ENGLISH LEARNERS SUCCESS FORUM

# Guidelines for Improving Science and Engineering Materials for Multilingual Learners

## Our Mission and Vision

Our mission is to expand educational equity for multilingual learners by increasing the supply of high-quality instructional materials that center their cultural and linguistic assets. This is in service of our vision to ensure every multilingual student engages in learning that allows them to thrive academically and choose their path for success.


### Acknowledgements

Nationally-recognized science and language experts and practitioners with extensive classroom experience developed these Guidelines to increase student access to high quality, standards-aligned instructional materials. The English Learners Success Forum would like to thank the following individuals for contributing to the creation and refinement of this document: Rebecca Abbott, Mary Avalos, Cathay Bhathena Fuller, Marco Bravo, Gina N. Cervetti, Vinci Daro, Caitlin Fine, Scott Grapin, Matt Krehbiel, Preetha Menon, Emily Adah Miller, Meredith Moran, Melissa Navarro, Helen Quinn, Jorge L. Solis, Enrique (Henry) Suárez, Sara Tolbert, Jeff Zwiers. We are also grateful to have received input and constructive feedback from our partners at HHMI BioInteractive. A special thanks to the writing team at ELSF–Lauren Stoll, Cathy Zozakiewicz, Ari Jamshidi, and Monica McNeely–as well as internal reviewers–Joanna Yip, Renae Skarin, and Jim Malamut.

# About the ELSF Guidelines

## Introduction

The ***Guidelines for Improving Science and Engineering Materials for Multilingual Learners*** (the Guidelines) were developed by experts in the field to provide specific guidance on essential characteristics and features of curricula (embedded in units, lessons, and teacher support materials) so that multilingual learners (MLLs) can thrive socially, emotionally, and academically. Instructional materials that follow these Guidelines have the potential to transform classrooms into rich language learning environments that promote three-dimensional learning by leveraging students' experiences and cultures using linguistically-responsive supports. ELSF believes that a curriculum reflecting these research-informed Guidelines will provide the necessary foundation for the simultaneous development of science and engineering practices, disciplinary core ideas, and crosscutting concepts, along with language and literacy for multilingual learners.

## Theoretical Underpinnings for the Science Guidelines

The *Framework for K–12 Science Education* outlines a new vision of three-dimensional science learning that foregrounds equity and prioritizes promoting scientific literacy for all (NRC, 2012, p.277). This vision articulates goals that are language-intensive and thus offers rich opportunities for language use and learning when well supported. Building on the *Framework*, the ELSF Guidelines prioritize science sensemaking to ensure that language is used for the purpose of making meaning and communicating about science ("language for use") (Lee, Quinn, & Valdes, 2012). In alignment with this vision of science and engineering learning, the Guidelines integrate the three dimensions of the *Framework* –science and engineering practices, disciplinary core ideas, and crosscutting concepts–as well as a focus on phenomena. Throughout the Guidelines these are often referred to as *science learning, three-dimensional, or the three dimensions.*

We acknowledge that there are diverse perspectives in the field on what is meant by "language" in the science classroom. Previous attempts to incorporate language instruction into science classrooms focused heavily on "scientifically accurate" ways of communicating in English and led to instructional strategies like pre-teaching vocabulary before students engage in science sensemaking. ELSF's approach shifts away from a focus on precise language as a prerequisite for participation and towards supporting students in negotiating and communicating meaning in science classrooms (Grapin et al., 2019). Thus, these Guidelines reflect the belief that the language for doing science involves multiple ways of using language (Suarez, 2020) and acknowledges that science does not only exist in English. This includes the commonplace and home language students bring as well as the specialized language commonly used in the international science community (Lee et al., 2019).

Mirroring this shift, there has been a call in recent years to retire the terms *English Learner* (EL) and *English Language Learner* (ELL) in order to "challenge the privileging of English and recognize the rich resources students bring to schools" (González-Howard, Suárez, & Grapin, 2021). While many policy documents, including the 2015 *Every Student Succeeds Act*, still use these terms, we intentionally use the term *multilingual learner* in these Guidelines to support this asset-based perspective.

