Elevating ELLs in a science classroom: Evidence-informed strategies to support language development used by a high school teacher

By Maria Zaman, Ryan Summers, & Sarah Boese-Noreen, USA

Learning science can be a daunting task, resembling the challenge of deciphering a complex foreign language for many individuals. The intricacy stems from the incorporation of vocabulary with Latin and Greek roots, intertwined with specialized jargon that references specific concepts. This linguistic complexity often proves to be a stumbling block for learners. As a bilingual educator, my constant endeavour is to explore inventive ways to make subjects more accessible, particularly for English language learners (ELLs). In a recent undertaking, I conducted a comprehensive interview with an experienced high school teacher, delving into effective strategies for teaching science to ELLs. This endeavor sheds light on the fact that mastering science surpasses conventional language skills, such as reading, writing, speaking, and listening in English (Weinburgh et al., 2019). Recognizing that science proficiency requires a multifaceted approach is paramount in addressing the unique challenges faced by ELLs in scientific education.

Sarah Boese-Noreen teaches physical science courses in Grand Forks, North Dakota, USA. Readers may wonder why experiences from a teacher in a state whose population is more than 83% white should be considered helpful by others working with ELLs in more diverse contexts. Local demographics in ND have changed over the past decade, partially due to job opportunities in the region and an uptick in the number of immigrants and refugees who have relocated to the state. As a result, the ND Latinx population increased 2.4 percentage points to 4.4% between 2010 and 2021. The black population has also increased from 1.2 percentage points to 3.3% during this period. The impacts of these changes have been felt by public schools. Many districts suddenly had an increased number of ELLs across a range of proficiency levels that needed support in all disciplines. Sarah's school is more diverse than the state average (approximately 71% white) and about 3% of their students were identified as ELLs during 2022-2023, and Sarah has been teaching sections of physical science with an emphasis on supporting ELLs since 2017.

The following are excerpts from my conversation with Sarah; specific strategies are highlighted and unpacked in hopes of helping other educators.

> ***Maria:*** What barriers do you encounter when teaching science to ELL students, and how do you overcome them?
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> ***Sarah:*** The language of science can be a barrier. For example, the technical language in textbooks typically uses the 3rd person tense and the writing is often difficult for ELLs.

During our conversation, it became clear that Sarah understands the unique challenges that ELL students face when grappling with scientific concepts and terminology.

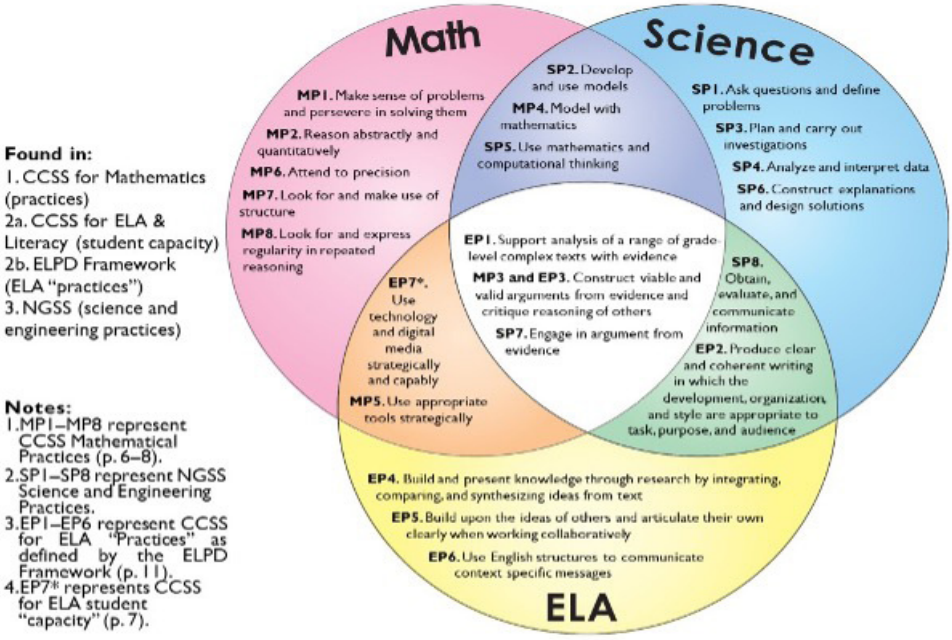
> ***Maria:*** What strategies do you implement to help ELL students comprehend scientific concepts and terminology?
>
> ***Sarah:*** We break down content into bite-sized portions. When introducing new ideas in class, we purposefully ask questions that are designed to expand on students' prior knowledge or help them make connections between the phenomena being investigated and what they already know.

Sarah uses strategies to help students build connections by breaking down complex ideas and providing students with graphic organizers to organize their thinking (e.g., concept maps, word walls, and Venn diagrams). She also asks questions about topics that elicit students' background knowledge (e.g., cultural or linguistic knowledge). This helps Sarah bridge diverse students' background knowledge and their science-related experiences to deepen their understanding of topics (Lee & Buxton, 2010).

