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Using Language-Expansive Approaches to Prepare Preservice Teachers to Teach Science with Multilingual Learners

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ABSTRACT

The current vision for equitable and reform-oriented science education emphasizes that all students should engage in language-rich science practices to make sense of natural phenomena. Yet, for multilingual learners, equitable participation requires teaching that expands what counts as language and sensemaking in science. This article introduces language-expansive approaches to science teacher education, which draw from translanguaging theory to position language as fluid, multimodal, and dynamic. Language-expansive pedagogy invites preservice teachers (PSTs) to recognize and leverage students' full communicative repertoires—including home languages, gestures, drawings, and other semiotic resources—as legitimate tools for doing and communicating science. Building on findings from a larger study of 23 science teacher educators (STEs) whose work centers on equitable and justice-oriented reform in science education, this practitioner piece shares approaches used by STEs who hold expansive orientations toward language and science. These STEs designed learning experiences that foregrounded critical stance-taking and reflection, encouraging PSTs to interrogate how dominant, racialized, and monolingual norms shape what counts as scientific knowledge and discourse. Through intentional modeling, dialogue, and analysis of classroom examples, these STEs helped PSTs reimagine multilingualism as a resource for scientific sensemaking rather than a barrier to overcome. We offer concrete strategies that STEs can adapt in their own courses to cultivate PSTs' "language for science" perspectives and to center language justice in science instruction. By shifting from English-dominant models of integration toward transformative re-conceptualizations of language and science, this work contributes to advancing equity-oriented science teacher education.

Keywords: preservice science teachers, translanguaging, multilingual learners

Introduction

The current vision for reform-oriented science instruction, represented by the Next Generation Science Standards (NGSS; NGSS Lead States, 2013), emphasizes the importance of all students engaging in language-rich science practices to support their sensemaking around natural phenomena (Lee et al., 2014; Lee & Stephens, 2020). The language-rich nature of science practices has primarily been described through linguistic modes and forms of communication (e.g., a student writing an explanation or students orally engaging in argument from evidence; González-Howard, Andersen, Méndez Pérez & Suárez, 2023). However, for this type of engagement to be truly equitable — particularly for language-minoritized students , such as multilingual learners (González-Howard & Suárez, 2021) — it is critical that educators support students in meaningfully partaking in science practices in language-expansive ways (González-Howard, Méndez Pérez & Andersen, 2024; Miller et al., 2018). Drawing on translanguaging theory and pedagogy, which position both language and language use as fluid, dynamic, and heterogeneous (García, 2011; García et al., 2017; Wei, 2018), language-expansive signals similar ideas within the science education context (González-Howard et al., 2023). In particular, we use language-expansive to emphasize the diverse and ever-evolving linguistic (e.g., written and spoken named languages, such as Mandarin, French and Spanish) and multimodal resources (e.g., gestures, models, embodied motion, drawings, graphs) that multilingual learners might fluidly draw upon as they use their full language repertoires to make sense of the world and to communicate science ideas when engaged in science practices (Grapin, 2019; Pierson & Grapin 2021; Suárez & Otero, 2024).

Relatedly, fostering transformative and equity-oriented science learning environments with and for multilingual learners (Grapin, Pierson, González-Howard, Ryu, Fine & Vogel, 2023; Lee & Grapin, 2025) requires that teachers develop a "language for science" perspective (González-Howard, Andersen, Méndez Pérez & Lee, 2024), which centers students' myriad language resources and the nuanced ways they might use them to explore, construct knowledge, and express their ideas about the world. Pedagogy aligned with this perspective challenges the dominance of standardized and racialized monolingual, English-language practices and moves beyond framing equity for multilingual learners as accessing and replicating pervasive disciplinary language norms; thus making visible the political nature of language and language use in schools (García et al., 2021; Grapin et al., 2025; Méndez Pérez, González-Howard & Suárez, 2025; Wei & García, 2022). When adopting a language for science perspective and enacting language-expansive pedagogy, teachers can disrupt narrow ideas and practices around language that have, and continue to, constrain multilingual learners' sensemaking experiences in science classes (Lemmi et al., 2019; Sedlacek et al., 2025; Suárez, 2020). Working towards the vision of science teaching and learning previously described has implications for how science teacher educators (STEs) might prepare preservice teachers to understand and support language-expansive instructional practices in their future classrooms.

Similar to others (e.g., Luft & Jones, 2022; Rutt et al., 2021; Venegas-Weber et al., 2024), we argue that science teacher education must include opportunities for preservice teachers to problematize their existing ideas around language, how students use language for sensemaking,

and which language resources are appropriate for students to use when engaging in science practices (González-Howard, Andersen, Garza & Tasnim, Accept with Major Revisions; González-Howard, Méndez Pérez & Andersen, 2024). However, we recognize that STEs themselves do not always receive adequate (if any) teacher preparation training (Zeichner, 2005), especially regarding means by which to best teach science with multilingual learners (NASEM, 2018; Woodard & Rao, 2020). Aiming to address this void in STEs' understandings and pedagogies, in this article (intended for an STE audience), we share and describe language-expansive instructional approaches that STEs might employ to center equity and language-justice for multilingual learners (Wilson-Lopez & Hasbún, 2023) in their science methods courses. We hope for STEs to understand that these approaches are not exhaustive, but are instead a starting point as our field continues to expand research that explores means by which to best develop preservice teachers' stances and pedagogies for teaching science with multilingual learners (González-Howard, Méndez Pérez & Andersen, 2024; Grapin et al., 2023; Lyon et al., 2018; Venegas-Weber et al., 2024). Additionally, though worthwhile and necessary, this work is challenging, must be done intentionally, and takes ongoing effort (González-Howard, Méndez Pérez, Andersen, Robinson & Garza, 2025). This sentiment was captured best by Vita, a STE with whom we recently worked and whose approaches we highlight through an illustrative vignette later on in this piece (González-Howard, Garza, & Tasnim, 2026):

> … what does it really mean to challenge and decenter the kind of exclusionary cultural norms and racial linguistic hierarchies that are built into every aspect of science learning standards or curricular materials, and foreground the contributions of many different communities and perspectives that have been just erased? … I'm still at some level trying to bring that reconceptualizing into practice with my course … but I haven't quite figured out … what it would mean to fully integrate a more reconceptualist pedagogy at every step of the way.