The goal of these Guidelines is to value, leverage, and build upon students' existing language resources to expand their linguistic repertoire, rather than replace their existing language. ELSF believes this is in service of equity for multilingual learners in several ways: 1) it acknowledges and values the meaning-making resources that multilingual students bring, 2) it avoids excluding multilingual learners from science learning because they have not yet developed technical English fluency, and 3) it expands their linguistic resources so students can make choices to use specialized language for specific purposes and audiences. It is important to emphasize that for the latter, the goal is not assimilation but rather promoting students' linguistic agency.

These Guidelines expand our definition of language and our ideas of how language can be leveraged to increase engagement with sensemaking in science classrooms. Here we move away from the language *of* science learning–which reflects the binary distinction between everyday and disciplinary language–and toward language *for* science learning, or the language students use to engage in sensemaking around scientific phenomena. This approach to incorporating language instruction into science classrooms benefits *all* students.

## Why This Work Matters

It is estimated that nearly 10% of public school students are classified as English Learners (ELs) (National Center for Education Statistics, 2019), but less than 20 percent of teachers are certified to teach multilingual learners (National Clearinghouse for English Language Acquisition, 2008) and nearly 70 % do not feel adequately prepared to effectively teach multilingual learners (EdTrust, 2022).

Paired with professional development, quality instructional materials can provide an important form of professional learning for teachers if content developers consider the strengths and needs of multilingual learners as an integral part of their materials development process (Edelson et al, 2021). Since instructional materials are what teachers interface with every day, they have some of the highest potential for impact (Ball & Cohen, 1996). These Guidelines support content developers to take this approach of providing educative support for teachers to reflect and improve on their practice to best serve multilingual learners.

Prior to launching, ELSF interviewed curriculum developers, national language and science experts and practitioners, and organizations advocating for high-quality curriculum to explore why most core K–12 curricular materials are not inclusive of the needs of multilingual learners. Findings reveal a lack of expertise in development staff, little concrete guidance on how to integrate support for multilingual learners within instructional materials, and consultations with experts that offer only a singular perspective and fail to provide reflections from a range of expertise within the MLL instructional community. While MLL experts are willing to support this work, they often receive invitations to collaborate and engage in the process of materials development too late in the process to make a significant contribution and impact.

ELSF was created to address the above challenges directly by:

1) Developing Guidelines that offer "the how" of MLL supports within the context of curricular materials;

2) Working directly with content developers by offering cycles of feedback from experienced MLL experts and practitioners based on the Guidelines; and

3) Sharing our learning through free tools and resources published on our website.

## Who Should Use These Guidelines

ELSF believes these Guidelines will benefit those who play a role in ensuring teachers have access to curricular materials that are high-quality and consider the needs of all students, including multilingual learners. Audiences may include:

- **Content developers**
  Ideally integrated into the design, prototyping, or creation of any new curricula, these Guidelines can be used by any developer of curriculum, which may include **publishers, state education agencies, districts, schools, or teachers**. Additionally, those seeking to **adapt or enhance** current materials to be more inclusive of the needs of multilingual learners can use the Guidelines to self-assess and revise materials to reflect the strategies and practices within each Area of Focus.

- **Professional learning communities**
  ELSF believes content and language learning should be simultaneous. Leaders who are looking for practical ways to support science teachers with multilingual learners in their classrooms could consider using the Guidelines **within professional learning communities** or to ground conversations **within professional learning experiences**.

- **Education leaders considering new curriculum**
  At minimum, each of the Guidelines should be reflected in high-quality core science materials that claim to be inclusive of the needs of multilingual learners. Leaders may use the Guidelines as a tool for reflecting on current support for multilingual learners, finding gaps, and determining appropriate actions to meet the needs of multilingual learners.

