

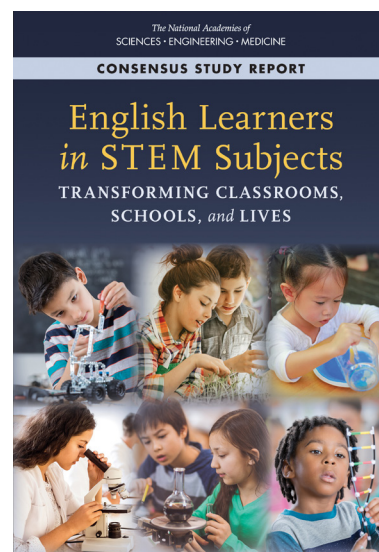
English Learners in STEM Subjects: Transforming Classrooms, Schools, and Lives

Highlights for Providers of Professional Learning for Teachers

English learners (ELs) comprise a diverse and talented pool of learners who bring valuable perspectives and resources to science, technology, engineering, and mathematics (STEM) classrooms that reflect their experiences with their home languages, homes and communities, as well as STEM schooling in other countries. Yet, many of these students' lack access to rigorous STEM learning opportunities, in part due to incorrect assumptions that English proficiency is a prerequisite for students to learn STEM content.

English Learners in STEM Subjects: Transforming Classrooms, Schools, and Lives (2018), a report from the National Academies of Sciences, Engineering, and Medicine, emphasizes the importance of teaching language and STEM content in an interconnected way and identifies factors that affect ELs' access to rigorous, grade-appropriate STEM content learning opportunities and their success in STEM.

The report presents the considerable evidence that ELs can participate in, contribute to, and succeed in STEM subjects with appropriate curricular and instructional support. Equipping teachers so that all students, including ELs, have opportunities to reach their full potential in STEM requires changes in classrooms and schools. This brief highlights information and recommendations from the report relevant to those who provide professional learning opportunities for teachers including: teacher education programs, teacher educators, and professional organizations for teachers.



TEACHER PREPARATION AND PROFESSIONAL LEARNING

Strategies for supporting teachers in promoting the success of ELs should take into account a broad range of factors, including differences across grade-levels, STEM disciplines, program models, teacher experience, geographic region, and broad variations within EL student populations. **Importantly, providing professional learning opportunities aimed at helping teachers integrate STEM content learning and language learning requires a move toward models centered on the assets that students, including ELs, bring to the classroom.** Many of the promising approaches for effectively preparing teachers to work with ELs explicitly acknowledge the roles that power and privilege play in achieving equitable STEM learning.

The report describes eight cross-cutting components of professional learning experiences for all teachers (both preservice and in-service) of STEM subjects who work with ELs.