Larger Study Context

The ideas we present in this article originated in a larger study in which we explored the approaches that STEs use within their methods courses to prepare preservice teachers to teach science with multilingual learners. The limited research that has been conducted around this area of inquiry has shown that STE's approaches vary widely, from centering how to integrate English language supports within science instruction to helping preservice teachers problematize pervasive language practices in schools (Rutt et al., 2021; Venegas-Weber et al., 2024). Yet, similar to how science teachers' instructional practices are influenced by their views on how students could or should use language in science learning environments (Lemmi et al., 2019; Sedlacek et al., 2025), we anticipated that the same might be true for STEs' instructional practices. Thus, in the larger study, we examined whether STEs' approaches were influenced by their language orientations for scientific sensemaking (Gonzalez-Howard et al., Accept with Major Revisions; González-Howard, Méndez Pérez, Andersen, Robinson & Garza, 2025).

We intentionally use the term "language orientation" to explore educators' ideas around language in and for science because it helps us highlight the consequential nature of the construct -- in the same ways that a compass orientation informs an action (e.g., moving in a

particular direction), a language orientation informs an instructional action (e.g., how teachers elicit student ideas) (Gonzalez-Howard et al., Accept with Major Revisions). Additionally, we conceptualize language orientations as multidimensional and falling on a spectrum, from more narrow to more expansive (González-Howard, Andersen, Méndez Pérez & Robinson, 2024), with language expansive orientations grounded in disciplinary perspectives on translanguaging (González-Howard, Andersen, Méndez Pérez & Suárez, 2023; Pierson & Grapin, 2021). In this piece, we share and illustrate approaches identified as supporting preservice teachers in developing language-expansive orientations for teaching science with multilingual learners; all of these approaches were common among STEs who themselves held language-expansive orientations. To provide transparency around how these approaches were identified, we next provide a brief overview of the larger study.

In the larger study, we purposely selected 62 STEs whose research and published work were explicitly self-identified as critical, equity-oriented, and/or justice-oriented (Creswell & Poth, 2016). This was often evident in the frameworks they drew upon, their focal participants, and their study topics. Furthermore, many of these STEs held leadership roles in organizations or committees committed to equity and justice in science education. We intentionally invited these individuals to understand and learn from the practices of STEs who are working to critically transform science education, particularly for marginalized student groups such as multilingual learners (Grapin et al., 2023b). As noted above, we identified potential STEs through a variety of sources, including conference proceedings, publications, and roles that they hold in journal editorial boards or professional organizations. Of those originally invited, 23 STEs ultimately agreed to participate. Those individuals completed a researcher-designed and validated online survey, which had been developed to measure the dimensions of teachers' language orientations for scientific sensemaking (González-Howard, Andersen, Méndez Pérez & Robinson, 2024). Analyzing the survey results showed that these 23 STEs held a range of language orientations (González-Howard, Andersen, Garza & Tasnim, Accepted with Major Revisions). We then chose five who demonstrated expansive language orientations to participate in an hour-long follow-up interview. The aim of that semi-structured interview (Kallio et al., 2016) was to learn about the approaches STEs were using to prepare preservice teachers to teach science with multilingual learners. The interview protocol was informed by prior research examining the instructional practices of STEs (e.g., Underwood & Mensah, 2018; Woodard & Rao, 2020).

Once the follow-up interviews were completed and transcribed, we iteratively developed a codebook that was grounded in existing literature around science teacher preparation focused on multilingual learners (e.g., Athanases & Oliveira, 2010; Bravo et al., 2014; Jung & Brown, 2016; Lukas & Villegas, 2013), as well as codes that emerged from the data (Miles et al., 2020). After finalizing the codebook, the first two authors independently coded the interview transcripts and met to compare their initial coding. The consensus codes for each interview were shared and discussed during weekly research meetings, after which the third author entered the coding process to corroborate all analytic decisions. Any disagreements were resolved through discussion and by checking evidence from the interview transcripts (Creswell & Poth, 2016).

The findings that we focus on in this piece elevate how — unlike prior research on preparing preservice teachers to teach science with multilingual learners, which primarily emphasized the integration of language and literacy within science instruction through modeled practices and scaffolded planning tools (Rutt et al., 2021) — STEs who held language-expansive orientations centered reflective and critical stance-taking as a pedagogical practice (González-Howard, Garza & Tasnim, 2026). Specifically, these five STEs guided preservice teachers to critically interrogate and problematize dominant perspectives about language in and for science (González-Howard, Andersen, Méndez Pérez & Lee, 2024) by intentionally disrupting racialized, monolingual norms and by troubling and expanding ideas about legitimate scientific discourse. These STEs also facilitated critical conversations at the intersections of preservice teachers' positionalities and backgrounds, and how those might relate to their understandings of, and experiences with, language and science.

Based on these findings, in the remainder of this article, we share how STEs might more equitably prepare preservice teachers to work with multilingual learners by offering concrete approaches and strategies that move beyond traditional models of language integration (that are predominantly English-centered) in science class instruction. What we share is innovative as it shifts the focus away from integrating English-language development supports within science instruction towards reshaping and transforming preservice teachers' epistemological understanding of both language and science (Grapin et al., , 2023; Venegas-Weber et al., 2024). By re-centering multilingual learners' existing and varied language repertoires as essential for science, this work contributes to an emerging area of inquiry in science teacher education (González-Howard, Andersen, Garza & Tasnim, Accept with Major Revisions; González-Howard, Méndez Pérez, Andersen, Robinson & Garza, 2025), challenging and expanding prevailing notions of what counts as sensemaking and generative forms of scientific communication, and who is viewed as scientific (Warren et al., 2020).