One-size-fits-all approaches do not attend to the heterogeneity of the multilingual learner population. To meet the social, emotional and academic needs of multilingual learners, instruction must consider the range of experiences, languages, cultures, and funds of knowledge that students bring to the classroom. In these Guidelines, we provide guidance on how to support teachers in attending to the diverse resources, strengths, and needs that students bring and recognize when and how to strategically implement supports in service of science sensemaking. As such, these Guidelines do not explicitly reference language proficiency and are not intended to replace English Language Proficiency Standards because they are parameters for the design of materials (see the role of ELD standards in content materials). Because states use a variety of frameworks and tests to measure student language proficiency, we suggest that content developers use a variety of frameworks in their curriculum and focus on instruction that provides flexible support according to students' strengths and needs.

# How to Read the Guidelines

## Areas of Focus

The Guidelines are organized into five areas of focus, sequenced intentionally to best support content developers. We present the *Interdependence of Science and Language Learning* first because it lays the foundation and acknowledges the backward design of most instructional materials. We place *Leveraging Students' Assets* next to take the stance that centering students is of the utmost importance and should frame all guidelines from a student-asset perspective. *Assessment for Science and Language Learning* then comes before *Supports and Structures for Science and Language Learning* because if an assessment is used for learning, that assessment should inform the supports and structures students need. Lastly, we conclude with *Metalinguistic and Metacognitive Awareness* which is interwoven throughout the entire design of materials.

## Guidelines and Specifications

The Guidelines in this next section explicitly elevate opportunities for simultaneous development of the three dimensions along with language and literacy in instructional materials. The first table includes an overview of the five science Areas of Focus and the 15 Guidelines, which are intended to be continuously integrated throughout the design of a curriculum.

The subsequent tables provide detailed specifications that accompany each guideline. These specifications include explanations, suggestions, strategies, supports, and examples that demonstrate how the Guidelines can be operationalized in materials development.

Note that the guidelines and specifications will often refer to *materials* and *teacher materials*. We use *materials* when developers can make decisions about whether guidance is best applied to student materials, teacher materials, or both. When the guidance is most applicable to teacher materials, we specify it as *teacher materials*.

*For additional explanation of key terms, please see the Appendix at the end of the Guidelines.*

# The Guidelines

The table below provides a preview of the Areas of Focus and research-informed Guidelines for Science and Engineering materials.

| **Area of Focus I**<br>Interdependence of Science and Language Learning | **Area of Focus II:**<br>Leveraging Students' Assets | **Area of Focus III:**<br>Assessment for Science and Language Learning | **Area of Focus IV:**<br>Supports and Structures for Science and Language Learning | **Area of Focus V:**<br>Metalinguistic and Metacognitive Awareness |
|---|---|---|---|---|
| **1.** Three-dimensional learning goals and pathways that explicitly integrate language and literacy in ways that are meaningful for students and their communities.<br><br>**2.** Sustained opportunities for interactive scientific discussions that develop and refine language for science sensemaking.<br><br>**3.** Sustained opportunities for reading, viewing, writing, and representing that develop and refine language for science sensemaking. | **4.** Support for continuously drawing on and incorporating students' cultural backgrounds and lived experiences in science learning.<br><br>**5.** Guidance for inviting multilingual learners to use and build on existing language resources to communicate scientific ideas.<br><br>**6.** Support for students to make choices so that multilingual learners are engaged in learning. | **7.** Assessments that give students multiple opportunities to demonstrate their science and language learning in a variety of ways over time.<br><br>**8.** Guidance for collecting and analyzing evidence of students' three-dimensional learning that attends to the language used to communicate that learning.<br><br>**9.** Guidance for responding to evidence from students to inform instructional decisions that support students in using language to communicate for specific purposes. | **10.** Guidance to foster inclusive and equitable student participation that supports the development of language based on students' needs.<br><br>**11.** Guidance for providing as-needed supports to address potential language demands and opportunities in a way that amplifies rather than simplifies language for sensemaking.<br><br>**12.** Guidance for implementing and gradually decreasing the use of supports for language development. | **13.** Support for teachers and students to make connections between the discipline of science and the language students are using.<br><br>**14.** Support for students to revise their scientific thinking and use of language as they engage in three-dimensional learning.<br><br>**15.** Support for students to further develop metalinguistic and metacognitive awareness by reflecting on how their scientific thinking and use of language has expanded over time. |

The following tables outline the Specifications (including models, explanations, practices, strategies, and supports) for meeting the corresponding evidence-based guidelines. ELSF review teams and content developers collaborate to review and provide specific, actionable feedback on curricular materials using the Guidelines.