Sarah added that her school uses curriculum materials that are aligned with the Next Generation Science Standards (NGSS) (Next Generation Science Standards, 2013), where the scientific and engineering practices offer rich opportunities for language learning, while supporting science learning, for all students, especially English language learners. When supported appropriately, students are capable of grasping science ideas through their emerging language and comprehending and carrying out sophisticated language functions (e.g., arguing from evidence, constructing explanations, developing models). This is possible even if students' linguistic abilities are developing and they are using less-than-perfect English. By engaging in such practices, moreover, they simultaneously build on their understanding of science and their language proficiency (i.e., capacity to do more with language). Science instruction consistent with the NGSS emphasize learning through engaging in scientific practices (National Research Council, 2012). These practices are language intensive and require students to interact with ideas using multiple modalities in increasingly strategic ways. Students must read, write, and speak about explanations of scientific phenomena (Lee & Stephens, 2020, p. 430). In Sarah's classroom students share ideas, often negotiating

them with peers to reach shared conclusions. Teaching in this way provides students with opportunities for language and science learning at the same time.

Figure 1 (*Relationships and convergences among mathematics, science, and ELA practices (adapted from Cheuk, 2013))*



During our conversation, Sarah mentioned multiple times that she finds herself modeling reading and writing strategies along with scientific reasoning while teaching. Almost all of her responses to my questions illustrated these interconnected goals.

> ***Maria:*** How do you help ELL students who may be missing foundational knowledge in science catch up with their peers?
>
> ***Sarah:*** We often place students into intentional small groups with a teacher or classroom leader and students are encouraged to share ideas and help each other. The teacher or classroom leader helps facilitate these discussions and they can address gaps in understanding as needed.

This arrangement gives Sarah an opportunity to work with small groups of students. She checks students' understanding and reinforces their comprehension during this time. Students in her classes follow a standard process when working with their group. Each group has a manager, which may a student or a teacher-leader, and that person is responsible for making sure that everyone stays on track with their

assigned tasks. Sarah believes in collaborative learning and she intentionally groups students based on the task and their individual needs. She strives to create an environment in the classroom where students feel empowered to learn from one another. Sometimes she groups students with the same primary language because language can be a resource for students as they are making meaning while engaging with science ideas.

Sarah said that reading was a routine task her 9th graders in physical science students completed in groups. She asks students to independently read an assigned portion from their textbook or other text material. Then, students work with their groups to summarize the reading, identify the ideas the authors assume they already know about the topic, and discuss how their understanding has changed following the reading. Teacher-leaders can capitalize on opportunities to support students' use of reading strategies for scientific texts, prompting them to use academic language functions (e.g., describe, explain, predict, infer, conclude) for science topics (Lee et al, 2013) All students can get to the point where they can collaboratively discuss science concepts in academic conversations, and there are plenty of resources available to help model these routines (Video Playlist: Engaging ELLs in Academic Conversations | Teaching Channel, 2023).

> These scientific and engineering practices offer rich opportunities and demands for language learning while they support science learning for all students, especially English language learners… When supported appropriately, these students are capable of learning science through their emerging language and comprehending and carrying out sophisticated language functions (e.g., arguing from evidence, constructing explanations, developing models) using less-than-perfect English. By engaging in such practices, moreover, they simultaneously build on their understanding of science and their language proficiency (i.e., capacity to do more with language). *(NGSS Lead States, 2013, Appendix D, Case Study 4)*

Sarah reiterated that all students benefit from a cooperative learning environment with peer collaboration. All students complete the same hands-on investigations in her science classes, too, so ELLs take part in all the same activities as their classmates. She stressed that all 9th grade students receive plenty of guidance to set them up for safe and productive learning in the lab setting at the beginning of the school year. Still, students' ability to read and follow instructions often gives her clues about the language skills of ELLs. These clues combined with writing samples, such as students' written laboratory notes and reports, help Sarah to gauge their understanding of scientific concepts and their language skills.

> ***Maria:*** How do you assess learning in your classroom?
>
> ***Sarah:*** All students are assessed using 4-point standards-based proficiency scale in my science class. For ELLs, their language skills are also assessed heavily at the beginning of each academic

year. In my 9th grade physical science class, for example, students complete several reading and writing tasks in the first couple months of school, and these tasks provide evidence about their proficiency.

As Sarah described how she thoughtfully selected tasks that could be used to provide evidence about students' science and language proficiency, I wondered how she used that information to make adjustments to her teaching.

Maria: How do you adjust your lessons to accommodate students of varying English proficiency levels?

Sarah: We ensure that every student, regardless of their English proficiency level, can access the material. For those with lower English proficiency, we provide content in their native language. What's interesting is that we encourage students to navigate between their native language and English, helping them bridge the language gap effectively.

Sarah effectively bridges the language gap and empowers students to grasp scientific content more thoroughly by allowing ELL students to navigate between their native language and English (Roseberry & Warren, 2008). This demonstrates her understanding of the cognitive processes involved in learning, as well as her commitment to accommodating students of varying English proficiency levels.

