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COMMENT

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Asset-oriented framing of science and language learning with multilingual learners

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A science teacher plans her science instruction with the vision of "all standards, all students." She wants to reach all of her students, including her increasing number of multilingual learners (MLs). The ML specialist at her school advises her to preteach and frontload vocabulary with MLs. However, the science teacher realizes that preteaching and frontloading of vocabulary with MLs is inconsistent with the vision of engaging all students, including MLs, in making sense of phenomena and problems as scientists and engineers do in their professional work. In addition, she recognizes her MLs contribute to class discourse using multiple modalities despite their less-than-perfect English.

A science education researcher sets out her research with the vision of "all standards, all students." She wants to frame her research around the increasing number of MLs in her school district and state. She knows that since the 1990s, the science education community has been reframing conceptions of what counts as science and how children learn science. She also knows that there is a consensus on the current science standards among policy, research, and practice and that these standards have been widely adopted or adapted across most of the states in the nation. Expecting ML education to be comparable to science education, she is looking for research synthesis and English language proficiency standards that reflect a consensus across the ML community. However, she cannot find either. The ML researchers at her institution respond that there has been no concerted effort to develop a consensus in the ML community.

The vision of A Framework for K-12 Science Education (National Research Council, 2012) and the Next Generation Science Standards (NGSS; NGSS Lead States, 2013b) requires the shift from traditional to contemporary approaches of science instruction along with the shift from a deficit-oriented view to an asset-oriented view of students. This vision began preparing the science education community for what will be the new normal following the COVID-19 pandemic in which science education should play key roles in identifying and addressing inequity in society. Currently, the new Administration is focusing on seven "immediate priorities," including three centered on science (i.e., COVID-19, climate, and healthcare) and two centered on equity (i.e., racial equity and immigration; https://www.whitehouse.gov/priorities/). Thus, the Administration places science and equity at the core. In addition, the Department of Education highlights equity for all students as a priority. Collectively, these priorities focusing on science and equity require dramatic changes in the education system and society.

Educational policies and practices with racial and linguistic minority students were traditionally framed in terms of what the students are lacking and how to fix this problem (a deficit-oriented view). In recent years, there have been growing efforts to reframe educational policies and practices so that the education system capitalizes on the resources that all students bring to the classroom (an asset-oriented view).

The education of MLs in content areas is a prime case of this shift from a deficit-oriented view to an asset-oriented view (González-Howard & Suárez, 2021; Lee et al., 2013; National Academies of Sciences, Engineering, and Medicine [NASEM], 2018; also see Rivera Maulucci & Mensah, 2015). Traditional approaches to ML education in the content areas focused on what MLs are lacking (i.e., English language proficiency) and how to fix this problem, for example, by preteaching and frontloading vocabulary as a precursor or prerequisite for MLs to participate in content area learning. Contemporary approaches, however, are shifting the focus to meaning-making resources that MLs bring to the classroom, for example, by engaging MLs in disciplinary practices and providing them with opportunities to use language and communicate disciplinary meaning regardless of their English language proficiency. Traditional approaches based on a deficit-oriented view embodied linguistically marginalizing pedagogy or linguistic inequity pedagogy, whereas contemporary approaches based on an asset-oriented view represent linguistically sustaining pedagogy or linguistic equity pedagogy (Paris, 2012).

The purpose of this commentary is two-fold: (a) to contrast contemporary asset-oriented perspectives with traditional deficit-oriented perspectives across policy, research, and practice and (b) to call on the science education research community to collaborate with the ML education community. In the literature, contemporary asset-based perspectives on science and language learning with MLs are only beginning to emerge. The science education research community, in collaboration with the ML education community, should embrace this call to reframe the research agenda. A research base that promotes linguistically sustaining pedagogy could guide educational policies and practices to reimagine what is possible to both support and challenge MLs as they engage in rigorous science learning and rich language use.

1 | CONTEMPORARY POLICY PERSPECTIVES

There have been parallel shifts in policy perspectives on content standards and English language proficiency standards with MLs. In science education, there is consensus among policymakers, researchers, and practitioners with regard to what counts as science and how K-12 students learn science based on the research synthesis in the *Framework*. Moreover, the *Framework* and the NGSS have been adopted or adapted by 44 states (https://ngss.nsta.org/About.aspx). Central to the vision of the *Framework* and the NGSS are three instructional shifts as students (a) make sense of phenomena and problems, (b) engage in three-dimensional learning, and (c) develop coherent learning progressions over time.

Science standards are expected of all students, thus, “all standards, all students” (NGSS Lead States, 2013a). The *Framework* and the NGSS place equity at the center, and traditional approaches to science learning are giving way to contemporary approaches. Traditionally, scientists and science teachers defined canonical knowledge of science disciplines, which was typically presented in science textbooks. Science knowledge in textbooks privileged literacy, which served as a de facto precursor or prerequisite to learn science. Some students learned science, but science did not make sense to many students, especially those with emerging literacy in English, including MLs. In contemporary approaches, all students make sense of phenomena and design solutions to problems as scientists and engineers do in their professional work. Based on an asset-oriented view, MLs, like all other students, are expected to meet science standards.