Language-Expansive Approaches

Emerging from the data analysis described above, we next share a list of approaches taken up by STEs that align with language-expansive orientations for scientific sensemaking (González-Howard, Andersen, Méndez Pérez & Suárez, 2023). As we mentioned earlier, these approaches are neither exhaustive nor prescriptive, but instead intended to inspire and inform STEs about possible new avenues they might take when preparing preservice teachers in their unique instructional contexts. Because the heterogeneous makeup of students who identify or are identified by their schools as multilingual is the fastest-growing student population across the United States (González-Howard & Suárez, 2021; NASEM, 2018), learning about and taking up these approaches would be of interest and beneficial for all individuals who are working to prepare the next generation of science teachers. Table 1 describes language-expansive approaches, along with relevant references and example instructional activities aligned with each approach, which the five focal STEs shared that they use in their science methods courses (González-Howard, Garza & Tasnim, 2026).

Table 1: Language-Expansive Science Teacher Educators' Approaches for Preservice Science Teacher Education

Instructional Approach (relevant references)	**Description**	**Example Activities Aligned with this Approach**
Approach 1: Problematizing language for scientific sensemaking (González-Howard, Méndez Pérez & Andersen, 2024; Roberts et al., 2016; Rosebery & Warren, 2008; Underwood & Mensah, 2018)	STEs engage preservice teachers in discussions and activities that support them in grappling with, and rethinking, language and the role of language in science	● Using different approaches (e.g., videos, guest speakers) to emphasize that scientific sensemaking is inherently multimodal and that it can look and sound differently depending on many things, like context and audience. ● Fostering a safe classroom environment for PSTs teachers to creatively and fluidly use all their language resources and practices to support their growing understandings around what counts as language in and for science. ● Framing multimodality as multiple forms of language (spoken and written named languages, models, drawings, gestures), each of which helps express different ways of thinking. All language forms are equally necessary and generative for scientific sensemaking. ● Explaining and finding authentic examples in which to showcase how an individual's language repertoire is continuously evolving and growing. ● Decentering English by troubling preservice teachers' thinking around terms commonly used in school spaces, like "linguistically diverse" or "mainstream." ● Engaging preservice teachers in autobiographical sharing of their science education experiences that are related to language and language use (e.g., memorization of vocabulary or terminology, being weeded out of classes in pre-med programs).
Approach 2: Engaging in ongoing critical conversations (Athanases & Oliveira, 2010; Lucas & Villegas, 2013, Underwood & Mensah, 2018)	STEs engage preservice teachers in critical conversations around a variety of topics that impact multilingual students' science learning experiences	● Addressing language biases in science and science curriculum to decenter English and attend to the cultural and linguistic inequities embedded in science education. ● Prioritizing discussions around how language is used in/for science by pushing back on terms such as "academic language" that ultimately privilege certain language forms over others. ● Structuring debates between preservice teachers around whether or not multilingual learners should be pre-taught scientific vocabulary. ● Providing support when preservice teachers share tensions or challenges around implementing translanguaging pedagogy in their field placements. ● Engaging preservice teachers to critically reflect on their intersectional identities, cultures, and positionalities in relation to language and their science experiences. ● Elevating the benefits and nuances of bi/multilingualism and attending to variations within named languages, including dialects.

Approach 3: Designing and teaching science lessons and/or science units (Andersen, Méndez Pérez, & González-Howard, 2022; Athanases & Oliveira, 2010; González-Howard, Robinson, Andersen, Vazquez, & Rodriguez, 2025; Jung & Brown, 2016; Nasir & Heineke. 2014)	STEs provide PSTs with opportunities to prepare and teach science lessons and reflect upon their experiences. This teaching might take place in the context of their placement classrooms or within the methods course itself via lesson rehearsals	● Supporting PSTs in planning a set of lessons for a science unit, with each lesson having a particular goal for PSTs to consider and work towards (e.g., authentically engaging students' communities, incorporating translanguaging pedagogy, scaffolding language development and use). After the initial planning, PSTs could be provided with a set of reflection questions to help them consider the extent to which they achieved each focal lesson goal. ● Tasking preservice teachers to design and carry out an "interactive science interview" or "science talk" with multilingual learners at their placement sites. ● Teaching PSTs how to customize existing, NGSS-aligned curriculum by integrating translanguaging pedagogy to enhance how multilingual learners might develop and use language for scientific sensemaking ● Including opportunities for PSTs to receive critical and supportive feedback around their instruction. Analyzing preservice teachers' teaching can take various forms, including: video or transcript analyses, examining student artifacts, and in-person discussions following an observation.
Approach 4: Immersion in science learning experiences (González-Howard, Méndez Pérez & Andersen, 2024; Lowell, 2024; Lucas & Villegas, 2013; Venegas-Weber et al., 2024)	STEs engage preservice teachers in science learning experiences from the perspective of students	● Encouraging preservice teachers to use different language modes and forms as they engage in science practices (e.g., intentionally developing models with drawing, writing, arrows, etc.) and then spending time reflecting on how being able to draw upon their full language repertoire enhanced their sensemaking. ● PSTs participate in science learning activities across different named languages (e.g., Spanish, Mandarin, English), registers and/or dialects, with STEs then helping them recognize how their complex sensemaking work occurred across these language forms. ● During immersion experiences, explicitly inviting preservice teachers to express their evolving science ideas using any and all language modes and forms of their choosing, and then elevating for their peers the nuanced ways that they do so ● Engaging preservice teachers in varied types of science learning experiences that tap into different language modes and forms for sensemaking (e.g., embodied movement during "Wondering Walks" or oral discourse during "Reader's Theater") ● Incorporating multilingual texts (e.g., readings, podcasts, videos) into science lesson immersion experiences ● STEs explicitly model translanguaging pedagogy to their preservice teachers as they engage with phenomena, plan and carry out investigations, and collectively make sense of data as they construct science knowledge