## **Area of Focus I:** Interdependence of Science and Language Learning

| **1. Three-dimensional learning goals and pathways that explicitly integrate language and literacy in ways that are meaningful for students and their communities** | **2. Sustained opportunities for interactive scientific discussions that develop and refine language for science sensemaking** | **3. Sustained opportunities for reading, viewing, writing, and representing that develop and refine language for science sensemaking** |
|---|---|---|
| **1a.** Materials state clear and specific integrated three-dimensional goals that emphasize the ways students use language for learning and communicating meaning in science.<br><br>**1b.** Materials introduce students to new language after students have developed conceptual understanding, in order to understand and communicate science ideas.<br><br>**1c.** Materials make the purpose of using language to communicate about scientific phenomena clear to students and teachers.<br><br>**1d.** Teacher materials articulate a pathway or progression of goals for three-dimensional learning and language learning throughout units. | **2a.** Materials include student-to-student discussions that are used for a variety of purposes as students investigate and make sense of scientific phenomena.<br><br>**2b.** Discussion opportunities strategically support specific goals for science and language learning.<br><br>**2c.** Materials offer ongoing discussion opportunities for students to listen actively, express, revisit, and refine their three-dimensional understanding and language over time.<br><br>**2d.** Materials provide support for all students to engage in scientific discussion to negotiate meaning with their peers (e.g., think-aloud modeling, differentiation for specific needs, protocols, strategies, etc.). | **3a.** Materials include opportunities to read, view, write, and represent for a variety of purposes as students investigate and make sense of scientific phenomena.<br><br>**3b.** Opportunities to read, view, write, and represent (e.g., models) strategically support specific goals for science and language learning.<br><br>**3c.** Materials offer ongoing opportunities for students to revisit and refine their three-dimensional understanding and language over time through reading, viewing, writing, and representing.<br><br>**3d.** Materials provide support for all students to engage in reading, viewing, writing, and representing tasks (e.g., think-aloud modeling, protocols, strategies, etc.). |
| **Examples and Resources:**<br>• Three-dimensional learning goals and pathways focus on developing language to describe the system rather than just the term "photosynthesis" (e.g., Students will collaboratively develop a model that uses pictures and labels to explain the inputs and outputs of photosynthesis in Elodea).<br>• Materials introduce new language within context as students explore phenomena and do not front-load vocabulary. | **Examples and Resources:**<br>• Authentic, discussion-worthy prompts driven by phenomena.<br>• Open-ended discourse for the purposes of exploring initial ideas about a new phenomena.<br>• Structured protocol for collaboratively building understanding towards an explanation or argument. | **Examples and Resources:**<br>• Science notebooks that prompt students to return to and revise models of the phenomenon as they come to consensus on an explanation of the phenomenon.<br>• Guidance for teachers to do a think-aloud modeling of how to close-read a scientific text or gather information from an instructional video or simulation. |

