Walking the Walk and Talking the Talk

Symmetry in *NGSS* teacher professional learning

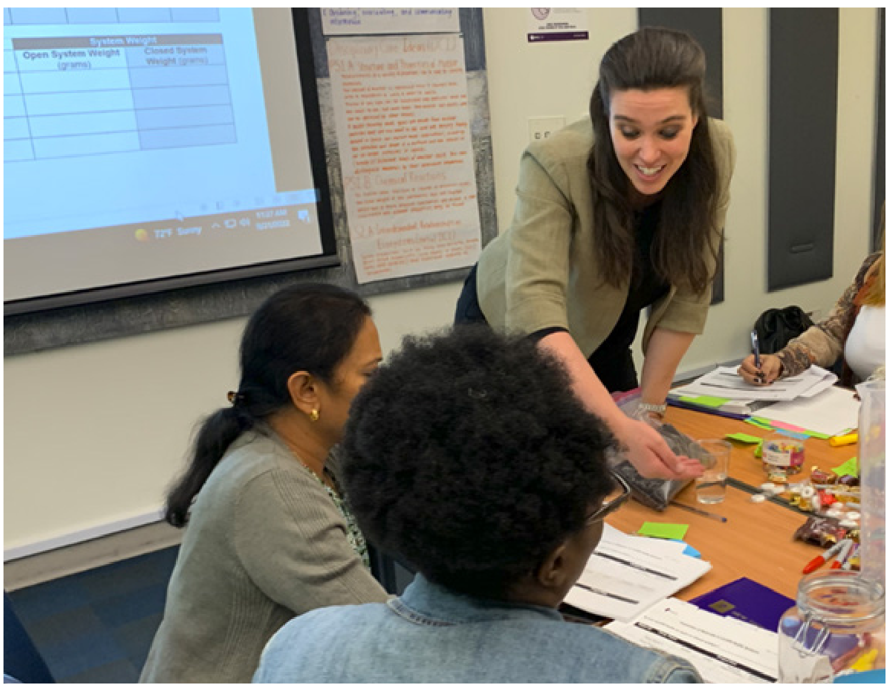
By Alison Haas, Abigail Schwenger, Leah Master, Scott E. Grapin, and Okhee Lee

The *Next Generation Science Standards* (*NGSS*) and *A Framework for K–12 Science Education* (NRC 2012) promote a vision of science learning in which students engage in three-dimensional learning to explain phenomena and design solutions to problems. As this vision requires shifts in student learning, it also requires shifts in teacher learning. In this article, we describe our approach to designing curriculum-based teacher professional learning that is *symmetrical* to student learning by giving teachers opportunities to learn in ways that reflect how students learn (Mehta and Fine 2019). If we expect teachers to use curricula in ways consistent with the *NGSS* vision, then the learning experiences we design for teachers should be symmetrical to the learning experiences we design for students.

First, we describe our approach to designing symmetrical professional learning experiences in three areas: (a) students bring assets, teachers bring assets; (b) students figure out, teachers figure out; and (c) students develop understanding over time, teachers develop understanding over time. Within each area, we promote symmetry at two levels. At one level, teachers engage in the curriculum like their students do. For example, teachers ask questions about phenomena, carry out investigations, develop models, and construct explanations, just as students do in the classroom. At another level, teachers make sense of our conceptual approach to *NGSS* instruction in ways that reflect the core principles of student learning that undergird the curriculum. For example, just as the curriculum does not frontload science concepts and vocabulary at the beginning of a unit, we avoid frontloading our conceptual approach at the beginning of professional development (PD). Instead, we make visible our approach over time and only after teachers have experienced lessons that embody a particular aspect of the approach (e.g., three-dimensional learning). To illustrate this symmetry, we use examples from our two-day workshop that prepared teachers to implement our *NGSS*-designed curriculum with a focus on multilingual learners.

OUR APPROACH

Our yearlong fifth-grade *NGSS*-designed curriculum promotes both science and language learning for all students with a focus on multilingual learners (MLs) (Lee et al. 2019). As the curriculum is currently undergoing a field trial in a large urban school district, we are developing a PD program to accompany the curriculum.



Teachers work in groups to construct an explanation.

We offer a two-day PD workshop before each of the four units in the curriculum to prepare teachers to implement each unit in their classrooms.

