NGSS for English Language Learners

From theory to planning to practice

By Emily Miller, Hedi Baxter Lauffer, and Paula Messina

The Problem

How can I support ELLs in mastering the scientific practice of argumentation while engaging with scientific ideas? My second and third graders were struggling with two related driving questions that linked big ideas from Earth and life sciences with the crosscutting concept Cause and Effect: Do the organisms you see above ground affect the below-ground system? Can changes to the below-ground system affect the organisms you see above ground?

My students had spent more than a month collecting evidence comparing the above- and below-ground characteristics of two ecosystems, a meadow with scattered deciduous trees (which we called a "deciduous ecosystem") and a conifer forest. We found that the coniferous ecosystem had fewer small plants and worms than the deciduous ecosystem and it had more clay and pine needles in the soil. The class had collected more evidence about ecosystems by monitoring the growth of Wisconsin Fast Plants, observing real worms in the classroom, and investigating soil and organisms from the two ecosystems. Today, the students were using the evidence they had compiled—on sentence strips, pictures, and photos on the "evidence wall"—and developing initial claims about a possible cause-and-effect relationship.

To practice argumentation and share and critique each other's claims, I had the whole class sit in a circle on the carpet. Each student team of three took a turn standing in front and sharing their claim. Because this was an ELL cluster, and it was the first time we were trying out the scientific practice of argumentation, I had taped sentence starters on the dry erase board:

I agree with you because…__ (evidence) ____
I don't agree with you because… __ (evidence) ___
What is your evidence that________?

Shameeka and Kiana volunteered to present first. They read from their scientific team notebook with a practiced chorus, "The deciduous plants growed (*sic*) more because they have more sunlight. The coniferous plants growed (*sic*) less because they had less sunlight. Plants need water, sunlight, and air to grow."

I looked around at the circle of students sitting on the carpet. After almost a month of studying these two ecosystems and having just finished collecting evidence about the soil, surely one of the students would raise the possibility that the difference in soil was important. I also hoped that a student would point out that we had not collected any evidence comparing sunlight in the two locations.

After I reread the sentence starters, I waited for reactions. Alan commented, "I agree with you, 'cause the deciduous has more growing around it and the coniferous has less so I agree with them." Yer said, "I agree with you because evidence is more sunlight on the deciduous. The coniferous hill was not so much." Shameeka and Kiana nodded. Two more students stated their agreement.

Finally, after a long wait time, Fernando asked, "What is your evidence that the deciduous has more sunlight?" And Kiana answered for the pair, "Maybe the coniferous tree had not as much sunlight because, right behind you there was shade and like the deciduous tree it was all shining and not a shady spot."

The class was satisfied with Kiana and Shameeka's claim supported by invented evidence, but I was discouraged. With a class of 75% ELLs, only a few students were actively engaged, and many students didn't seem to understand the importance of prioritizing evidence. Even though every partnership had crafted a completely different scientific claim, instead of using the different claims to challenge each other, students began their review with, "I agree with you because…" I needed to go back to the drawing board and plan this lesson to provide better language supports for my ELLs, and stimulate evidence-based argumentation around science core ideas about cause-and-effect relationships.

Theory

The solution to this problem diverged from the traditional method of supporting ELL's language development separately from the rest of the class. Because of the *Next Generation Science Standards* (*NGSS*), all of my students needed to learn the practice of scientific argumentation within the context of sense-making about core ideas in science. The goal, to meet the *NGSS*, enabled me to simultaneously address language goals and content goals.

Objectives based on core ideas instead of discrete facts: The *Framework* assigns only three or four core ideas for each scientific discipline—Earth, life, physical and engineering—which span grades K–12 (NRC 2012). These core ideas are developed and expanded along a learning progression that increases in complexity, from very simple and concrete in early elementary, to sophisticated and abstract in high school. In my unit, for second and third graders, I wanted my students to become familiar with two "big ideas" from the *Framework* at the level appropriate for their grade:

1. LS2.C: Ecosystem Dynamics, Functioning, and Resilience – What happens to ecosystems when the environment changes?
2. ESS2.E: Biogeology – How do living organisms alter the Earth's process and structures?

The overall "big idea" of my unit was that there is a relationship between the organisms they see above ground and the below-ground system. At the second- and third-grade level, for example, one of my goals was understanding that changes in the trees above ground would affect the soil and, in turn, differences in soil influence vegetation. Finer details within this big idea, such as the role of nutrient cycling, soil chemistry, and the influence of tannins, would be reserved for higher grades. Three specific performance expectations relate directly to the big ideas in second and third grade:

Biological Evolution: Unity and Diversity

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

Inheritance and Variation of Traits: Life Cycles and Traits

3-LS3-2. Use evidence to support the exploration that traits can be influenced by the environment.

Interdependent Relationships in Ecosystems

2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.

