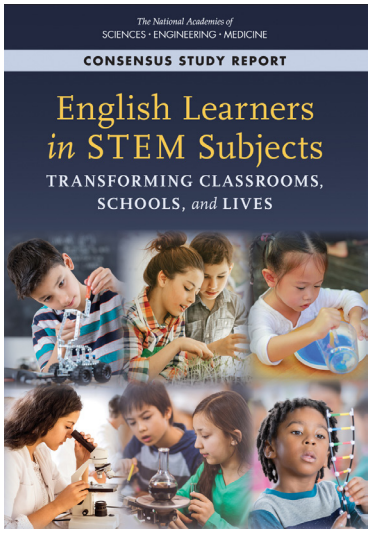
Consensus Study Report

October 2018

HIGHLIGHTS

English Learners in STEM Subjects: Transforming Classrooms, Schools, and Lives



The imperative that all students, including English learners (ELs), achieve high academic standards and have opportunities to participate in science, technology, engineering, and mathematics (STEM) learning has become even more urgent and complex given shifts in science and mathematics standards. ELs comprise a diverse and multitalented pool of learners, yet these students continue to be underrepresented and lack access to rigorous STEM learning opportunities. Organizing schools and preparing teachers so that all students can reach their full potential in STEM can transform the lives of individual students and teachers, as well as schools and society as a whole.

English Learners in STEM Subjects: Transforming Classrooms, Schools, and Lives (2018), a report from the National Academies of Sciences, Engineering, and Medicine, showcases the interconnectedness of language and content area learning and identifies factors that affect ELs' opportunities to engage in rigorous, grade-appropriate STEM learning. The report recommends steps that policy makers, district and school leaders, and educators can take to increase this access and to support ELs' engagement and success in these subjects.

RECOGNIZING ASSETS THAT ENGLISH LEARNERS BRING TO CLASSROOMS

Schools sometimes operate under the incorrect assumption that English proficiency is a prerequisite for students to meaningfully engage with STEM learning. However, substantial evidence suggests that with appropriate curricular and instructional support, ELs can participate in, contribute to, and succeed in STEM classrooms.

ELs are developing bilingual competence at the same time they are learning school subjects, something other students are not expected to do. They bring new perspectives and resources to the classroom; their cultural diversity offers opportunities for sharing new ideas and new ways of thinking about STEM that can benefit their peers. Students who have had STEM instruction in other countries may also bring important proficiency in content or may have alternative ways of doing STEM work from which other students could learn.

Research suggests that a shift is needed in order to recognize these assets that ELs bring to the classroom and to understand that some deficits in performance arise from systematic lack of access to grade-level, content-rich, language-rich STEM learning opportunities rather than from limited ability or language proficiency or from cultural differences.

EFFECTIVE INSTRUCTIONAL STRATEGIES FOR STEM LEARNING AND LANGUAGE DEVELOPMENT

ELs develop both STEM knowledge and language proficiency when they are engaged in meaningful participation in the kinds of activities in which STEM experts and professionals regularly engage. While there is no language without content, there is some content that is less dependent on language. STEM subjects include alternative routes to acquiring knowledge—experimentation, demonstration of phenomena, and demonstration of practices—through which students can gain a sense of STEM content without resorting mainly to language to access meaning. It is through this experience that language is also learned—for example, as students engage in the disciplinary practices, they have a shared experience with their peers while using multiple resources to communicate their ideas—drawing, gesturing, and use of home language—in addition to the language in which they are learning the content.

Research demonstrates the effectiveness of teachers who engage ELs in authentic STEM activities and practices, and who encourage ELs to draw on their full range of linguistic and communicative competencies. Many instructional strategies show great promise, such as:

Engaging students in STEM disciplinary practices. As students engage in STEM content learning, they grapple with the language, ideas, concepts, and practices of the discipline, transforming what they learn into different representations or presenting it to a different audience, moving between concrete and abstract knowledge. They communicate their ideas with peers and the teacher and construct disciplinary meaning with the STEM classroom community. Capitalizing on ELs' prior knowledge and interests is an important starting point for linking disciplinary practices and language. For example, research has demonstrated how argumentative discussion is a major feature of social interaction among Haitian adults and how this discourse pattern can be leveraged as a resource for students as they practice argumentation in class.