To illustrate our approach, we draw examples from our PD that prepared teachers to implement the first nine-week unit in our curriculum. This unit addresses physical and life science *NGSS* performance expectations and is anchored in the following driving question: *What happens to our garbage?* The 34 participating teachers came from 13 schools in a large urban school district, ranged in teaching experience from 0–26 years, and taught in classrooms with a percentage of MLs above the district average.

FIGURE 1

Driving question board created by teachers in the PD workshop.

STUDENTS BRING ASSETS, TEACHERS BRING ASSETS

Teachers bring rich knowledge and experiences, both personal and professional, to PD, just as their students bring rich knowledge and experiences to the science classroom. In PD, we adopt an asset-oriented approach that positions teachers as valued collaborators and contributors.

At one level of symmetry, we cultivate the assets teachers bring by engaging them in the curriculum. For example, at the beginning of PD, teachers participate in the driving question (DQ) board process. Teachers write questions on sticky notes about the phenomenon of garbage, discuss those questions in small groups, and then share their questions with the whole group to create the DQ board (Figure 1). As teachers share their questions with the group, they often reveal a deficit view of themselves. For example, Lizette (all names are pseudonyms) wrote, "Why does trash stink?" on her sticky note. Before sharing with the whole group, she prefaced her contribution by saying, "I have a dumb question." However, her question about the smell of garbage related to a disciplinary core idea in the unit—smell is a gas made of particles moving freely. Another teacher, Gabby, hesitantly remarked, "I have a question, but it doesn't really relate, so it's not good." But her question about the garbage handling system ("Where does the garbage truck go?") related to a crosscutting concept featured in the unit—systems and system models. Over the two-day workshop, teachers shifted from initially failing to acknowledge their own assets (e.g., "I have a dumb question") to confidently contributing to the community of practice (e.g., "Wait, I have one more idea to share!"). By helping teachers recognize their own assets, we supported them in envisioning how they might cultivate their students' assets in the science classroom.

At another level, we cultivate the assets that teachers bring to help them make sense of our conceptual approach to *NGSS* instruction. For example, after developing the DQ board, teachers review the accompanying lesson plan. One group of three teachers, with a combined 69 years of teaching experience, had extensive knowledge of the "I do, we do, you do" gradual release model. As one teacher, Isabel, reviewed the lesson plan, she asked why it was not explicitly structured according to the gradual release model. Instead of dismissing Isabel's question, we affirmed the asset that she and her team were bringing to the table: knowledge of a widely used approach. Then, we leveraged Isabel's asset to extend her thinking and connect to our approach. We discussed trade-offs of "I do, we do, you do" in science classrooms, where too much structure and guidance early on in a lesson or unit can hinder students' curiosity and short-circuit their development of ideas (National Academies of Sciences, Engineering, and Medicine 2022). Also, we affirmed Isabel's contribution by guiding her to see how different types of scaffolding were built into our curriculum, especially when introducing new science and engineering practices (e.g., writing an argument). By leveraging teachers' assets rather than dismissing their contributions, we support them in building on and expanding their instructional practices to meet the vision of *NGSS* instruction.

STUDENTS FIGURE OUT, TEACHERS FIGURE OUT

Teachers figure out in PD in parallel with how their students figure out in the science classroom. In PD, we engage teachers in three-dimensional learning while also supporting them to figure out new ways of teaching the *NGSS* with MLs.

At one level of symmetry, teachers figure out phenomena by engaging in three-dimensional learning as students do. For example, teachers worked in small groups to answer the question: *What causes changes in the food materials in landfill bottles?* In constructing an explanation, teachers came to whole-group consensus on the claim that microbes caused changes in the food materials. Then, teachers shared evidence for the claim. A group shared, "the banana turned brown." As facilitators in this discussion, we wrote the evidence on the board as teachers shared it. When teachers saw the compiled evidence, they realized it was incomplete as it did not reference specific data from investigations. Teachers reconvened in their small groups to revise their evidence and came back to the whole group. This time, they shared specific evidence: "In our landfill bottles, the banana turned brown. From the article, we figured out that this was due to microbes decomposing the banana." Teachers laughed as they realized they had done what their students might do. In this way, experiencing the curriculum for themselves offered teachers insight into where their students might face difficulty. Teachers also experienced three-dimensional learning in which they constructed an explanation (science and engineering practice) that microbes cause food materials to decompose (disciplinary core idea) in the landfill bottle system (crosscutting concept).

