Supporting multilingual students' engagement in science practices: A case for fostering translanguaging science classrooms

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Introduction & Purpose

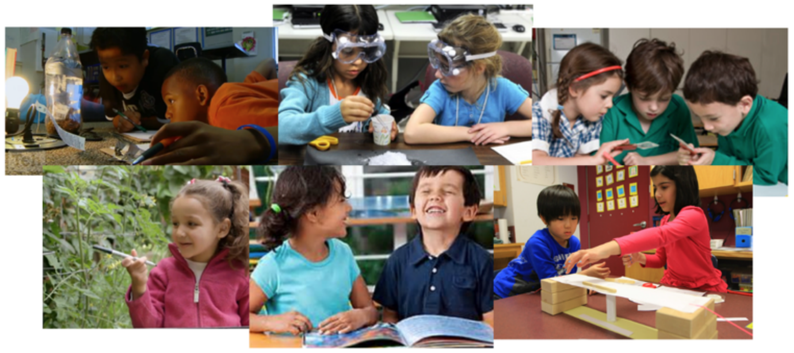
- The Next Generation Science Standards (NGSS States, 2013) emphasize students engaging in practices that are authentic to and common amongst the sciences to figure out their own understanding of the natural world (Osborne, 2014).
- Integrating science practices in classroom instruction has the potential to make learning spaces more equitable if an expansive view of scientific sensemaking is adopted, one that reflects the wide ranging meaning-making resources students use to communicate and make sense of core science ideas (Bang et al., 2017).
- Science practices are inherently language-intensive (Lee et al., 2013), a rigor augmented by two additional factors:
  - The complex analytic tasks students carry out when using science practices often occur in real-time (González-Howard et al., 2017).
  - Students frequently engage in multiple practices simultaneously (Osborne, 2014).
- Given these language demands, it is imperative to focus on the science learning experiences of multilingual students; these students typically have teachers who have not received training around science practices (Osborne, 2014), or the ways language is central to scientific sensemaking (Lee et al., 2013).
- The purpose of this work is to (a) provide a comprehensive synthesis of the literature regarding multilingual students' experiences with science practices; which in turn is used to (b) offer concrete directions for future research in order to expand views around what is recognized and valued as scientific sensemaking repertoires.

Who are Multilingual Students?

- The term "multilingual" was intentionally chosen because it is asset-oriented and reflects our dispositions toward equity and justice (González-Howard & Suárez, 2021). Specifically, it positions these students' as growing their semiotic repertoire from which they can make and express meaning (García, 2011).
- Multilingual students - which make up nearly 10% of the total US student population (NCES, 2013) - are an extremely diverse group that vary across many factors including (but not limited to): the languages that they know and use (and proficiency in these languages), race, ethnicity, socioeconomic and family backgrounds, schooling experiences, generational status in this country, and type of services received for English language development at school (e.g., ESL, SEI, bilingual) (NASEM, 2018).

Databases & Search Terms	•Databases Academic Search Complete , Education Source, ERIC, and PsychINFO •Keywords related to science education (e.g., science teaching), science practices (e.g., engaging in argument from evidence), as well as terms used to refer to the focal student population (e.g., English language learners)
Timeframe	•2012-2020, which allowed us to focus on research related to the science practices as operationalized through the Framework (NRC, 2012) and the NGSS (NGSS Lead States, 2013).
Inclusion Criterion	•Empirical peer-reviewed manuscripts
Exclusion Criterion	•Exclusion occurred most often because a study did not focus on multilingual students' experiences with science practices, but instead on their engagement in inquiry, or their general use of academic science language.
Result	•22 publications were included in the current review.

Figure 1. Methods for Literature Review.



Trend 1: *What understandings and instructional approaches do teachers have and use to support their multilingual students' engagement in science practices?*

Trend 2: *How is language used for scientific sensemaking, and how can this knowledge be leveraged to support multilingual students' engagement in science practices?*

Trend 3: *What are the various ways that multilingual students use language, or are encouraged to use language, to engage in science practices?*

Figure 2. Trends in Topics of Research Inquiry.

Trend 1: Teachers' Understandings and Instructional Approaches

- Most studies focused on a single science practice (namely: explanation, argumentation, or modeling) (e.g., Wu et al., 2019; Larsson & Jakobsson, 2020; Suárez, 2020).
- Studies across explanation, modeling, and argumentation highlight the affordance of sensemaking activities occurring in smaller group structures (Swanson et al., 2014), incorporating English language scaffolds (González-Howard et al., 2017), and with students being encouraged to use all their communicative resources to mediate collaboration and meaning making (Suárez, 2020).
- However, contradictions emerged around teachers' instruction (e.g., some language supports can constrain students' construction of explanations; Rodriguez-Mojica, 2019).

Theme 2: Highlighting the Ways Language is used for Scientific Sensemaking

- Many studies have converged on the notion of their being a *language of science*, which is highly specialized in both terminology and its form and function (Poza, 2018).
- The focus on language use across these studies has varied in grain size:
  - Large gain size of language use - have explored how to support multilingual students in learning the various ways that language is structured when making meaning in science (e.g., a CER statement; González-Howard et al., 2017).
  - Small gain size of language use - have used systemic functional linguistics (SFL) as a tool to help support multilingual students' learning (e.g., using words related to *usuality* or *likelihood* to examine the strength of evidence in text; Symons, 2017).

Theme 3: Exploring Students' Use of Language for Scientific Sensemaking

- How students choose to engage in science practices is greatly determined by classroom norms; often explicitly and implicitly reinforced by teachers (Suárez, 2020).
- This trend had the fewest amount of studies, which identified and examined the linguistic **or** non-linguistic resources multilingual students use when sensemaking. Specifically:
  - Communicating across named languages (e.g., Kang et al., 2017).
  - Using both colloquial and scientific language (e.g., Karlsson et al., 2020).
  - Through multimodalities (e.g., Grapin, 2019).

Directions for Future Research

- Multilingual students have historically received unequal and inadequate instruction in science (NASEM, 2018), an issue that is compounded by two related factors:
  - Dominant views around language and its role in science - these views tend to focus on, and privilege, productive (writing, speaking) and receptive (reading, listening) linguistic skills, and consider non-linguistic forms of communication - like gestures, graphs, and drawings - as rudimentary and/or supplementary (González-Howard & Suárez, 2021).
  - Certain approaches to doing science and expressing scientific knowledge are privileged over other approaches (Bang et al., 2017).
- To have a truly expansive view of how language is used for scientific sensemaking, attention should be given to how multilingual students engage in **translanguaging** when using science practices to figure out natural phenomena.
  - Translanguaging pedagogy is "grounded in the practices [of multilinguals] that are readily observable" (García, 2009, p. 45), which encompasses their full semiotic repertoires (i.e., linguistic and nonlinguistic meaning making resources).
- In addition to promoting and examining how multilingual students use translanguaging to construct and revise scientific knowledge, our synthesis revealed that future research should also:
  - Examine the interrelated nature of science practices; not only examine student engagement in one science practice.
  - Problematize science practices not typically consider "language-intensive," such as planning and carrying out investigations or analyzing and interpreting data.

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