## **Area of Focus II:** Leveraging Students' Assets

| 4. Support for continuously drawing on and incorporating students' cultural backgrounds and lived experiences in science learning | 5. Guidance for inviting multilingual learners to use and build on existing language resources to communicate scientific ideas | 6. Support for students to make choices so that multilingual learners are engaged in learning |
|---|---|---|
| **4a.** Materials use phenomena that are of personal, cultural, local, and/or global significance and are engaging to students without essentializing.<br>**4b.** Materials include activities that connect to students' prior knowledge, cultures, and home and community experiences, or activate students' curiosity.<br>**4c.** Teacher materials include relevant and practical suggestions for connecting science learning to students' lives and/or interests and to their communities.<br>**4d.** Materials offer opportunities for clarifying and building knowledge related to unfamiliar contexts and phenomena. | **5a.** Teacher materials guide teachers to value multilingual learners' written, spoken, and nonverbal contributions in co-constructing scientific knowledge, including all language that students bring.<br>**5b.** Materials provide opportunities and rationales for multilingual learners to use and integrate home language, everyday English, and nonverbal communication as they engage in scientific sensemaking and use language to communicate for specific purposes.<br>**5c.** Student materials are provided in multiple languages to support student sensemaking of scientific ideas. | **6a.** Whenever possible, materials provide opportunities for students to make choices in how they learn the material and/or how they demonstrate what they learned (e.g., topic, question, modality, etc.).<br>**6b.** Materials provide opportunities and rationales for students to make choices in topics that are relevant to their identity.<br>**6c.** Teacher materials provide guidance for structuring student choice in a way that promotes agency while also aligning with the goals for science and language learning. |
| **Examples and Resources:**<br>• Provides guidance to identify a related locally-relevant phenomena.<br>• Prompts students to share similar phenomena from their lives.<br>• Qualities of a Good Anchor Phenomenon STEM Teaching Tool. | **Examples and Resources:**<br>• Encouraging translanguaging in collaborative work as students are making sense of a phenomenon.<br>• Teacher materials include ideas for ways to support productive discourse, such as strategic partnering (e.g. same-language partners), and encouraging a variety of non-verbal communication. | **Examples and Resources:**<br>• Students identify their own question to investigate or data to collect that is related to the anchoring phenomenon.<br>• In a unit about human impacts on environment, students are encouraged to choose an issue relevant to their communities (e.g., pesticide effect on environment and people that work there). |

## **Area of Focus III:** Assessment for Science and Language Learning

| 7. **Assessments that give students multiple opportunities to demonstrate their science and language learning in a variety of ways over time** | 8. **Guidance for collecting and analyzing evidence of students' three-dimensional learning that attends to the language used to communicate that learning** | 9. **Guidance for responding to evidence from students to inform instructional decisions that support students in using language to communicate for specific purposes** |
|---|---|---|
| **7a.** Materials include ongoing assessments (formative and summative) that prompt students to show evidence of science and engineering practices, disciplinary core ideas, and crosscutting concepts using relevant language practices.<br><br>**7b.** Assessment opportunities include a variety of ways for students to communicate science and language learning in ways that are relevant to students, strategically providing supports as needed.<br><br>**7c**. Assessment opportunities enable students to draw on and make use of their existing language resources (e.g., everyday language, gestures, etc.). | **8a.** Teacher materials provide examples of assessment responses at a range of understandings across the three dimensions that represent and acknowledge the variety of language that can be used.<br><br>**8b.** Materials include rubrics that specifically identify and describe a progression of the three dimensions that represent and acknowledge a variety of language that might be elicited from the assessment.<br><br>**8c.** Teacher materials include guidance and rationale for teachers to look for a variety of evidence of students' science proficiency even if students' English proficiency is still emerging. | **9a.** Teacher materials suggest ways to guide students' progress in expressing their scientific ideas and questions with language best suited to that purpose.<br><br>**9b.** Teacher materials provide a variety of guidance for how to respond to student evidence in the moment and in future instruction to help students progress towards goals for science and language learning. |
| **Examples and Resources:**<br><br>• Collaborative model formatively assessed in a gallery walk; followed by written explanation revised using Stronger and Clearer that serves as another formative assessment.<br><br>• Students have the option to create a podcast or TikTok about global warming, rather than just write an essay.<br><br>• SAEBL Checklist. | **Examples and Resources:**<br><br>• Look/listen-for guidance that illustrates a range of proficiency in students' responses.<br><br>• Materials provide guidance for the teacher to co-develop a rubric with students based on their context. | **Examples and Resources:**<br><br>• Guidance for teachers to share anonymized samples from formative assessments for students to reflect on how their language can be expanded to become more precise in making meaning. For example: a student sample shows: "the animal blends in to the trees" and students discuss how this can also be communicated as "the animal camouflages with its environment." |