Using multiple modalities. Modalities refer to the multiple channels through which communication occurs—spoken and written language, as well as nonlinguistic modalities such as gestures, pictures, and graphs. In the STEM classroom, students use multiple modalities to engage in the disciplinary practices. Multiple modalities may be especially useful for supporting ELs to engage in language-intensive practices, such as arguing from evidence and constructing explanations; for example, ELs use drawings, symbols, and text to construct model-supported explanations as they analyze and interpret data.

Leveraging multiple meaning-making resources. By the time ELs come to school, they already possess a range of knowledge, values, and ways of looking at the world that have developed during their socialization into their families and communities that could be leveraged to support STEM learning. For example, everyday language, ways of talking, and out-of-school experiences are all resources students use as they participate in STEM-based discussions.

Although research has revealed the effectiveness of these and other instructional practices, less-effective practices are still used. There is evidence that teachers of STEM content are not adequately prepared to foster the simultaneous development of language and content knowledge.

SYSTEMIC OPPORTUNITIES AND CHALLENGES

Policies at the federal, state, and local levels can either facilitate ELs' opportunities in STEM or constrain teaching and learning in ways that are detrimental to ELs' success. School districts that demonstrate success have leaders who attend to the system-wide coherence by implementing organizational

structures that enable the integration of language and content learning among components of the system—instruction, curriculum assessment, professional development, and policies for categorization of ELs—as well as within and between levels of administration (state, district, school).

In addition, much work remains to be done to ensure that the assessments used with ELs yield inferences that are fair, valid, and reliable. Language is the means through which tests are administered, limiting the extent to which appropriate generalization can be made about ELs' academic achievement. In order to develop fair, valid, and reliable assessments, it is imperative that ELs be included during large-scale and classroom test development.

The classification of ELs has substantial implications for understanding ELs' performance in STEM, given that classification affects everything from policy to research to instruction. The practice of excluding English-proficient ELs from the EL accountability group leads to overestimation of academic achievement gaps in STEM between ELs and non-ELs, and consequently to misperceptions of ELs' STEM proficiency and ineffective policy responses. Inconsistency in the classification and reclassification process within and across states further complicates the policy landscape of ELs and the identification of effective policies and practices.

RECOMMENDATIONS

The report offers a set of recommendations to guide the efforts of policy makers, district and school leaders, and educators as they work to support ELs' learning in STEM subjects.

RECOMMENDATION 1: Evaluate current policies, approaches, and resources that have the potential to negatively affect ELs' access to STEM learning opportunities, including classification and reclassification, course-taking, classroom instruction, program models offered, professional development, staffing, and fiscal resources, etc.

- Federal agencies should evaluate the ways in which funds are allocated for research and development that would enhance teaching and learning in STEM for ELs, including efforts that foster pipeline and training programs to increase the number of teachers qualified to teach STEM to ELs.
- States should evaluate their definition of English learner, including proper specification of entrance and exit procedures and criteria for districts. Districts should examine the policies and procedures that are in place for consistently implementing these state procedures/criteria for classifying/reclassifying ELs.
- States should evaluate policies associated with the timing of large-scale state assessments and waivers for assessment (i.e., waivers for science assessment), frameworks for teacher certification, and the distribution of financial and human resources.
- District leaders and school personnel should examine (a) the program models and placement of ELs in STEM courses with particular attention to grade bands as well as issues associated with overrepresentation of ELs in remedial courses, (b) preparation of STEM teachers with attention to schools with large EL populations, (c) the opportunities for teacher collaboration and professional development, and (d) the distribution of financial and human resources.
- Schools should evaluate ELs' success in STEM classes, the quality of STEM classroom instruction and the positioning of ELs in the classroom, the qualifications of teachers hired, the professional development opportunities offered to teachers, and the resources (e.g., time and space) allocated to STEM learning.

RECOMMENDATION 2: Develop a high-quality framework to identify and remove barriers to ELs' participation in rigorous STEM learning opportunities.

