Research in Brief

This is an ongoing column featuring brief reports and mini-literature reviews on current theories and practices in TESOL and its related fields. Please send article submissions to the column editor, Xiaochen Du, University of Florida at mosaic@nystesol.org

Building an Ecology of Equitable and Linguistically Responsive Science Curricula for ELLs: A Literature Review

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Given the diversifying student population in U.S. public schools, it is crucial to re-examine whether schools are providing equitable education for ELLs in science classrooms. Most ELLs are placed in mainstream classrooms rather than specialized ESL or bilingual classes and are struggling to comprehend academic content (de Jong, 2014). Science is one of the subjects that has exhibited a consistent achievement gap between ELLs and non-ELLs (Buxton & Lee, 2014; Callahan & Shifrer, 2016). In the STEM field, it is more likely that ELLs' linguistic needs are not met, and the misconception that language is the only barrier for ELLs' academic success poses further challenges. Through a literature review of empirical research on science curriculum for ELLs, I argue for curricular reform efforts and a holistic evaluation of research that can build an ecology of equitable and linguistically responsive science education for ELLs.

This literature review is informed by two theoretical frameworks: Lucas and Villegas' (2013) framework for linguistically responsive teachers and Bronfenbrenner's (2014) ecological systems model. Lucas and Villegas articulate four key elements in their framework including (a) developing sociolinguistic consciousness, valuing diversity, and inclination to advocacy; (b) identifying classroom language demand; (c) learning and developing an understanding of SLA and ELLs' background; and (d) scaffolding instruction. Although this framework provides essential guidelines for content instruction, this also imposes more responsibility on the teacher rather than considering other curricular aspects. Thus, Bronfenbrenner's ecological systems model allowed a holistic evaluation of the science curricula for ELLs.

Bronfenbrenner's (2014) ecological systems model, first introduced in 1974, presents five ecological systems that influence a child's development: microsystems, mesosystems, exosystems, macrosystems, and chronosystems. In this review, three ecological systems, macro-, meso-, and microsystems became relevant. Microsystems refer to the interpersonal relations in a child's immediate environment. Mesosystems are the system of the microsystems which links between two or more settings, such as a pattern between a classroom and a family. Lastly, macrosystems represent the overarching pattern of micro- or mesosystems such as the culture, belief systems, material resources, or opportunity structures.

Review of the literature concerning the macrosystems of science curricula for ELLs highlights (a) transformation in ideologies and belief systems and (b) shifts in national standards and policy efforts. These macro-level curricular changes involved linguistically and culturally sensitive assessments, standards, and educational philosophies (e.g., Gamez & Parker, 2018; Mitchell, 2018; Smith et al., 2017). Currently, the *Every Student Succeeds Act* of 2015 returns greater control of education to state and local government, which includes direct funding to states that provide equitable and high-quality education for ELLs (Broughton et al., 2019). These efforts suggest macrosystems promoting more accessible science education for ELLs.

Curricular changes in macrosystems affect meso- and microsystems and may transform teachers' belief systems and efforts toward teacher education reform. In the mesosystems, policy and standards were implemented in the school district and program levels including (a) professional development (b) collaborations between science and ESL teachers, and (c) examination of local communities in which ELLs are involved (e.g., Aldana & Matinez 2018; Gamez & Parker, 2018; Irby et al., 2018; Lyon, 2017). Although science teachers face challenges teaching contents to ELLs, they were able to sustain language-rich pedagogies and practices when the professional development opportunities are consistent and promote a community of practice.

Lastly, the microsystems in the literature presented "best practices" in valuing ELLs' language, culture, knowledge, and ability to succeed in science classrooms. These involved transformations in teaching practices such as (a) providing language support, (b) implementing formative assessments, (c) integrating home languages, (d) eliciting prior knowledge, and (e) building relationships with ELLs (e.g., Gamez & Parker, 2018; Meyer & Crawford, 2015; Swanson et al., 2013). Based on Lucas and Villegas' (2013)

framework for linguistically responsive teaching, many practices in the literature represent the second and fourth elements, *identifying classroom language demand* and *scaffolding instruction.* Looking back on the macro- and mesosystems, all four elements are not represented in those ecological systems nor are they in the microsystems. This makes me wonder whether our current science curricula are linguistically responsive in a way that there is an ecology of equitable education for ELLs.

This brief literature review has implications for future curriculum development and research. Though a plethora of research has explored effective evidence-based science instruction and presented possible curricular transformation that can lead to high-quality science education for ELLs, such reform still imposes more responsibility on either the student or the teacher—the microsystems. In the microsystems, teachers already deal with constraints such as accountability, the test-oriented system, and the limited time and resources to provide accommodations for ELLs. A greater focus on integrating responsibility to the other systems is necessary when developing programs and policy models and providing a more equitable science curricula for ELLs.

By integrating two theoretical frameworks in the literature review process, it was possible to get a holistic review of the current research. All four elements in Lucas and Villegas' (2013) framework for linguistically responsive teaching need to be considered in each ecological system. In the macrosystems, policy, standards, and materials need to examine how ELLs are positioned in the discourse and whether their diverse needs, knowledge and academic potential are regarded. In the mesosystems, multiliteracy skills and linguistic awareness need to be promoted in a sustaining manner accompanying consistent collaboration within the school, district, and community. In the microsystems, ELLs' linguistic repertoire should be valued as an asset and their backgrounds need to be acknowledged by establishing fluid communications. Through the enactment of linguistically responsive teaching, the curriculum can build an ecology of equitable science education for ELLs.

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