Approach 5: Discussing views of multilingual learners (Bravo et al., 2014; Athanases & Oliveira, 2010; Lee, 2021; Rosebery & Warren, 2008; Venegas-Weber, & Thompson, 2025; Walker & Stone, 2010)	STEs create opportunities for preservice teachers to discuss their views about multilingual learners generally, and also about multilingual learners in the context of science education specifically, as well as possible underlying rationales for those views	● STE responds to and challenges deficit narratives of multilingual learners that preservice teachers might hold or share that they heard others voice (e.g., multilingual learners are not able to engage in rigorous science instruction until reaching a certain English language proficiency) in order to support them in developing asset-oriented views of multilingual learners and their abilities ● Preservice teachers discuss the labels – and implications of the labels – often used to describe multilingual learners (e.g., language learner, English language learner, limited English proficiency, language minority, etc.) ● STEs provide space for preservice teachers to share (anonymously or not) questions and concerns they might have around teaching science with multilingual learners, as well as opportunities for the class to discuss those questions and concerns ● Preservice teachers discuss common schooling practices that multilingual learners experience, including school language policies, and how those might support or hinder their science learning experiences (e.g., homogenous grouping by English language proficiency or by additional named languages used, pull out methods, sheltered English instruction, the extent to which students can speak across named languages in dual-language classrooms) ● Preservice teachers are provided ample opportunities to consider and learn how to draw upon multilingual learners' funds of knowledge and make meaningful connections to their families and communities within their science instruction

It is important to note that these approaches are not mutually exclusive as STEs shared that they often used multiple approaches simultaneously (e.g., engaged their PSTs in critical conversations - Approach 2 - around designing and teaching science lessons with multilingual learners - Approach 3). To further illustrate the nuanced ways STEs might choose to take up the language-expansive approaches captured in Table 1, we next present two vignettes (inspired by interviews with two STEs from the larger project; González-Howard, Garza & Tasnim, 2026).

Illustrative Vignettes

In the following section, we present two vignettes (Langer, 2016) that bring to life the ideas shared in Table 1, showcasing different ways STEs might take up language-expansive approaches when preparing preservice teachers to teach science with multilingual learners. Although there were five STEs who we engaged in follow-up interviews because they demonstrated language-expansive orientations on the survey (González-Howard, Andersen, Méndez Pérez & Robinson, 2024), in this piece, we highlight two of these individuals via vignettes. Though this decision was largely based on space constraints, we feel the two STEs chosen shed light on generative and transformative approaches for teacher preparation. To create these vignettes, the first and second authors constructed researcher-authored composite narratives (Marchant, 2024), with each vignette representing one STE and synthesizing multiple data sources (i.e., their interview and survey data) to highlight that educator's patterned approaches and pedagogical moves. We use first-person narration in these vignettes to foreground each STE's designed choices and their role in shaping learning opportunities. Draft vignettes were corroborated with the third author to ensure alignment with the data corpus, participants' consensus codes, intentions and experiences.

These vignettes highlight how STEs' approaches are shaped by each educator's positionality and experiences, as well as their unique teaching context and goals for their science methods course (Underwood & Mensah, 2018). By showing how these approaches manifest in real elementary science methods courses, the vignettes demonstrate the flexibility and responsiveness of language-expansive pedagogy in science teacher education (González-Howard, Méndez Pérez & Andersen, 2024).

Each vignette begins with a brief introductory paragraph that provides context, including information about the elementary science methods course that the focal STE teaches, how long they have been teaching it, and their course goals. The main body of the vignette (in italics) includes quotes from the educator (i.e., data from the larger study context; González-Howard, Garza & Tasnim, 2026), highlighting various language-expansive approaches in bolded text (e.g., **Approach 1**) that align with the approaches detailed in Table 1 above. Each vignette then concludes with a short analytical paragraph and descriptive commentary.

Mina's Vignette

Mina (all names are pseudonyms) is an Assistant Professor in her fifth year of teaching a K–5 science methods course at a mid-sized R2 university in the midwestern United States. The teacher education program in which she works serves a highly linguistically diverse group of

preservice teachers pursuing teaching certifications in general education, bilingual education, and/or English as a Second Language (ESL). Her instruction is primarily in English, though she occasionally uses Spanish, a practice that aligns with the teacher education program's emphasis on preparing educators to work with multilingual learners. Mina's approach to science teacher education is shaped by her own personal experiences as a multilingual learner and her critical awareness of raciolinguistic ideologies (Flores & Rosa, 2015). Within her teacher education program, translanguaging (García, 2011; Otheguy et al., 2015) and discussions about language and positionality are woven throughout preservice teachers' coursework, not always as the main focus of each course, but as ongoing threads across all the courses. Mina creates opportunities for preservice teachers to engage in science learning across named languages (e.g., English and Spanish) to help them recognize the assets all students carry and can tap into during those experiences. Furthermore, she supports preservice teachers in grappling with the political nature of science and in understanding that the dominant ways that the discipline is taught in schools reflect those political framings. A main goal of Mina is for preservice teachers to recognize the responsibility they each hold to challenge and disrupt dominant narratives in their own teaching.