In ML education, the Every Student Succeeds Act of 2015 mandates that "the State has adopted English language proficiency standards that are aligned with the challenging State academic standards" (U.S. Department of Education, 2015, p. 24). The direction of this relationship calls for "language proficiency standards [to] align to content standards and not the other way around" (NASEM, 2018, p. 10). This means that "the language to be learned needs to focus on the important STEM content and what is known about how children learn STEM content" (NASEM, 2018, p. 10). Moreover, federal legislation makes clear that "language proficiency is not a prerequisite for content instruction, but an outcome of effective content instruction" (NASEM, 2018, p. 10). Based on an asset-oriented view, MLs are expected to engage in learning science regardless of their English language proficiency.

2 | CONTEMPORARY THEORETICAL PERSPECTIVES

There have been parallel shifts in theoretical perspectives on science learning and language learning with MLs. In science learning, traditional perspectives focused on individual learners' mastery of discrete elements of science content, whereas contemporary perspectives emphasize that students make sense of phenomena and problems as scientists and engineers do in their professional work (National Research Council, 2012). Because contemporary perspectives involve using and applying knowledge for a particular purpose, they have been referred to as *knowledge-in-use* (Harris et al., 2016). In ML education, traditional perspectives focused on discrete elements of vocabulary (lexicon) and grammar (syntax) to be internalized by individual learners, whereas contemporary perspectives emphasize that language is a set of meaning-making practices learned through participation in social contexts (Larsen-Freeman, 2007; Valdés, 2015). Because contemporary perspectives involve using language for a particular purpose, they have been referred to as *language-in-use* (Lee et al., 2013). Based on an asset-oriented view, MLs engage in rigorous science learning and rich language use through the mutually supportive nature of science and language learning (NASEM, 2018).

As MLs engage in science and engineering practices (e.g., developing models, arguing from evidence, and constructing explanations), they use language for the purpose of making sense of phenomena and problems through interactions with peers and the teacher. MLs use language and other meaning-making resources purposefully while "doing" science and communicating ideas about science (González-Howard & McNeill, 2016; Lee et al., 2013; Swanson et al., 2014). The focus is on "what language does" (i.e., functional use of language for a purpose), beyond "what language is" (i.e., structural elements of language, including vocabulary and grammar; Grapin et al., 2019). Based on an asset-oriented view, MLs use multiple meaning-making resources to communicate their increasingly precise ideas about science over the course of instruction (e.g., see NASEM, 2018, Box 3-1 on pp. 64–65).

3 | CONTEMPORARY PEDAGOGICAL PERSPECTIVES

Several instructional approaches are described to illustrate the deficit-oriented view underlying traditional approaches and the asset-oriented view of contemporary approaches (Lee & Stephens, 2020; NASEM, 2018). First, traditional sheltered instruction with MLs often provided highly simplified content that seldom satisfied grade-level content expectations. This approach failed to meet the goals of content standards that are expected of all students, including MLs. In addition, simplification of language, coupled with simplification of content, can have unintended consequences for MLs. For example, as cause and effect is a crosscutting concept across science disciplines, shortening a sentence by eliminating words that establish a causal relationship (e.g., because, therefore) can actually make it more difficult for MLs to learn disciplinary content (Davison & Kantor, 1982). Instead, contemporary approaches highlight amplifying language to both support and challenge MLs with academically rigorous content (Bunch, 2014; Walqui & Bunch, 2019). While traditional approaches brought the text, task, and activity "down" to the English language proficiency of MLs (i.e., simplifying), contemporary approaches bring MLs "up" to the academic rigor of the text, task, and activity (i.e., amplifying).

Traditional approaches contended that (a) a certain level of English language proficiency was a precursor or prerequisite to meaningfully engage in content area learning; (b) MLs had to be proficient in English before they could be successful in content area classrooms; and (c) for participation in content area classrooms, MLs first needed to have proficiency in disciplinary talk—vocabulary words and definitions. These approaches led to preteaching and frontloading of vocabulary as a precursor or prerequisite to learn science. Instead, contemporary approaches recognize that language is a product of interaction and learning and highlight using language for a particular purpose.