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Scientific Argumentation

The practice of scientific argumentation, one of the eight scientific practices in NGSS, demands high-level thinking and complex language for elementary students. It requires them to attend to the claim, the evidence, and the connection or lack of connection between the two at the same time. In addition, students must have a command of the language to listen (or read) claims, and then critique them effectively.

The *NGSS* Practice Matrix (NGSS Lead States 2013) outlines the expectations for this practice in grades K–2.

- Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument.
- Construct an argument with evidence to support a claim.

For grades 3–5, one expectation is:

- Compare and refine arguments based on an evaluation of the evidence presented.

ELLs and non-ELLs face the same challenges: use language like a scientist does, and collaborate to support growth in scientific understanding. My ELLs needed to learn to use English meaningfully, but all my students had to learn how to engage in meaningful discourse about science.

New Language Goals for ELLs With *NGSS*?

Teachers of ELLs are expected to develop *language goals* for each content-based activity, forming a foundation for ELL support in the classroom. Language goals are devised by combining content objectives with the language domain (reading, writing, listening, or speaking), and a language support for each student. Each goal merges the *content objective* in a district standard with a verb that directs what language should be produced, and adds an appropriate support. For example, a level 3 student (developing) language goal might be, "describe with simple and expanded sentences different properties of earth materials using graphic organizers."

But these language goals, in science, can impose inauthentic language that is uninteresting to the students, not reflective of how scientists ultimately use language for, and divorced from what the rest of the class is doing. To illustrate this point, I had one colleague who was conducting a floating and sinking investigation with her ELLs, and wanted the students to use the simple phrases, "The _______ sinks," or, "The ________ floats," emphasizing the complete sentence and the third person. She told me later that she was frustrated because the students were so engaged by talking about their discoveries to each other, she just couldn't get them to stop and use her sentences. Another teacher wanted her fifth-grade students to adopt the conditional structure and chose to focus on repeating, "It could be red or it could be blue," to talk about the blood vessels and veins in the body. Although she was able to get the students to use the phrase, one wonders how much actual content they were learning.

NGSS expands our traditional notion of science mastery and offers new language opportunities for ELLs. Instead of focusing on isolated facts and vocabulary, it merges core scientific ideas and crosscutting concepts with scientific and engineering practices. As a result, language intensive practices, such as argumentation, are elevated. According to Lee, Quinn, and Valdes what you do with language, as well as using the "language of science," becomes an integral part of the content objective (2012; 2013).

The initial, pre-*NGSS*, goal for this unit was, "Provide simple sentences stating you agree or disagree with the scientific claim with a partner." My students used English but did not show effective engagement with the practice of argumentation or with the science ideas. The *NGSS* related language goal for ELL students, "Provide simple sentences that describe how plants and organisms change their environment and vice-versa with a partner to *develop an evidence-based argument*," integrates the practice and thus the purpose of language in science.

The Can-Do rubric (see NSTA Connection) shows what may be expected of ELLs at each level. Awareness of the subsequent level enables teachers to plan for and support each student's achievement through careful scaffolding and instruction.

With *NGSS*, the language goals for ELLs look almost identical to the content goal for everyone in the class because the language-intensive practice is blended with core ideas and crosscutting concepts. *NGSS* offers the opportunity for classmates to struggle together and support each other toward the same language-based content objective. Everyone is engaged in argumentation using evidence about cause and effect.

Planning

Focus on the Language-Intensive Practice for All Students

To begin, I had to figure out how to support all students in developing fluency in the language of science and engage in scientific argumentation by prioritizing evidence. The parts of the argument—especially the claims, evidence, and reasoning (McNeil and Krajcik 2012)—had to be unambiguous and accessible to all. Also, I planned more scaffolds to promote whole-class and partner dialogue:

1. Each presenting three-person team would use a graphic organizer to model their claims, evidence, and reasoning with words and pictures. This would assist listening and comprehension of the presentation.

2. Team members would need to get up and point to the evidence on the wall, or in their notebook, before they used it in their claims. This expectation scaffolded the prioritization of evidence and speaking and listening for the pairs.

3. The same three sentence starters the students had used in the earlier example for their claims review panel would support argumentation.

4. My students would require some explicit modeling about how to come to an agreement with a partner. We would practice using the pictures and words on the evidence wall and model negotiation with words. (Some students suggested that, if they disagree with each other in science, they could use "rock, paper, scissors" to come to agreement.)

5. Before critiquing, teams would practice their critiques out loud with each other. This supported reading for all students.

6. Finally, the dialogue would necessitate a lot of wait time, paraphrasing, and checks for understanding.

Practice

Supporting the Entire Class in Scientific Argumentation

We focused on the following Cause and Effect driving questions: Do the organisms you see above ground change the below-ground system? Can the below-ground system change the organisms you see above ground?