As I prepare to meet my new cohort of preservice teachers, I am mindful of one of my major course goals: to ensure preservice teachers are not "culturalized" into thinking of multilingual students as fundamentally different from other science learners. Instead, I aim to help them recognize how dominant approaches to science marginalize students, and that they can actively disrupt "traditional notions of science." On the first day of class, I invite preservice teachers to reflect on their own experiences with science and language, using autobiographical sharing to surface memories, emotions, and assumptions **(Approaches 1 & 2)**. *This invitation sets the tone for problematizing common narratives of science as apolitical and neutral. I assign numerous readings and podcasts that explore multilingual learners' experiences in science through the lenses of language, family, and community* **(Approach 5)**. *I also share videos of students engaging in science using a range of language resources — multiple registers, various named languages, gestures, and visual tools — so that preservice teachers can witness and engage with the authentic heterogeneity of scientific sensemaking* **(Approach 4)**. *As they engage with such classroom artifacts I tell them that"if we want students to be successful at sensemaking, we have to give them opportunities to be able to engage in these different types of thinking through these different types of languages…students talking with their hands, students are measuring… giving you some vibes with their body language...all of these modes of communication are so essential for students at all ages to be engaging with science"* **(Approach 1)**. *These experiences help me frame language in expansive ways, an idea that I lean into as I emphasize that science practices are inherently multimodal and that honoring the diverse modes students might draw upon is essential for supporting all learners, and especially multilingual learners* **(Approaches 1 & 5).**

Recognizing language as central to disrupting dominant, raciolinguistic notions of science, I collaborate with colleagues to embed Learning in Places — an Indigenous-based framework that draws on students' cultural and linguistic family science practices (Learning in Places Collaborative, 2021) — into my methods course. Preservice teachers are energized by these experiences, especially with the opportunity to engage with science in nature, beyond the

constraints of textbooks and in ways that attend to science vocabulary in decontextualized ways. Hands-on activities (e.g., manipulating models, drawing, gesturing, and using tools) offer diverse entry points and provide preservice teachers with different ways of thinking and using language for sensemaking, which ultimately allows them to experience language as embodied and multidimensional **(Approaches 1 & 4)**. *As preservice teachers begin their fieldwork in schools, I guide them to intentionally integrate these varied modes for sensemaking into their lesson plans.*

Furthermore, as they begin learning how to design units and assessments, I introduce preservice teachers to WIDA strategies to help them identify relevant language objectives so that they learn to meaningfully integrate literacy alongside science objectives **(Approach 3)**. *For example, I encourage preservice teachers to attend to the language functions embedded in scientific practices, such as connecting words that support explanations around cause and effect. I stress that these "pedagogical decisions" and supports should not be merely functional, but also reflect critical and cultural ways of doing science, encouraging preservice teachers to elicit and value how "students get or share ideas from the community across languages"* **(Approaches 1, 2 & 5)**. *Video analysis of their own teaching becomes a tool for reflection, helping preservice teachers examine, problematize, and refine their enactments* **(Approach 3)**. *I make myself available as a resource, especially when preservice teachers face pushback in field placements for incorporating translanguaging practices* **(Approach 5)**. *I am prepared for those challenges, with research, frameworks, and strategies that affirm the course goal of reshaping science education to be more just, inclusive, and linguistically expansive* **(Approach 1)**.

This vignette illustrates a deeply intentional and multifaceted approach to supporting preservice teachers in reimagining the role of language in science education. Moreover, rooted in a broader commitment to justice, this STE embeds translanguaging and draws on students' family knowledge systems through tools like Learning in Places, affirming cultural and linguistic resources as central to doing and learning science. Thus, by providing preservice teachers with the tools and space to challenge racialized, monoglossic ideologies and school-based language hierarchies, Mina positions language itself as a site of disruption and transformation.

Vita's Vignette

Vita is an Assistant Professor at a large R1 university in the midwestern United States. For the last seven years, she has taught elementary science methods to undergraduate preservice teachers pursuing general, bilingual, or ESL certification. In this course, Vita heavily focuses on developing preservice teachers' ability to recognize that scientific fields, schools generally, and science classrooms specifically, are not neutral spaces politically, linguistically, or culturally. She aims to shed light on how these spaces have histories of discrimination and are involved in the "production and policing of raciolinguistic hierarchies." Specifically, Vita wants preservice teachers to understand science as a tool that can be repurposed for justice-oriented ends, a task she believes can only be accomplished after unpacking assumptions and pervasive ideas that individuals hold about what counts as science. She grounds her science methods course in different frameworks that are aligned with her course objectives, including: Justice-

Centered Pedagogy (Morales-Doyle, 2017), Ambitious Science Teaching (Windschitl et al., 2020), and Interpretive Power (Rosebery & Warren, 2008). Vita self-identifies as "somewhat" bilingual, having studied Spanish and lived in Spain for a short time. She is also deeply focused on challenging cultural and linguistic norms in science education, and is intentional about addressing in her methods course how these issues remain hidden.

I want preservice teachers in my science methods course to develop critical analytical skills that enable them to recognize that schools and science classrooms have historically been, and continue to be, discriminatory places. During the first week of the class, preservice teachers read a bilingual book, 'The Water Walker' (Robertson, 2021), and an environmental justice comic named 'Mayah's Lot' (Bratspies, 2019). I intentionally chose these two texts for numerous reasons, including: to challenge their assumption about this course, to begin helping them see the connections between language and science, to prompt them to reflect on their own experiences as science learners, and to trouble the notion of someone identifying as "linguistically normal" ***(Approach 1)****. Throughout this course, preservice teachers have opportunities to critically analyze science curriculum to identify the problematic ways that those materials center monolingual, English resources and practices* ***(Approach 1).*** *Once preservice teachers are able to recognize those issues, they begin to learn about translanguaging pedagogy and why it is important for them to develop science lessons and unit plans that integrate it to disrupt raciolinguistic hierarchies and decenter English* ***(Approaches 1 & 3)****.*

Before delving into how to design just science instruction, I engage preservice teachers in discussions around terms commonly placed on students. We spend time unpacking the terms English learner, emerging bilingual, and multilingual learner, and importantly, we discuss how taking up asset-oriented terminology does not imply changes to these students' science learning experiences (González-Howard & Suárez, 2021); those instructional changes need to be intentional and come from teachers ***(Approaches 1 & 2)****. To support this message, preservice teachers co-design and implement an activity called a 'Science Talk' (Rosebery & Warren, 2008) in their placement sites. This mini-lesson involves preservice teachers engaging a small group of multilingual learners around a science topic of their choosing while intentionally using the space to elicit learners' full language repertoires for sensemaking* ***(Approach 3)****. After, preservice teachers critically reflect on whether there were moments during which they opened, or limited, students' sensemaking, a reflection that pushes them to consider issues of power, equity, inclusivity, and the diverse assets multilingual learners bring to school* ***(Approaches 3 & 5)****.*