Finally, traditional approaches viewed disciplinary vocabulary as disciplinary language. For example, there was much focus on tiered vocabulary words (Beck et al., 1983; Beck & McKeown, 2007) or lists of academic vocabulary words (Coxhead, 2000). While contemporary approaches recognize that disciplinary vocabulary is one key feature of disciplinary language when the vocabulary is used in context, language in science disciplines extends far beyond vocabulary. MLs use multiple *modalities*, including both linguistic modalities (i.e., listening, speaking, reading, and writing) and nonlinguistic modalities (e.g., embodiments, gestures, tables, graphs, and diagrammatic or computational models). Multimodality, especially nonlinguistic modalities, is essential to doing science and especially beneficial to MLs (Ryoo & Bedell, 2018; Zhang, 2015). Based on an asset-oriented view, recognizing the importance of multimodality reorients the focus from what MLs lack in terms of language to the various meaning-making resources they bring to the science classroom (Grapin, 2019). In addition, MLs draw on a variety of *registers*, ranging from everyday to specialized language. Specialized registers afford the precision necessary to communicate disciplinary meaning (Brown et al., 2019; Grapin et al., 2019). Precision "goes beyond science vocabulary" (NASEM, 2018, p. 65) and "privileges disciplinary meaning by focusing on how students use language to engage in the STEM disciplinary practices" (NASEM, 2018, pp. 77–78). MLs can communicate precise disciplinary meaning using less-than-perfect English. Based on an asset-oriented view, "language is a product of doing science, not a precursor or prerequisite for doing science and MLs need ample opportunities to do science" (NASEM, 2018, p. 65).

Contemporary instructional approaches highlight two key features. First, these approaches begin with science and then use language needed to learn science. They both support and challenge MLs as they make sense of phenomena and problems, while amplifying language as MLs engage in disciplinary practices and discourse. Second, the emphasis on language use to learn science from the disciplinary perspective is a shift from the emphasis on vocabulary and grammar as a precursor or prerequisite to learn science from the language perspective.

4 | CALL FOR ACTION

With the vision of "all standards, all students" (NGSS Lead States, 2013a), contemporary approaches to science learning hold equitable expectations of all students. From policy, theoretical, and pedagogical perspectives, contemporary approaches to science and language learning with MLs are mutually supportive of each other. This commentary advocates for an equity viewpoint by calling on science education researchers to move away from linguistically marginalizing pedagogy based on a deficit-oriented view and toward linguistically sustaining pedagogy based on an asset-oriented view.

It is noted that unlike the science education community with its consensus across policy, research, and practice on what counts as science and how children learn science, the ML education community has not developed a consensus on what language is and does and how language is learned. Currently, there are multiple sets of English language proficiency standards, multiple theoretical perspectives, and multiple instructional approaches in ML education (Lee, 2018). This lack of consensus in ML education presents challenges for collaboration with science education and other content areas. Despite these challenges, the science education research community should embrace the call to reframe the research agenda. Science education researchers should intentionally and explicitly map out where and how to look for resources, both disciplinary and linguistic, that MLs bring to the science classroom. This research agenda could be framed in terms of the three instructional shifts that are central to the vision of the *Framework* and the NGSS and the affordances of these shifts for language use with MLs (Buxton & Caswell, 2020).

The first instructional shift involves all students, including MLs, making sense of phenomena and designing solutions to problems as scientists and engineers do in their professional work. The research agenda could address the role of phenomena and problems that capitalize on MLs' science experience and language use and provide affordances for MLs to learn science and language. As one approach, local phenomena and problems rooted in everyday experiences could be compelling to students to figure out, give a purpose to their science learning, provide a reason to communicate ideas with peers and the teacher, and help students take agency in their own learning (Lee, 2020). Moreover, local phenomena help students, including MLs, see the relevance of science to their everyday lives and future careers.

The second instructional shift involves all students, including MLs, engaging in three-dimensional learning to make sense of phenomena and problems. As they "do" science, they use language. While communicating ideas about science with peers and the teacher, students use multiple modalities, including both linguistic and nonlinguistic modalities (Grapin, 2019). They also use registers, ranging from everyday to specialized registers (Brown et al., 2019; Grapin et al., 2019). The research agenda could address how three-dimensional learning provides opportunities for MLs to use multiple modalities (e.g., develop models) and specialized registers to communicate precise disciplinary meaning using less-than-perfect English.

Finally, the third instructional shift involves all students, including MLs, developing coherent learning progressions over time. To communicate the sophistication of their ideas about science over the course of instruction, MLs use multiple modalities more strategically along with more specialized registers. The research agenda could address how sophisticated understanding of science and specialized use of language progress over the course of instruction.

A research agenda to promote linguistically sustaining pedagogy could guide educational policies and practices to reimagine what is possible to both support and challenge MLs to engage in rigorous science learning and rich language use. This could be reinforced by several key factors in the science education community, including (a) a conceptual grounding for what science is and how K-12 students learn science based on the *Framework*; (b) consensus among policymakers, researchers, and practitioners regarding classroom implementation of the NGSS; and (c) the scale of implementation throughout the education system based on adoption and adaptation of the *Framework* or the NGSS by most of the states across the nation. Science education researchers, in collaboration with ML educators, could develop a research base that helps educational policymakers and practitioners create science classrooms centered around equity so that all students, including MLs, are fully engaged in learning science through linguistically sustaining pedagogy.

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