

Reimagining Science Lessons through Translanguaging: Supporting Multilingual Students’ Scientific Sensemaking in the Context of Science and Engineering Practices

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Ms. Silva, who teaches sixth-grade science in a school with a large population of multilingual students, is reviewing lesson plans for the next science unit. Her school recently began adopting the *Next Generation Science Standards (NGSS)*, which emphasize the importance of students jointly “figuring out” or “making sense of” science phenomena while engaging in science and engineering practices (SEPs). Last year, she collaborated with colleagues to reorganize units around engaging and authentic science phenomena. The focal phenomenon for the upcoming unit was grounded in the essential question: How do environmental conditions impact the growth of plants? Students will explore this question in the context of designing a sustainable balcony garden that can grow edible produce in small spaces. Ultimately, evidence gathered in learning activities and investigations throughout this unit should support students in constructing a scientific explanation based on evidence for how environmental factors influence the growth of plants, which students can use to justify their garden designs (MS-LS1-5; NGSS Lead States 2013). Last year, when teaching this revised unit, Ms. Silva saw a big change in students’ overall eagerness to learn. Yet she still wonders about the extent to which all students, particularly her multilingual students, meaningfully used SEPs to “make sense of” the focal phenomena.

With these thoughts in mind, Ms. Silva examines one of her tried-and-true investigations for the upcoming unit in which students conduct an investigation to determine what environmental factors influence the growth of plants. In this lesson, students compare the growth

of a lima bean seed planted under direct sunlight with one planted in a shaded area. In the past, most students have been able to follow the prewritten procedure and reach the intended conclusion—that lima beans grow better when provided with direct sunlight. However, on deeper inspection of the lesson, Ms. Silva realizes that she—not her students—posed the question to be investigated and planned all aspects of the investigation. This prompted the following questions to run through her mind: How can I redesign this lesson so that students are the ones actively and meaningfully engaging in SEPs? What opportunities and challenges might arise for my multilingual students as they take on more of the sensemaking responsibility in this lesson, and how can I better support them?

This vignette poses a common dilemma teachers face as they seek to revise and improve existing curricula to better align with the *NGSS*, all while considering their particular student population. The *NGSS* calls for students to learn disciplinary core content by engaging in a combination of eight SEPs, such as planning and carrying out investigations and constructing explanations (NGSS Lead States 2013). SEPs support sensemaking by acting as a vehicle through which students actively work to “figure out” rather than “learn about” big science ideas (Schwarz, Passmore, and Reiser 2017). However, each SEP is inherently language intensive and requires students to use language in new and complex ways (González-Howard, Andersen, & Méndez Pérez 2021).

Multilingual students—an extremely diverse group of individuals who vary across countless factors, including the languages that they know and their proficiency in these languages—must navigate these demands while simultaneously developing their understanding and use of English. Similar to how students learn content through engagement in SEPs (Schwarz, Passmore, and Reiser 2017), research has shown that multilingual students’ language

development is best supported in the context of content learning (Lee et al. 2019). Authentic and rigorous use of SEPs provides multilingual students with opportunities to engage in new ways of communication, expanding their ability to use language and other sensemaking resources to grow their understandings of natural phenomena (Lee et al. 2019). For such learning to occur, however, teachers must learn to leverage and encourage the use of all the sensemaking resources available to students.

In this article, we explore how teachers can better support multilingual students' scientific sensemaking in the context of SEPs, specifically through *translanguaging*—the ways individuals engage in sensemaking and express ideas using all of their resources for communication, which include linguistic and nonlinguistic modes (Suárez 2020). We first introduce and describe translanguaging, then explore concrete steps teachers can take to redesign science lessons using a translanguaging approach, focusing on moments when students meaningfully engage in SEPs for sensemaking. These steps will be illustrated using the opening vignette from Ms. Silva's classroom. The examples used in this article come from an amalgam of teachers' classrooms that we have worked with in the past and strategies identified in research literature as best practices for supporting multilingual students' scientific sensemaking. While the strategies highlighted in this article have been demonstrated to support multilingual students, they will also help teachers to reimagine their lessons in ways that support *all* students, especially students across a spectrum of ability levels whose resources for sensemaking go unnoticed or underleveraged during science learning.