## **Area of Focus IV:** Supports and Structures for Science and Language Learning

| **10. Guidance to foster inclusive and Equitable Student Participation that supports the development of language based on students' needs** | **11. Guidance for providing as-needed supports to address potential language demands and opportunities in a way that amplifies rather than simplifies language for sensemaking** | **12. Guidance for implementing and gradually decreasing the use of supports for language development** |
|---|---|---|
| **10a.** Materials present a balance of independent, paired, small-group, and whole-class activities.<br><br>**10b.** Flexible grouping structures are recommended to enhance student learning and language development (e.g., heterogeneous groups, home language groups, groups by level, etc.).<br><br>**10c.** Teacher materials give guidance on what to look for, listen for, questions to ask, how to monitor for equity and/or feedback to give when meeting with students individually or in small groups.<br><br>**10d.** Materials provide consistent and sustainable norms, routines, and/or monitoring tools to promote and reflect on equitable participation. | **11a.** Materials include activities that provide students with multiple entry points and multiple ways to express and represent their understanding.<br><br>**11b.** Teacher materials identify possible language demands and opportunities (e.g., passive voice, nominalization, technical vocabulary, science-specific language functions, graphs and models, etc.).<br><br>**11c.** Materials amplify (rather than simplify) language by providing a variety of support for students with different linguistic strengths and needs (e.g., language routines, discussion protocols, sentence frames, etc.).<br><br>**11d.** Supports are embedded throughout both student and teacher materials rather than as an add-on (e.g., "For MLLs" call-out boxes). | **12a.** Materials consistently provide access to cognitively-demanding tasks, and guidance is provided for when and how to use supports to encourage productive struggle before intervening.<br><br>**12b.** Materials help teachers understand the progression of particular skills and gradually decrease supports for students to gain independence in tackling rigorous tasks.<br><br>**12c.** Materials provide guidance on how to modify supports according to students' strengths and needs. |
| **Examples and Resources:**<br>• Uses consistent discussion protocols and talk moves.<br>• Organizing students in home language groups in early sensemaking discussions.<br>• Consistent reinforcement, feedback, and class discussions to reflect on how students are following norms that value all students' contributions.<br>• Use a monitoring tool (e.g., discussion map) to examine student participation across the class, paying attention to underserved groups in science (e.g., MLLs, girls). | **Examples and Resources:**<br>• Instead of oversimplifying the language and concepts in science texts, provide close reading with annotation strategies and pair with structured discussions to support the reading activity.<br>• Teacher materials identify science-specific language (e.g., technical vocabulary, disciplinary language, multiple-meaning words, metaphors, etc.), and provide guidance to explicitly review with students in context (no pre-teaching).<br>• Provide visuals and diagrams to make abstract concepts/language more concrete. | **Examples and Resources:**<br>• Decrease supports across writing tasks throughout a unit (ie., teacher think-aloud > flowchart with sentence stems > independent writing). |

## **Area of Focus V:** Metalinguistic and Metacognitive Awareness

| 13. **Support for teachers and students to make connections between the discipline of science and the language students are using** | 14. **Support for students to revise their scientific thinking and use of language as they engage in three-dimensional learning** | 15. **Support for students to further develop metalinguistic and metacognitive awareness by reflecting on how their scientific thinking and use of language has expanded over time** |
|---|---|---|
| **13a.** Teacher materials provide guidance to support students in flexibly using their home language and English for the purposes of science and language learning.<br><br>**13b.** Materials provide strategies to help students understand the relationship between the three dimensions and the variety of language used (everyday, science-specific, and home language, etc.).<br><br>**13c.** Materials provide guidance for students to reflect on the audience and context when selecting language for a task. | **14a.** Materials provide opportunities for students to receive feedback in order to revise and refine their work, as they develop science and language learning over time.<br><br>**14b.** Materials include guidance on how to provide feedback to students so that they can advance their use of the three dimensions and language simultaneously.<br><br>**14c.** Materials provide support to guide students in analyzing their own or their peers' work and revising to meet goals for science and language learning. | **15a.** Materials prompt students to self-reflect on their learning towards goals for science and language learning.<br><br>**15b.** Materials prompt students to reflect on how their scientific thinking has expanded over time (e.g. "the puddle disappeared" to "the puddle evaporated into the air").<br><br>**15c.** Materials prompt students to reflect on how their language has expanded over time (e.g., "the puddle goes into the air" and "the water from the puddle evaporates into the air"). |
| **Examples and Resources:**<br><br>• Encourage translanguaging in order to engage in science comprehension or to fine-tune expression of ideas.<br><br>• Collect and display (see pg. 11) all language used for sensemaking about phenomena (e.g., everyday language, home language, science-specific language).<br><br>• Reflection about contextual use of specific language structures (e.g., everyday language for sensemaking discussions and science-specific language for a scientific publication). | **Examples and Resources:**<br><br>• Guided protocols and student-friendly rubrics for students to self-assess and give peer feedback on a multimodal project.<br><br>• Students have a guided discussion with a peer about their solutions to an engineering design problem and talk about proposed modifications based on whether it met specific design criteria. | **Examples and Resources:**<br><br>• Student-facing portfolios in which students collect artifacts over the course of a unit and reflect on how their ideas and language changed over time.<br><br>• KWL (Know-Wonder-Learn) charts revisited throughout the investigation.<br><br>• Students reflect on how the way they describe a phenomenon becomes more precise or meaningful after having multiple opportunities to discuss and co-construct ideas with peers and their teacher.<br><br>• Revisiting Driving Question Boards throughout a unit. |