I intentionally dedicate time and space in my methods course for preservice teachers to consider the nuances of language and translanguaging in teaching and learning science. For example, I show them classroom videos of a local Black science teacher, who breaks down assumptions about African-American vernacular English ***(Approach 1)****. I also invite an expert in bilingual education to attend my course, so that preservice teachers have an opportunity to engage in critical conversation around questions they have pertaining to multilingual learners, and the ways that schooling systems are currently structured to support them. After these kinds of experiences, they unpack "assumptions about language" and language-minoritized learners that they might hold (or held)* ***(Approaches 1, 2 & 5)****. Over the years, I have found that it is not*

uncommon for some preservice teachers to say that while they find the translanguaging strategies they are learning to be helpful, they do not always find them necessary because "I do not have any multilingual students in my class." When such comments arise, I have learned to push back and respond, "if you're in a room of all students who have been taught to think of themselves as … white and monolingual, then continuing to present science to them in a way that is just English monolingualism is also reinforcing an inaccurate representation of who scientists are and how science is communicated." ***(Approaches 1, 2 & 5)***.

This second vignette also illustrates a science methods course that is deeply rooted in equity, justice, and reform-oriented science teaching. Moreover, Vita is strongly intentional about her science methods course being a space where preservice teachers develop critical analytical skills that enable them to recognize and push back against pervasive discriminatory practices in schools, especially those related to students' use of language for sensemaking. In particular, the last quote in the vignette captures the ways that she helps all preservice teachers (especially those who identify as White and monolingual) to realize that when they are taught science solely through English, it reinforces a narrow and inaccurate image of both scientists, scientific sensemaking, and scientific communication. Vita's final comment also underscores the importance of disrupting monolingual norms in science education to reflect the diversity of language resources and practices within the scientific community.

Concluding Remarks and Reflection

As science teacher educators, we have an opportunity to reshape how future teachers understand language, learning, and equity in science education (González-Howard, Méndez Pérez, Andersen, Robinson & Garza, 2025; Luft & Jones, 2022; Underwood & Mensah, 2018). The approaches and practices shared in this article demonstrate how language-expansive pedagogy (González-Howard, Andersen, Méndez Pérez & Suárez, 2023) — which needs to start during teacher preparation — can open generative possibilities for more inclusive, critical, and responsive science teaching with multilingual learners. While grounded in the work of a small group of science teacher educators, these cases offer productive insights into how STEs are challenging dominant, monolingual, and raciolinguistic ideologies (Flores & Rosa, 2015; Lemmi et al., 2019) and point to important directions for continued learning and inquiry in this emergent area of research. From creating opportunities for preservice teachers to reflect upon their own experiences with language and science (González-Howard, Méndez Pérez & Andersen, 2024; Venegas-Weber & Thompson, 2025), to centering multilingualism for more authentic representation of the discipline (Roberts et al., 2016; Rutt et al., 2021) to engaging preservice teachers in the multimodal realities of scientific inquiry and sensemaking (González-Howard, Robinson, Andersen, Vazquez & Rodriguez, 2025; Grapin, 2019) we can make clear and strong the stance that language is not a barrier to overcome, but a deeply nuanced and complex resource to honor and leverage (Lee & Grapin, 2025; Venegas-Weber et al., 2024). These approaches not only affirm the linguistic and cultural identities of multilingual learners but also expand what counts as rigorous science teaching and learning for the benefit of all students (Bravo et al., 2014; García et al., 2017; Lee et al., 2014).

Similar to how we found many language-expansive STEs to work with their preservice teachers, we conclude this piece with some questions for the reader to ponder. Specifically, as you reflect on the teacher preparation program in which you work, and the science methods courses that you teach, we invite you to consider: *What are my own language orientations around science, and how have they been shaped by my experiences with language and science education? How do my course materials, assignments, or assessments reflect (or resist) dominant notions of language in science? What shifts might I make to better center multilingual, multimodal, and culturally sustaining practices in my methods course?* As illustrated by Vita's reflection at the opening of this manuscript, such questions are not abstract exercises but generative entry points through which science teacher educators come to recognize tensions in their practice and experiment with concrete shifts in how they design and enact their science methods courses. By honestly considering and reacting to these questions, we can work collectively to prepare preservice teachers who not only recognize but actively disrupt inequitable language norms in science education — making space for all students to fully and authentically participate in scientific sensemaking.

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References

Andersen, S., Méndez Pérez, K. & González-Howard, M. (2022). Reimagining science lessons through translanguaging: Supporting multilingual students' scientific sensemaking in the context of science and engineering practices. *Science Scope, 46(*2), 25-31.

Athanases, S. Z., & Oliveira, L., C., D. (2010). Toward program-wide coherence in preparing teachers to teach and advocate for English language learners. In *Teacher preparation for linguistically diverse classrooms* (pp. 215-235). Routledge.

Bratspies, R. M. (2019). Mayah's Lot: Teaching Environmental Justice With Comic Books. *Forthcoming chapter in The Media Method: Teaching Law With Pop Culture (Christine A. Corcos, ed.)*.

Bravo, M. A., Mosqueda, E., Solís, J. L., & Stoddart, T. (2014). Possibilities and limits of integrating science and diversity education in preservice elementary teacher preparation. *Journal of Science Teacher Education*, *25*(5), 601-619.

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.

Flores, N., & Rosa, J. (2015). Undoing appropriateness: Raciolinguistic ideologies and language diversity in education. *Harvard educational review*, *85*(2), 149-171.