How can a translanguaging approach support multilingual students' scientific sensemaking?

In science education, there is a tendency to prioritize linguistic modes of communication (what we typically think of as “language”) when supporting multilingual students’ scientific sensemaking (González-Howard et al., 2021). However, multilingual students have a variety of sensemaking resources that they can draw on to engage in and communicate science learning that are often left untapped. For example, students’ linguistic resources may include the multiple languages they speak (or are learning to speak) and range from less formal modes, such as everyday language, to more formal academic language. Students also have at their disposal many nonlinguistic resources, including gestures, drawing, and use of symbols in addition to those typically used in science such as modeling, graphing, or charting. Table 1 highlights many possible linguistic and nonlinguistic resources that multilingual students can use for scientific sensemaking.

It is not enough for teachers to leverage one or two of these resources in a given lesson. Instead, we argue that teachers should encourage multilingual students to move freely between them and use all of their sensemaking resources through a translanguaging approach. An important aspect of translanguaging is recognizing how all of our students’ nonlinguistic and linguistic modes of communication can be used synergistically to support and express scientific sensemaking. For example, a teacher using a translanguaging approach might encourage students to write *and* draw their explanation for a phenomenon, rather than relying solely on writing.

Table 2 provides a number of translanguaging strategies, which have been shown to support multilingual students’ sensemaking in science and can be incorporated into existing science lessons or used as a resource when designing new lessons. It is important to note that although we include recommendations that may address either linguistic or nonlinguistic resources, these strategies should not be used in isolation. Instead, teachers should seek to

include strategies that draw on a broad range of students’ sensemaking resources simultaneously. When learning to incorporate any new strategy, it is helpful to picture what using this new approach might look and sound like. For this reason, Table 2 includes possible teacher prompts to illustrate how teachers might incorporate a translanguaging approach in their classroom.

What steps can I take to redesign a science lesson using a translanguaging approach?

To integrate a translanguaging approach in the classroom, teachers must recognize the language demands present in a particular unit, lesson, or moment in science instruction—including how language is used to engage in specific SEPs—and then find ways to leverage students’ multiple sensemaking resources. Figure 1 depicts a flowchart that can guide teachers through redesigning existing science lessons to take on a translanguaging approach. Through this process, teachers are asked to consider how they might leverage their multilingual students’ assets and address potential challenges they might encounter. In the remainder of the article, we explore these steps in detail and return to Ms. Silva’s classroom to illustrate this approach in practice.

STEP 1: What are the learning goals for the unit, lesson, or moment?

Teachers should consider the learning goals present in the unit, in the lesson, or within a single moment, so that revisions enhance multilingual students’ ability to achieve these goals. For instance, a lesson goal might be for students to develop models explaining how plants grow, while a goal for a learning moment could be to identify affordances or limitations of each model. To exemplify this process, we return to Ms. Silva’s classroom. Following the process outlined in Figure 1, Ms. Silva might identify the lesson’s learning goal as “students plan and implement an

investigation to gather evidence about what environmental factors influence the growth of plants.” However, by posing the question to be explored and designing the investigation herself, she realized that she limited students' ability to make sense of the many factors (aside from sunlight) that influence plants’ abilities to live and grow. Thus, her current lesson plan was not supporting the lesson’s learning goal.

STEP 2: Which science and engineering practice(s) support the learning goals?

To support authentic learning through SEPs, teachers must identify the practice(s) students will engage in. The focal SEP(s) may be explicitly described within the *NGSS* performance expectation the learning goals address. However, it is also possible that students draw on multiple SEPs to accomplish the learning goals. In her lesson, Ms. Silva identified *planning and carrying out investigations* as the SEP that she wanted her students to use to figure out what environmental factors influence the growth and development of lima beans. At the middle school level, this SEP involves students identifying questions to investigate and deciding what will count as evidence, what variables should be controlled, and what materials are needed to carry out the investigation (NGSS Lead States 2013).