# Appendix: Explanation of Key Terms

**Science Learning:** Science learning refers to the ways that students use the three dimensions of *the Framework* as they make sense of phenomena and solve problems. The dimensions for both science and engineering are the science and engineering practices, disciplinary core ideas, and crosscutting concepts. Throughout the Guidelines, this is also often referred to as three-dimensional or the three dimensions.

**Language Learning:** Language learning refers to the language used for doing science, including any language used for meaning-making and focused on the language students use to communicate about science. This consists of science-specific language, or the word, sentence, and discourse-level features of doing and communicating about science in scientific communities (e.g., passive voice, nominalization, technical vocabulary, science-specific language forms and functions, multimodal representations like graphs and models, etc.). However, it also includes any language students use including nonverbal communication and the embodiment of ideas through gestures.

**Literacy:** We define literacy as the ability to read, write, speak, listen, and represent. We explicitly include representation as an aspect of literacy since representations are so important to the discipline of science (e.g., data tables, graphs, models, computational representations, etc.)

**Assessment:** While assessment refers to both formative and summative assessments within instructional materials, this guidance highly emphasizes formative assessments as critical to implementing the goals for three-dimensional learning. Formative assessment should be embedded within everyday tasks and the evidence generated by students should be used to tailor instruction around their strengths and needs—ideally inviting students into this process to become agents in their own learning (Black & William, 1998). Assessments should collect evidence of learning from students in a variety of ways, including through speaking and visually representing, not just through writing.

**Supports:** Supports refer to any aspect of the instructional materials that supports students in using language to understand and communicate scientific ideas (e.g., grouping structures, discussion protocols, talk moves, graphic organizers, etc.). These are often referred to as scaffolds, but we have intentionally chosen the term supports to communicate their flexible and responsive use based on students' strengths and needs.

**Equitable Student Participation:** Equitable participation refers to when all students are supported to actively engage in learning and assessment activities, especially those that have been historically marginalized (e.g., multilingual learners). This involves educators using intentional supports, routines (e.g., active listening, honest sharing), developing inclusive environmental conditions (asset-based, building trust, encouraging diverse voices) and acknowledging and disrupting inequity (e.g., monitor and respond to how race, language or gender may play a role in uneven levels of engagement). *Adapted from Kirwan Institute Guidelines for Civic Engagement and Hammond, Z. Power of Protocols for Equity, 2020.*

**Student Agency:** Agency can be defined as a "student's desire, ability, and power to determine their own course of action." Teachers "can support student agency: through curriculum, instruction, assessment, and the ways in which they structure learning opportunities" (Wall et al., 2018. p. 2).

**Essentializing:** A practice that involves focusing on differences when categorizing people and to infer attributes about people within this group (Tawa, LoPresti and Lynch, 2020); for example, including a particular scientific phenomenon in a classroom because the teacher feels that it applies to a specific subset of students based on what makes them different from the rest of the students.