García, O. (2011). Bilingual education in the 21st century: A global perspective. John Wiley & Sons.

García, O., Flores, N., Seltzer, K., Wei, L., Otheguy, R., & Rosa, J. (2021). Rejecting abyssal thinking in the language and education of racialized bilinguals: A manifesto. *Critical inquiry in language studies*, *18*(3), 203-228.

García, O., Johnson, S. I., Seltzer, K., & Valdés, G. (2017). *The translanguaging classroom: Leveraging student bilingualism for learning*. Philadelphia, PA: Caslon.

González-Howard, M., Andersen, S., Garza, L. & Tasnim, N. (Accept with Major Revisions). "I am still wrestling with how to bring this perspective on language to bear in my role": Science teacher educators' language orientations for scientific sensemaking. *Science Education.*

González-Howard, M., Andersen, S., Méndez Pérez, K. & Robinson, C. (2024, March 17 - 20). *Conceptualizing and measuring pedagogical content knowledge of language for scientific sensemaking.* [Paper presentation]. National Association for Research in Science Teaching Annual Conference, Denver, CO.

González-Howard, M., Andersen, S., Méndez Pérez, K. & Suárez, E. (2023). Language views for scientific sensemaking matter: A synthesis of research on multilingual students' experiences with science practices through a translanguaging lens. *Educational Researcher, 52*(9), 570-579*.*

González-Howard, M., Garza, L. & Tasnim, N.(2026, April 19 - 22). *Exploring science teacher educators' language orientations and their approaches for teaching science with multilingual learners.* [Paper to be presented]. National Association of Research in Science Teaching, Seattle, WA.

González-Howard, M., Méndez Pérez, K. & Andersen, S. (2024). Learning to notice multilingual students' language use for scientific sensemaking: Integrating translanguaging theory and pedagogy in an elementary science methods course. In O. Andrews & A. Tomlin (Eds.), *When We Hear Them: Attuning Teachers to Language Diverse Learners.* Charlotte, NC: Information Age Publishing. (pp. 213-226).

González-Howard, M., Méndez Pérez, K. M., Andersen, S., Robinson, C., & Garza, L. (2025). Collective (Un) Learning: A Self-Examination of Science Teacher Educators' Evolving Translanguaging Pedagogy for Eliciting and Elevating Student Ideas. *Science Education*.

González-Howard, M., Andersen, S., Méndez Pérez, K., & Lee, S. (2024). Re-imagining science education research toward a language for science perspective. *Cultural Studies of Science Education, 19*(2), 287-293.

González-Howard, M., Robinson, C., Andersen, S., Vazquez, M., & Rodriguez, N. (2025). Developing prospective teachers' language-expansive noticing: Attuning to multilingual students' scientific sensemaking during interactive science interviews. *Science and Children, 62(5), 26-32.*

González-Howard, M., & Suárez, E. (2021). Retiring the term English language learners: Moving toward linguistic justice through asset-oriented framing. *Journal of Research in Science Teaching*, *58*(5).

Grapin, S. (2019). Multimodality in the new content standards era: Implications for English learners. *TESOL Quarterly, 53*(1), 30-55.

Grapin, S. E., Pierson, A., González-Howard, M., Ryu, M., Fine, C., & Vogel, S. (2023). Science education with multilingual learners: Equity as access and equity as transformation. *Science Education*, *107*(4), 999-1032.

Grapin, S. E., Ramos Borrego, M., & Navarro, V. G. (2025). Translanguaging in US K–12 science and engineering education: A review of the literature through the lens of equity. *Journal of Research in Science Teaching, 62*(1), 15–48.

Jung, K. G., & Brown, J. C. (2016). Examining the effectiveness of an academic language planning organizer as a tool for planning science academic language instruction and supports. *Journal of Science Teacher Education*, *27*(8), 847-872.

Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, *72*(12), 2954-2965.

Langer, P. C. (2016). The research vignette: Reflexive writing as interpretative representation of qualitative inquiry—A methodological proposition. *Qualitative Inquiry*, *22*(9), 735-744.

Learning in Places Collaborative (2021). Classroom storyline. Learning in Places website. https://learninginplaces.org

Lee, O. (2021). Asset-oriented framing of science and language learning with multilingual learners. *Journal of Research in Science Teaching*, *58*(7), 1073-1079.

Lee, O., & Grapin, S. (2025). Justice-centered STEM education with multilingual learners to address societal challenges: A conceptual framework. *Journal of Research in Science Teaching*, *62*(5), 1202-1231.

Lee, O., Miller, E. C., & Januszyk, R. (2014). Next generation science standards: All standards, all students. *Journal of Science Teacher Education*, *25*(2), 223-233.

Lee, O., & Stephens, A. (2020). English learners in STEM subjects: Contemporary views of STEM subjects and language with English learners. *Educational Researcher*, *49*(6), 426-432.

Lemmi, C., Brown, B. A., Wild, A., Zummo, L., & Sedlacek, Q. (2019). Language ideologies in science education. *Science Education*, *103*(4), 854-874.

Lowell, B. R. (2024). The student hat in professional development: Building epistemic empathy to support teacher learning. *Science Education*, *108*(2), 581-607.

Lucas, T., & Villegas, A. M. (2013). Preparing linguistically responsive teachers: Laying the foundation in preservice teacher education. *Theory into practice*, *52*(2), 98-109.

Luft, J.A., & Jones, M.G. (Eds.). (2022). Handbook of Research on Science Teacher Education (1st ed.). Routledge.

Lyon, E. G., Stoddart, T., Bunch, G. C., Tolbert, S., Salinas, I., & Solis, J. (2018). Improving the preparation of novice secondary science teachers for English learners: A proof of concept study. *Science Education*, *102*(6), 1288-1318.

Marchant, C. N. G., Gutiérrez, G. S., Johnson, A. R., Aguilar, A. R., Méndez Pérez, K. M., & Baniahmadi, M. (2024). The Rodrigo & Luz Chronicles. *Journal Committed to Social Change on Race and Ethnicity (JCSCORE)*, *10*(2), 44-64.