My students' success, for ELLs and non-ELLs alike, would stem from effective scaffolding for the inherent, authentic use of language-intensive scientific practices, while engaging with core scientific ideas.

I asked for Sergio and Tenzin to present first. Segio tapped his pencil on the words of his graphic organizer. "Claim. The worms finished their work in the soil, and so the worms went away. They want to be in soil that has more food to eat." The picture showed a fleet of worms traveling underground from the left side to the right side of the picture where there was a deciduous tree. One worm had a bubble above his head that read, "I am done working and I am hungry!" Tenzin read the words under the evidence picture, "Evidence: There are no decomposing leaves in the coniferous soil. Worms eat decomposing leaves." And Sergio read, "Reasoning: Plants need worms to grow."

I provided a sentence strip for the teams to write their critiques of the claim. Student were using the sentence starters and consulting with each other. Because of the fishbowl modeling we had done (a few students had volunteered to discuss reviews in front of their peers), students were talking and then writing, passing the marker back and forth to write the sentence. I had insisted partners find and touch the appropriate evidence, so I could hear the tapping on the evidence wall as they moved to the wall and located the words and pictures they needed.

After providing time to read their reviews out loud to their team, I picked a stick, "Mbodje?" With a little assistance from Miguel, Mbodje asked for evidence that the worms were done working—a very astute question. Undaunted, Sergio explained their claim enthusiastically, "Worms don't like pine needles. In the school yard there were worms working in there. And the coniferous hill, like, why plants didn't grow good because the coniferous hill, there's, like, not leaves only pine needles."

I waited for a response. Shameeka said finally, "Who knows if worms like pine needles, or if they don't like pine needles!" I asked, "Shameeka, you want evidence, right?" "Yes, I do!"

Romeo, a non-ELL, demonstrated that he understood the importance of providing evidence, "I think maybe we should find a worm, get some pine needles, dig a hole, and then see what the reaction of what the worm is gonna do. His reaction is to maybe go to a different hole." To make sure everyone was following Romeo's thinking, I asked him to come up to the front and act out his idea for an investigation, which he enjoyed thoroughly.

Suddenly, a lot of students wanted to talk, so I asked them to comment to their partner first, and then we went around the circle. Each pair had the chance to pass or contribute their scientific thinking.

Yer, an ELL, said, "We could put… coniferous soil and the pine needles in the thing. And put one worm in the coniferous. And leaves in the deciduous and the worm. And we could see what grows faster." I summarized her words, "So Yer, you would like to add a worm to both soils and observe the plants?" Yer smiled, nodded, pleased.

Yer's partner Mai said, "We would tell if worms get the plants to grow." I said, "Thank you, Mai, say more, if both plants live, what would that tell you?"

"It's the worms and their work."

Mai, Yer, and Romeo, two ELLs and a non-ELL, were collaborating to construct understanding, supporting each other in their struggle to make meaning. They were also talking like scientists, discussing routes to gather more evidence to refine their claims. I designed this lesson with *NGSS* outcomes in mind for all my students, as well as the explicit goal to promote meaningful dialogue about science. My ELLs actively participated and therefore flourished: sharing knowledge and practicing language.

Follow-Up Practices

To conclude the unit, we revised our driving question to, "How does the pine-needle-rich soil affect growth and development in Fast Plants?" We designed a Wisconsin Fast Plant investigation that allowed us to refine our claims about the cause-and-effect relationship. We used the Fast Plants in a bottle growing system as models for the plants that grow in the two different ecosystems we had observed. The same soil was placed in each bottle, but we layered pine needles on top of the soil in one bottle to represent the conifer forest.

The Fast Plant that grew in the potting mix with pine needles showed signs of stress compared to the Fast Plants grown in the same potting mix without needles. We observed that plants grown in needle-rich soils had smaller cotyledons, smaller true leaves, fewer buds and flowers, and were shorter. We also observed that the water in the reservoir under the needle-rich soil was a brown color, unlike the clear water in the reservoir of the control plants. We reasoned that the pine needles caused the stress by changing the water, which we knew was important for the growth of Fast Plants. So, the pine needles may have changed the soil in the environment and affected the growth of the Fast Plants. If what happened in our model system happens in the conifer forest where there are even more pine needles, there may be a cause-and-effect relationship for why there aren't many organisms or small plants growing in the conifer forest.

Conclusion

The *NGSS* raise the bar for every student, ELLs and non-ELLs alike, to engage with language-intensive scientific practices, crosscutting concepts, and core ideas while using language. This presents teachers with an array of challenges. A great deal of thought and planning for language supports and modifications to more traditional approaches to teaching are required. However, these efforts ultimately provide opportunities for ELLs, giving them authentic applications for language learning while advancing their understanding of science. ■

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NSTA Connection

Download the rubric at *www.nsta.org/SC1401.*