STEP 3: How is language used to engage in the focal science and engineering practice(s)?

When it comes to considering the role of language in SEPs, attention tends to be placed on those that are most obviously language intensive, such as argumentation and explanation. For example, when considering the practice of generating explanations, we immediately recognize that this practice requires students to communicate in productive ways (i.e., via speaking or writing). This often leads us to assume that multilingual students must first be proficient in

English before they can engage in these practices. However, two issues arise from such an assumption. One, assuming English is a prerequisite, limits multilingual students' opportunities to engage in rich science learning. Secondly, speaking and writing are not the only ways multilingual students can represent scientific explanations. Students can also develop a drawn model or use their bodies and gestures to communicate their explanation for a phenomenon (Suárez 2020). It is important to note that all eight SEPs require students to use language in new ways and through both linguistic and nonlinguistic modes (González-Howard et al., 2021). Returning to Ms. Silva's classroom example, she would need to consider the language demands embedded in *planning and carrying out investigations*. Ms. Silva may determine that to plan an investigation, students must use language to negotiate procedures with their peers, record these procedures, and communicate and provide peer feedback to ensure the investigation tests one variable at a time. While planning their investigations, students may also be introduced to new scientific terms such as *variable(s)* and *control* in the context of meaningfully using them. Previously, Ms. Silva's lesson provided students with a step-by-step procedure to follow and also pretaught these terms, both of which limited the ways her students were able to use language to engage in this practice.

STEP 4: How can we leverage students' multiple sensemaking resources using a translanguaging approach?

Finally, it is important to intentionally incorporate opportunities for students to meet the associated language demands using all of their sensemaking resources. As previously mentioned, Table 2 includes a number of strategies teachers can employ when taking a translanguaging approach to support multilingual students' sensemaking. Returning to our vignette example, Ms.

Silva would need to consider how to leverage students' many sensemaking resources as they work with peers to plan investigations. This lesson redesign might first encourage student groups to discuss ideas using a range of their linguistic resources to negotiate their plans, such as their home languages, their everyday language, and their developing English and academic science vocabulary. For example, Ms. Silva might plan to say, "What are some things in an outdoor garden environment that you think impact plants' ability to grow?" Based on her students' responses, she might ask, "Is there a word you use at home for this idea?" Second, Ms. Silva could ask students to document these ideas using a combination of words or drawings, intentionally leveraging her multilingual students' nonlinguistic meaning-making resources. Here, she might say, "Use your hands to show what you mean by _____" or "What did you notice about how [student] used their body to explain their ideas?" Furthermore, Ms. Silva might encourage students to use their science notebooks to document ideas in the ways that make most sense to them, reminding students that "words are just one way to represent our ideas on paper." Thus, their science notebooks become a place where students can make connections between writing and nonlinguistic representations to help communicate and track changes in their developing understandings of the focal phenomena.

With these revisions, Ms. Silva might expect students to form plans that involve one or more variables and controls. In previous years, Ms. Silva pretaught the terms *variable* and *control*. Her redesigned lesson, however, supports students in developing an understanding of these terms as the ideas behind them emerge authentically in students' planning. Ms. Silva also, therefore, plans to help students give a name to the concepts as they are discussing them in their plans. For example, if students' investigation plans illustrate the idea that they should only change one thing at a time, she can say, "I see in this drawn-out plan that we only want to change

one ‘thing’ in our experiment. Another word we use in science for that is *variable—or something that varies*. Perhaps we can include that word next to the image of this investigation set up?”