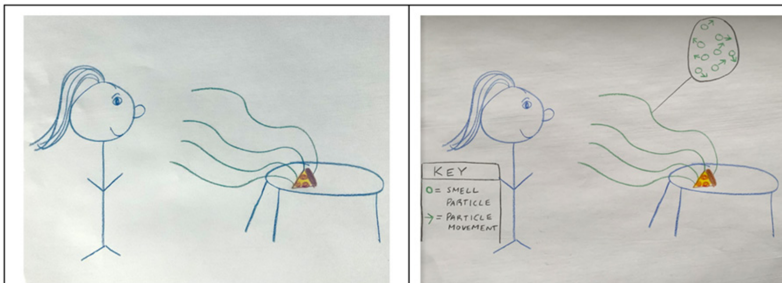
At another level, by reflecting on the process of constructing an explanation, teachers figured out our conceptual approach to science and language integration. Specifically, teachers made sense of the importance of *precision* in the science classroom. The discussion began with teachers reflecting on what constitutes a "good" explanation. At first, the teachers prioritized vocabulary and grammar, making comments such as, "Grammar has to be correct for a good claim and evidence." However, as teachers examined sample student explanations and an assessment rubric to evaluate those explanations, they figured out that precision does not require science vocabulary or grammatical accuracy. In fact, focusing narrowly on science vocabulary and grammatical accuracy could lead to overlooking students' science understanding, especially with MLs (Grapin et al. 2019). Instead of only looking for science vocabulary in the sample explanations, teachers began looking for the *ideas* that students were communicating—an instructional practice we hope carries over into their classrooms.

STUDENTS DEVELOP UNDERSTANDING OVER TIME, TEACHERS DEVELOP UNDERSTANDING OVER TIME

Teachers, like their students, develop understanding over time. We structure

FIGURE 2

Sample teacher smell models.



Initial Model | Revised Model

PD so that teachers develop both science understanding and instructional practices to promote their students' science understanding and language use over lessons and units.

At one level of symmetry, teachers develop understanding over time by engaging in the curriculum. For example, during PD, teachers develop models of smell like students. At the initial modeling phase in an early lesson of the unit, some teachers represented smell as clouds or lines like students often do (see left side of Figure 2). Additionally, some teachers did not realize the sophistication of the practice of modeling at the fifth-grade level and did not include labels or a key in their models. Later in the unit, teachers revised their models to represent smell as particles moving freely and, in doing so, developed their understanding of the modeling practice (see right side of Figure 2).

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At another level, teachers develop understanding of our conceptual approach over PD. For example, teachers experienced the importance of multiple modalities (e.g., drawings, symbols, gestures, language), which are particularly beneficial for MLs.

Toward the end of the second day of PD, teachers evaluated two student models representing how the smell of pizza made its way to the nose. In one model developed by an ML, smell particles were represented by dots moving in various directions, as indicated by arrows, but with no accompanying text. In another model developed by a student who was not an ML, the text accompanying the model included science vocabulary, including *particles*, *moving freely*, and *gas*; however, the model showed smell moving in a direct path from the pizza to the nose. In comparing these two models, teachers had a breakthrough moment of understanding and appreciating how an approach to instruction in which language is not the "be-all and end-all" can empower MLs to participate and excel in the science classroom.

CONCLUSION

The *NGSS* call for shifts in teachers' instructional practices, especially in linguistically diverse science classrooms. PD that is symmetrical to student learning is one way to prepare teachers for this ambitious vision of science instruction. Ultimately, symmetry is powerful because the core principles of student learning that inform our approach to *NGSS* instruction apply to learning generally. All learning, whether with children or adults, involves cultivating assets, figuring things out, and developing understanding over time. As teachers engage in symmetrical professional learning experiences, they will not only be prepared to teach, but they will also enjoy the professional learning process—rekindling a love for science and promoting a deeper understanding of the student experience. Put simply, if we, as PD facilitators and teacher educators, don't "walk the walk" and "talk the talk" of the *NGSS* vision when it comes to PD, teachers cannot be expected to do so in their classrooms.

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