Méndez Pérez, G., González-Howard, M., & Suárez, E., (2025). Bienvenidos a la conversación: Examinations of translanguaging across science and engineering education research. *Journal of Research in Science Teaching, 62*(1), 3-14.

Miles, M., Huberman, A. M., & Saldaña, J. (2020). Qualitative data analysis: A methods sourcebook (4th ed.). Thousand Oaks, CA: Sage Publications.

Miller, E., Manz, E., Russ, R., Stroupe, D., & Berland, L. (2018). Addressing the epistemic elephant in the room: Epistemic agency and the next generation science standards. *Journal of Research in Science Teaching*, *55*(7), 1053-1075.

Morales-Doyle, D. (2017). Justice-centered science pedagogy: A catalyst for academic achievement and social transformation. *Science Education*, *101*(6), 1034-1060.

Morales-Doyle, D., & Frausto, A. (2021). Youth participatory science: A grassroots science curriculum framework. *Educational Action Research*, *29*(1), 60-78.

Nasir, A., & Heineke, A. J. (2014). Teacher candidates and Latina/o English learners at Fenton elementary school: The role of early clinical experiences in urban teacher education. *Association of Mexican American Educators Journal*, *8*(1). 60-71

National Academies of Sciences, Engineering, and Medicine. (2018). *English learners in STEM subjects: Transforming classrooms, schools, and lives*. Washington, DC: The National Academic Press.

NGSS Lead States. (2013). Next Generation Science Standards: For states, by states. Washington, DC: National Academies Press. http://www.nextgenscience.org/ next-generation-science-standards

Otheguy, R., García, O., & Reid, W. (2015). Clarifying translanguaging and deconstructing named languages: A perspective from linguistics. *Applied linguistics review*, *6*(3), 281-307.

Pierson, A. E., & Grapin, S. E. (2021). A disciplinary perspective on translanguaging. *Bilingual Research Journal*, *44*(3), 318-334.

Roberts, S. A., Bianchini, J. A., Sook Lee, J., Hough, S., & Carpenter, S. L. (2016). Developing an adaptive disposition for supporting English language learners in science: A capstone science methods course. In A. W. Oliveira & M. H. Weinburgh (Eds.), *Science teacher preparation in content-based second language acquisition* (pp. 79–95). New York: Springer.

Robertson, J. (2021). *The water walker*. Second Story Press.

Rosebery, A. S., & Warren, B. (Eds.). (2008). *Teaching science to English language learners: Building on students' strengths*. NSTA Press.

Rutt, A., Mumba, F., & Kibler, A. (2021). Preparing preservice teachers to teach science to English learners: A review. *Journal of Research in Science Teaching*, *58*(5), 625-660.

Sedlacek, Q. C., Lemmi, C., Feldman, K., Ortiz, N., & León, M. (2025). African American Language in science education: A translanguaging perspective. *Journal of Research in Science Teaching, 62*(1), 228-269.

Suárez, E. (2020). "Estoy Explorando Science": Emergent bilingual students problematizing electrical phenomena through translanguaging. *Science Education*, *104*(5), 791-826.

Suárez, E., & Otero, V. (2024). Ting, tang, tong: Emergent bilingual students investigating and constructing evidence-based explanations about sound production. *Journal of Research in Science Teaching*, *61*(1), 137-169.

Takeuchi, M. A., Kayumova, S., de Araujo, Z., & Madkins, T. C. (2022). Going beyond# RetireELL: A call for anti-colonial approaches to languages in STEM education. *Journal of Research in Science Teaching*, *59*(5), 876.

Underwood, J. B., & Mensah, F. M. (2018). An investigation of science teacher educators' perceptions of culturally relevant pedagogy. *Journal of Science Teacher Education*, *29*(1), 46-64.

Walker, C. L., & Stone, K. (2010). Preparing teachers to reach English language learners: Pre service and in-service initiatives. In T. Lucas (Eds.), *Teacher preparation for linguistically diverse classrooms* (pp. 127–142). New York: Routledge.

Warren, B., Vossoughi, S., Rosebery, A. S., Bang, M., & Taylor, E. V. (2020). Multiple ways of knowing: re-imagining disciplinary learning. In the *Handbook of the Cultural Foundations of Learning* (1st ed., Vol. 1, pp. 277–294). Routledge.

Wei, L. (2018). Translanguaging as a practical theory of language. *Applied linguistics*, *39*(1), 9-30.

Wei, L., & García, O. (2022). Not a first language but one repertoire: Translanguaging as a decolonizing project. *RELC Journal*, *53*(2), 313-324.

Wilson-Lopez, A., & Hasbún, I. M. (2023). Countering science as White property through linguistic justice. *Journal of Research in Science Teaching*, *60*(3), 675-677.

Windschitl, M., Thompson, J., & Braaten, M. (2020). *Ambitious science teaching*. Harvard Education Press.

Woodard, R., & Rao, A. (2020). Tensions and possibilities in fostering critical language ideologies in elementary teacher education. *Studying Teacher Education, 16*(2), 183-203.

Venegas-Weber, P., Betancourt, C., Gonzales, G. C., Thompson, J., Varghese, M., & Li, H. J. (2024). Broadening what counts as science: Developing teacher candidates' translanguaging stances in their teacher education program towards translingual, multimodal, interdisciplinary, and justice-centered elementary science practices. *Teaching and Teacher Education*, *148*, 104662.

Venegas-Weber, P., & Thompson, J. (2025). Bilingual, Black, Indigenous, and People of Color teacher candidates' translanguaging selves: Working with their multilingual assets and identities as future elementary science teachers. *Journal of Research in Science Teaching*, *62*(1), 163-192.

Zeichner, K. (2005). Becoming a teacher educator: A personal perspective. *Teaching and Teacher Education*, *21*(2), 117-124.