**Translanguaging:** Translanguaging includes the ways in which multilingual learners leverage all their linguistic resources for the purpose of sensemaking beyond what is typically defined by the discipline (Otheguy et al., 2015). This is not to be confused with code-switching (communicating by using two or more languages simultaneously) which is typically used when an acceptable term is not known in a specific language. Code-switching often implies that there is only one accepted term, while translanguaging implies that there are a multitude of acceptable ways to communicate an idea, and that these depend on the purpose at hand (Suarez, 2020).

**Metacognitive:** Students' ability to intentionally reflect on their thinking to create awareness of their learning process. This includes planning, monitoring, and evaluation of learning to make adjustments to learning strategies (WIDA, 2020).

**Metalinguistic:** Students' "ability to reflect about language and how it works, the choices one makes with language, how language influences and is influenced by context, as well as how language use creates meanings and enacts relationships among people and things"(WIDA, 2020).

# References

Ball, D. L., & Cohen, D. K. (1996). Reform by the book: What is—or might be—the role of curriculum materials in teacher learning and instructional reform? Educational Researcher, 25(9), 6–14.

Ballantyne, K. G., Sanderman, A. R., & Levy, J. (2008). Educating English Language Learners: Building Teacher Capacity. Roundtable Report. National Clearinghouse for English Language Acquisition & Language Instruction Educational Programs.

Black, Paul and Wiliam, Dylan (1998) 'Assessment and Classroom Learning', Assessment in Education: Principles, Policy & Practice, 5:1, 7 — 74.

Edelson, D. C., Reiser, B. J., McNeill, K. L., Mohan, A., Novak, M., Mohan, L., ... & Suárez, E. (2021). Developing research-based instructional materials to support large-scale transformation of science teaching and learning: The approach of the OpenSciEd middle school program. Journal of Science Teacher Education, 32(7), 780-804.

Gonzalez-Howard, M. & Suárez, E & Grapin, S. (2021, August 17). A Call to #retireELL in Science Education. NSTA. https://www.nsta.org/blog/call-retireell-science-education

Grapin, S. E., Llosa, L., Haas, A., Goggins, M., & Lee, O. (2019). Precision: Toward a meaning-centered view of language use with English learners in the content areas. Linguistics and Education, 50, 71-83.

Hammond, Z. The power of protocols for equity. Educational Leadership, v77 n7 p45-50 Apr 2020. The power of protocols.

Holley, K. The principles for equitable and inclusive civic engagement. Kirwin Institute for the Study of Race and Ethnicity. The Ohio State University. www.kirwaninstitute.osu.edu.

Lee, O., Llosa, L., Grapin, S. E., Haas, A., & Goggins, M. (2019). Science and language integration with English learners: A conceptual framework guiding instructional materials development. Science Education, 103(2), 317-337.

Lee, O., Quinn, H., & Valdes, G. (2012). Language Demands and Opportunities in Relation to Next Generation Science Standards for English Language Learners: What Teachers Need to Know. Understanding Language: Stanford University School of Education.

National Research Council 2012. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press. https://doi.org/10.17226/13165.

National Center for Education Statistics (2019). The condition of education 2019 (NCES 2019–144). U.S. Department of Education.

OECD Learning Compass 2030. Student Agency, India, The Duke of Edinburgh's International Award Foundation. www.oecd.org/education/2030-project/learning/student-agency

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

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

Tawa, J., LoPresti, A., & Lynch, D. (2020). Deconstructing racial essentialism in the classroom: The impact of social constructionist curricula on student diversity interaction. Journal for Multicultural Education.

Wall, A., Massey, D., & Vaughn, M. (2018). Research summary: Student agency. Retrieved [4/29/22] from http://www.amle.org/BrowsebyTopic/WhatsNew/WNDet/TabId/270/artmid/888/articleid/995/Student-Agency.aspx

WIDA. (2020). WIDA English language development standards framework, 2020 edition: Kindergarten–grade 12. Board of Regents of the University of Wisconsin System.