Finally, Ms. Silva could plan to assess students’ progress using a gallery walk, where students explain their procedure to peers. While describing this activity, Ms. Silva could remind students to “be sure to use gestures or point to your drawings and written plans as you explain your procedure to peers so that they understand your plan and may ask questions or provide feedback.” This activity highlights the affordances of both linguistic and nonlinguistic modes of communication, allowing students’ current understandings and ideas to shine in whichever way they choose to express them. Ultimately, by providing multilingual students with opportunities to move seamlessly between these multiple modalities (i.e., engage in translanguaging), they will be encouraged to use language in ways that will not only push their understanding of the content (González-Howard et al., 2021) but will also better support them in showing what they know.

Concluding thoughts

When shifting our instruction to better bring to life the vision behind the *NGSS*, it becomes our responsibility as teachers to ensure that all of our students have rich opportunities to participate and engage in authentic science learning. As seen in our example from Ms. Silva’s classroom, leveraging and encouraging translanguaging in the context of SEPs can support multilingual students in both their content learning and in developing deeper understanding of how language is used to meaningfully engage in SEPs. Encouraging students to represent new terms and ideas in multiple ways, switch fluidly between different modes of language, and make connections between their home language(s) and scientific phenomena helps multilingual students draw on their full range of sensemaking resources and ultimately helps them form

deeper understandings of the focal phenomena. Incorporating a translanguaging approach will take time, practice, and much reflection as we continue to rethink what “counts” as doing science and, just as important, what “counts” as language in science (González-Howard, Suárez, & Grapin, 2021). Yet by recognizing and leveraging the various ways that multilingual students make sense of scientific phenomena and the various resources available to them for doing so, we have the potential to create more equitable learning experiences and classrooms.

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Figure 1. Steps for Redesigning a Lesson Plan Using a Translanguaging Approach