- District and school leaders should identify and enact norms of shared responsibility for success of ELs in STEM both within the district central office and within schools, developed by teams of district and school leaders associated with STEM and ELD/ESL education.

- States should take an active role in collecting and sharing resources across schools and districts. Leaders in states, districts, and schools should continuously evaluate, monitor, and refine policies to ensure that ELs' STEM learning outcomes are comparable to their never-EL peers.

RECOMMENDATION 3: Equip teachers and teacher candidates with the requisite tools and preparation to effectively engage and positively position ELs in STEM content learning.

- Preservice teacher education programs should require courses that include learning research-based practices on how to best support ELs in learning STEM subjects.
- Preservice teacher education programs and providers of in-service professional development should provide opportunities to engage in field experiences that include ELs in both classroom settings and informal learning environments.
- ESL teacher education programs and providers of in-service professional development should design programs that include collaboration with teachers of STEM content to support ELs' grade-appropriate content and language learning in STEM.
- Teacher educators and professionals involved in pre- and in-service teacher learning should develop resources for teachers, teacher educators, and school and district leaders that illustrate productive, research-based instructional practices for supporting ELs in STEM learning. Preservice teacher education and teacher credentialing programs should take account of teacher knowledge of large-scale STEM assessment interpretation, classroom summative task design, and formative assessment practices with ELs.

RECOMMENDATION 4: Develop high-quality STEM curricular materials and integrate formative assessment into classroom practice to both facilitate and assess ELs' progress through the curriculum.

- Curriculum developers, educators, and EL researchers should work together to develop curricular materials and resources that consider the diversity of ELs' needs as the materials are being developed and throughout the design process.
- EL researchers, curriculum developers, assessment professionals, teacher educators, professional learning providers, and teachers should work collaboratively to strengthen teachers' formative assessment skills to improve STEM instruction and promote ELs' learning.

RECOMMENDATION 5: Encourage and facilitate engagement with stakeholders in ELs' local environment to support STEM learning.

- Schools and districts should reach out to families and caregivers to help them understand the available instructional programs in STEM and the different academic and occupational opportunities related to STEM, including what resources might be available in the community.
- Schools and districts should collaborate with community organizations and form external partnerships with organizations that focus on informal STEM learning to make an active effort to directly engage ELs and their caregivers in STEM-related learning activities in an effort to understand their EL families' and communities' assets and needs.

RECOMMENDATION 6: Design comprehensive and cohesive STEM assessment systems that consider ELs and the impact of those assessments on STEM academic achievement for all students.

- Developers of large-scale STEM assessments need to develop and use population sampling frameworks that better reflect the heterogeneity of EL populations to ensure the proper inclusion of statistically representative samples of ELs in the process of test development according to sociodemographic variables including language proficiency, first language, geographical distribution, and socioeconomic status.

- Decision makers, researchers, funding agencies, and professionals in the relevant fields need to develop standards on the numbers and characteristics of students that need to be documented and reported in projects and contracts involving EL STEM assessment.

RECOMMENDATION 7: Review existing assessment accommodation policies and develop accessibility resources.

- States, districts, and schools need to review their existing policies regarding the use of accommodations during accountability assessments to ensure that ELs are afforded access to those linguistic accommodations that best meet their needs during instruction as well as during assessment.
- States, districts, and schools should also examine their implementation of accommodations to ensure that accommodations are implemented with high fidelity for all ELs, take steps to improve implementation when high fidelity is not realized, and improve poor implementation when it is present.
- States and districts involved in developing new computer-administered assessments or revising existing computer-administered assessments, should develop those assessments to incorporate accessibility resources rather than rely on accommodations.
- States involved in the development of new STEM assessments should apply universal design principles in the initial development and consider ELs from the beginning.

COMMITTEE ON SUPPORTING ENGLISH LEARNERS IN STEM SUBJECTS

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For More Information . . . This Consensus Study Report Highlights was prepared by the Board on Science Education based on the Consensus Study Report *English Learners in STEM Subjects: Transforming Classrooms, Schools, and Lives* (2018). The study was sponsored by the National Science Foundation. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project. Copies of the Consensus Study Report are available from the National Academies Press, (800) 624-6242; http://www.nas.edu/ELinSTEM.

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