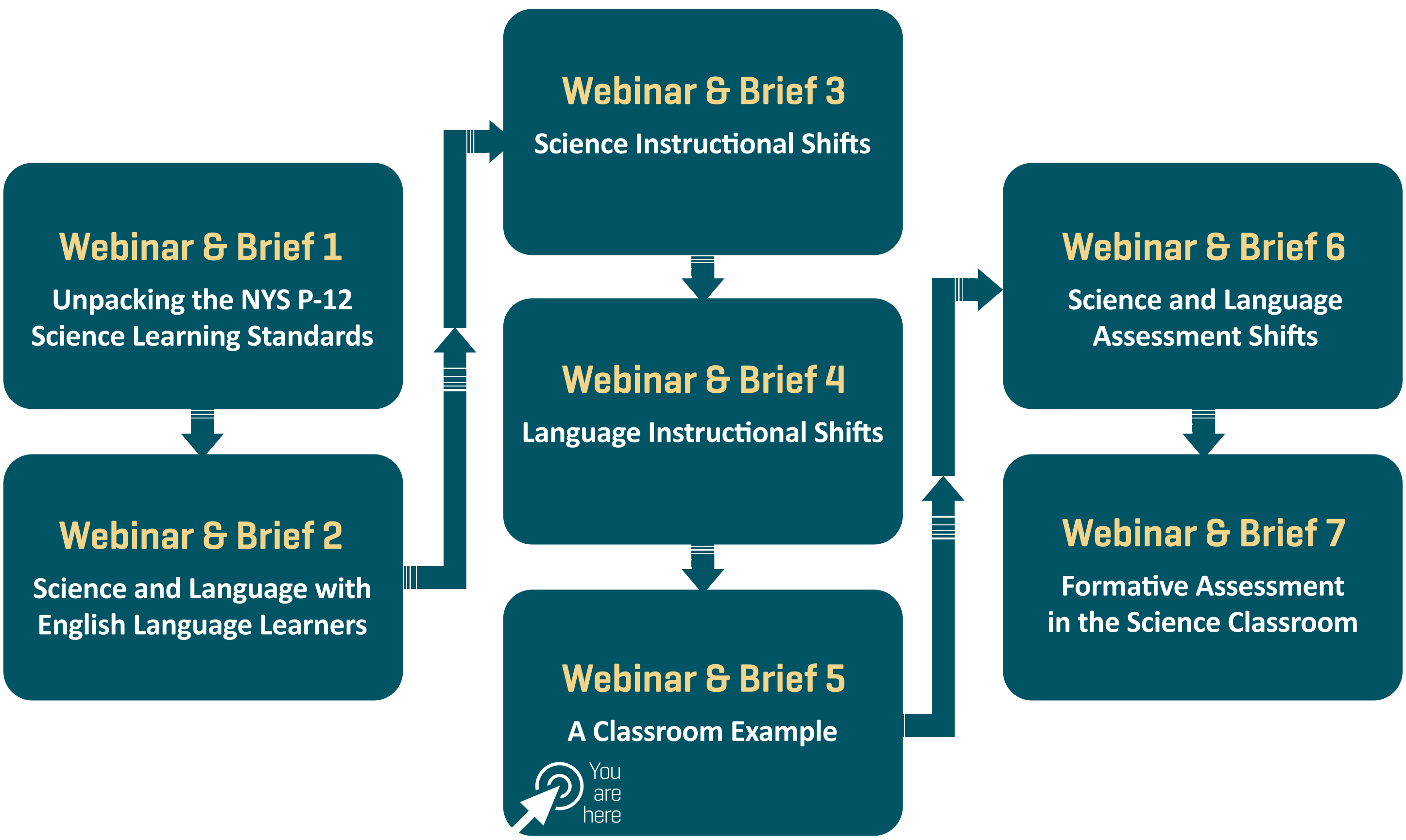
The focus on the phenomenon of garbage is sustained over the course of the entire unit. The phenomenon was not just used to pique student interest and then abandoned to focus exclusively on the science concepts and ideas. Instead, students developed understanding of and used the science concepts and ideas for the purpose of making sense of the phenomenon and answering the driving question.

Conclusion

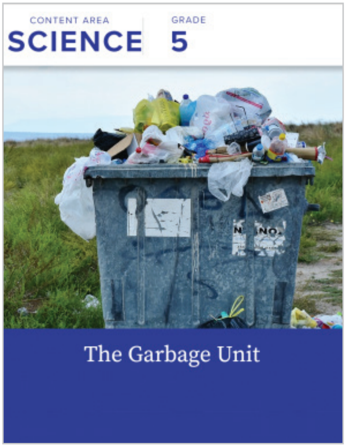
We have illustrated how the recommendations related to the science and language instructional shifts can be enacted in the classroom. What is important to highlight is that the science and language instructional shifts work together and support each other. For example, when teachers anchor science instruction in local phenomena that are real and relevant to students, teachers provide opportunities for students to use all of their linguistic resources from the beginning of instruction. When teachers engage students in three-dimensional learning, they provide opportunities for students to communicate their ideas using multiple modalities and everyday and specialized registers in purposeful interactions. When teachers plan instruction with learning progressions in mind so that students' science understanding becomes more sophisticated over a unit and over a year, teachers also guide students to develop increasingly sophisticated ways of communicating ideas, including more strategic use of modalities, more specialized registers, and language choices adapted to the communicative demands of different interactions.

This type of science instruction transforms the classroom from a place where students read and memorize information to one where students engage in meaningful, purposeful activities that promote both science and language learning. All students, including ELLs, benefit from instruction aligned to these recommendations.

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



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

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