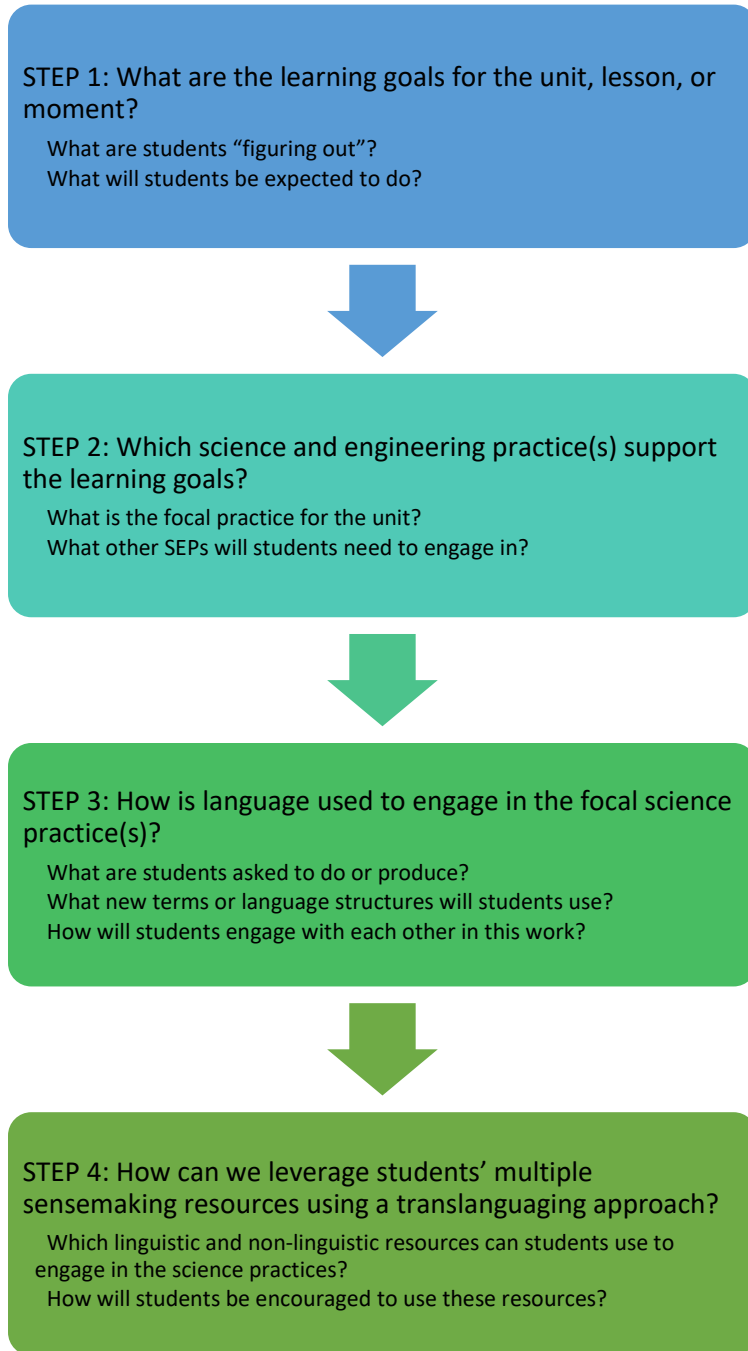


Table 1. Linguistic and Non-linguistic Modes of Communication for Scientific Sensemaking

Linguistic Modes of Communication	Non-linguistic Modes of Communication
- Languages used at home (e.g. Spanish, Farsi, Portuguese, etc.) - Languages they are developing proficiency in (e.g., English) - Everyday language (e.g. language spoken outside of typical academic settings, usually between peers) - Academic science vocabulary - Structural forms typical of language in science (e.g., Claim-Evidence-Reasoning statements for argumentation or “If...then” statements for hypotheses)	- Gestures and kinesthetic movements - Mathematical or scientific symbols and formulas (e.g. +, -, ×, ÷, =, Δ, →, △, ⊗) - Graphs and Charts (e.g. bar graphs, pie charts, histograms, scatterplots) - Data tables - Drawings and pictures - Models (e.g. drawn models, physical models, or kinesthetic models)

Table 2. Strategies for Supporting a Translanguaging Approach in Science

Strategy Description	Example Teacher Prompts
During moments when students are tasked with making their thinking visible (i.e. via oral discussion, presentation, etc.): - Students should be encouraged to transition fluidly between home named languages, colloquial language, their emerging English, and academic science language (drawing on all linguistic resources). - Teachers can also encourage students to draw or use gesture to represent their ideas (drawing on any non-linguistic resources) - Teachers can encourage students to notice how their peers are using their hands, bodies, or language to communicate their ideas.	“Is there a word you use at home for this idea?” “What are some other ways we talk about [science idea].” “Where else have we heard this word?” “I hear [student] using the word ____, another word we use in science for that is ____.” “Use your hands to show what you mean by ____” “How can you use your bodies to describe ____?” “How might you explain ____ through a drawing?” “What objects might you use to model [science process or science idea]?” “Did you notice how [student] used their hands/body/drawing to represent [science idea]?”

When students are tasked with reading science texts: - Teachers can provide (where possible) translated materials or highlight cognates in an English-only text. - Teachers can partner students with other multilingual peers during reading time who can assist students in making sense of particular words and phrases. Teachers can encourage students to highlight words or phrases they don't understand to discuss with their partner or small groups. - Teachers can also supplement text with images, charts, or graphs to help students access text information in multiple ways.	"Are there any words or phrases you aren't sure about?" "This word is also _____ in _____ language." "What is a more common way to say this?" "Does anyone know what _____ means?" "Ask your table partner for help if you find a word or phrase you don't know." "Does the image/drawing/chart in the text tell you anything more about the idea?"
During activities that task students with writing their ideas: - Teachers can encourage students to write in the language(s) they are most comfortable or familiar with. - Teachers can also encourage students to include drawings to represent their thinking, which can include any combination of drawn models, graphs, charts, symbols, or even mathematical formulas.	"Draw and write your explanation/observation of _____ phenomena." "Remember that words are just one way to represent our ideas on paper." "Can you draw what you mean?" "How can you organize your data to show any patterns?" "What are some ways you might represent your data or observations?" "How can you represent any patterns you see?"