All the thoughtful planning that Sarah described made me wonder about the types of support she had available at her to school.

Maria: Do you collaborate with other teachers and staff to support ELL students in their science education?

Sarah: I collaborate closely with an English language (EL) teacher and specialist at our high school. We meet regularly to exchange ideas and discuss strategies, and work together to address the unique needs of our students.

Sarah praised her colleague, saying "she brings invaluable insight and experience to the field of teaching English language learners." Sarah teaches at a comparatively large high school in North Dakota (approximately 1140 students enrolled for 2023-2024), and she is fortunate to have access to an English-language specialist as a resource for her and her students.

Throughout the conversation, Sarah stressed the importance of personalization when trying to connect with ELLs. This is something she says that her colleague has helped her to better understand. Learning in

science flourishes when classroom topics have relevancy to students' own experiences and cultures (National Research Council, 2012). Sarah has deepened her commitment to incorporating diverse perspectives into the science topics she introduces. "We want to incorporate the life stories and perspectives of our students into the classroom," Sarah said. This stance is beneficial for all students because they gain global competence by examining local, global and intercultural issues, and develop an understanding about the perspectives and world views of others (Barrett, 2018).

As educational institutions undergo a transformation characterized by increasing diversity and a growing population of ELLs, it becomes imperative to equip teachers with the necessary tools and strategies to address the unique needs of all students (Weinburgh et al., 2019). This shift underscores the pressing demand for inclusive pedagogical approaches that not only acknowledge linguistic diversity but also cultivate an environment where every student, regardless of their language background, can thrive academically and engage meaningfully in the learning process. Thus, the commitment to preparing educators for this evolving landscape becomes a cornerstone in fostering an inclusive and equitable educational experience for all.

References

Barrett, M. (2018, May 11). Preparing our youth for an inclusive and sustainable world: The OECD Pisa Global Competence Framework. *Academia.edu*. https://www.academia.edu/36612235/Preparing_our_youth_for_an_inclusive_and_sustainable_world_The_OECD_PISA_global_competence_framework

Cheuk, T. (2013). *Relationships and convergences among the mathematics, science, and ELA practices*. Stanford University

Jones, L. (2021, March 1). Video playlist: Engaging ELLs in academic conversations. *Teaching channel with learners edge*. https://www.teachingchannel.com/k12-hub/blog/ells-academic-conversations/

Lee, O., & Buxton, C. C. (2010). *Diversity and equity in science education: Theory, research, and practice*. Teachers College Press

Lee, O., Llosa, L., Grapin, S., 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. https://doi.org/10.1002/sce.21498

Lee, O., Quinn, H., & Valdés, G. (2013). Science and language for English language learners in relation to Next Generation Science Standards and with implications for common core state standards for English language arts and mathematics. *Educational Researcher*, *42*(4), 223–233. https://doi.org/10.3102/0013189x13480524

Lee, O., & Stephens, A. (2020). *English learners in STEM subjects*: Contemporary views on stem subjects and language with English learners. *Educational Researcher*, *49*(6), 426–432. https://doi.org/10.3102/0013189x20923708

National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. National Academies Press.

NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*. National Academies Press.

Preparing Our youth for an inclusive and sustainable world: The OECD PISA Global Competence Framework. (2018). OECD Publishing.

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

Weinburgh, M. H., Silva, C., & Smith, K. (2019). Supporting emergent multilingual learners in science, Grades 7-12.

Author Bios

Maria Zaman is a passionate educator currently pursuing a PhD in Teaching and Leadership at the University of North Dakota. With over five years of experience in education in Bangladesh, Maria has taught English Composition at UND, contributing to the academic growth of her students. As a bilingual individual, Maria recognizes the significance of providing equitable educational opportunities. Her teaching philosophy revolves around creating an atmosphere where all students, regardless of their linguistic background, feel empowered to excel. Through her dedication to inclusive education, Maria strives to make a positive impact on the educational landscape, emphasizing the importance of language proficiency in unlocking academic success.

Ryan Summers is a science education researcher whose research and teaching focuses on helping others understand and appreciate science. Ryan investigates the views held by students and teachers about how scientific knowledge is generated as well as representations of these ideas contained within instructional materials. He builds on a foundation of scholarship that acknowledges social and cultural influences on the development of scientific knowledge. Ryan also prepares science educators to help middle and high school students grasp these ideas in the future as an associate professor of science education at the University of North Dakota.

Sarah Boese-Noreen is an educator who aims to provide all learners with equitable opportunities to engage with science ideas. Sarah teaches physical science classes for students with varied levels of English proficiency. Sarah believes that all learners are capable of understanding, representing, and communicating science ideas. Sarah's commitment to these beliefs led her to embed written and verbal tasks in her classes to specifically attend to the varied needs of the growing number of students learning English as a second language at Red River High School located in Grand Forks, ND, USA.