- 1. Targeted teacher learning around common societal biases and beliefs.** Commonly held biases and beliefs about ELs can influence classroom interactions and practices, and negatively affect ELs' learning outcomes. Teacher preparation programs that specifically address implicit assumptions, beliefs, and expectations that teachers have about working with ELs can mitigate this. **When teachers and teacher candidates have opportunities to examine their own cultural and linguistic backgrounds and self-perceptions in relation to their work with ELs in STEM, they are more likely to focus on the assets EL students bring to the classroom.** Specifically, teacher education programs that explicitly focus on teachers' backgrounds in the context of their pedagogical practices, such as through community-based immersion programs, can serve to bridge social and cultural gaps between teachers and their students.
- 2. Explicit integration of STEM content and disciplinary language.** ELs develop STEM content knowledge and language simultaneously when they can engage in discipline-based learning experiences that require language use. Because language is an essential part of the practices of all of the STEM disciplines, teachers need explicit knowledge about how the intentional use of language shapes students' meaning-making in STEM subjects. Research suggests that teachers can improve their ability to engage and teach ELs effectively by developing as teachers of language as well as teachers of STEM disciplinary content. Therefore, **current and future teachers of STEM subjects should be provided with learning opportunities that use and facilitate disciplinary language and integrate these practices into content instruction.**
- 3. Shared professional learning experiences for ESL and STEM content teachers.** Learning to teach disciplinary content in innovative ways, while also learning to use language in new ways to meet the needs of all students, including ELs, is a dual challenge for teachers of STEM subjects. One structure that has proven to be effective is the integration of trained ESL teachers and paraprofessionals into STEM classrooms. **Shared professional learning experiences for ESL and STEM content teachers allow them to collaborate, share their expertise with one another, and establish a shared vision for the integration of disciplinary content and language.** Moreover, restructuring teacher education coursework to more specifically address collaboration between ESL and content teachers leads to improvements in teachers' attitudes and practices for supporting ELs.
- 4. Facilitation of multilingual instructional approaches in STEM classrooms.** The broad range of linguistic resources that ELs possess are powerful assets that can be leveraged for making and communicating meaning in STEM classrooms. **Preparing teachers to uncover disciplinary understanding requires education focused on the intersection of understanding students' diverse linguistic resources with developing teachers' skills as language planners.** Research on instructional strategies and student learning highlights the value of encouraging ELs to use their full range of linguistic and communicative competencies for STEM learning. For example, when ELs are encouraged to draw, gesture, or even use their home language as they explain concepts, their deep conceptual understanding can be surfaced even if they are still working towards developing the use of precise disciplinary vocabulary.
- 5. Use and adaptation of research-based curriculum.** Curriculum units designed to integrate instructional strategies for language and content together are valuable tools for teachers in supporting ELs. Research shows that when given agency to help create and adapt curriculum, teachers increase their implementation of research-based, innovative practices to support ELs. Additionally, **teachers show increasing willingness and ability to design and enhance curriculum materials to meet the STEM subject learning needs of their ELs when they have worked collaboratively with researchers on specific strategies.** However, increasing expectations that teachers should adapt curriculum for ELs, especially modifications that consider students' language and culture, will require significant professional learning and ongoing support.

6. Use of culturally sustaining pedagogies and explicit attention to equity. Culturally sustaining pedagogies recognize and build on the value of the experiences that ELs bring to the classroom. Positive effects on students' learning in STEM subjects have been observed when teachers make meaningful connections to students' linguistic and cultural experiences. However, many teachers of STEM subjects who work with these populations have limited experiences as a linguistic or cultural minority. **Equipping teachers to teach STEM to ELs requires not only developing their familiarity with culturally responsive and equity-focused pedagogy, but also well-designed field experiences (e.g., community-based immersion programs) that align with and support these approaches.** Moreover, for teacher candidates, the role of field supervisors as mentors is a key component of these field experiences.

7. Engagement with families. A persistent family-school connection strongly promotes EL's long-term educational attainment, and teachers play a central role in fostering a trusting collaboration with families. In addition, teachers' attitudes, including those about race, ethnicity, language, and socio-economic status, are critical factors that influence the extent to which teachers and families come together to support ELs. **Professional learning models that focus on engaging children and families from culturally and linguistically diverse backgrounds in STEM can have a number of important effects including: helping teachers and schools shift to an asset orientation toward ELs' STEM learning; increasing the engagement of families of ELs in other school-based activities, and improving ELs' motivation in their STEM learning.** Additionally, contact and collaboration with diverse ethnic and linguistic communities in out-of-school settings can support teachers in effectively teaching STEM content to ELs.

8. Support for effective use of classroom assessment. Classroom assessments (e.g., summative and formative) are important for teachers' use in instructional planning and student-level decision making. Through formative assessment, students are able to express their ideas using models/diagrams and explain those ideas in their own words, which allows teachers to engage in sustained conversation with students. Therefore, it is especially suited to help teachers assess ELs' content thinking so they can build on what students say/know. **Teacher preparation programs and professional learning should be designed to support and evaluate teachers as they become critical assessment users, task designers, and interpreters of student performances.** Teachers need support in building familiarity with the cultural backgrounds of their students so that they do not come to erroneous conclusions about their students' STEM understanding. In addition, teachers need to be able to critically interpret and integrate information yielded by classroom assessments with other sources of information on their ELs' STEM learning.

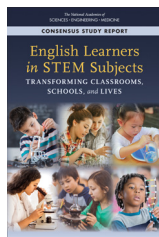
RECOMMENDATIONS

The report offers a set of recommendations to guide the efforts of policymakers, state, district, and school leaders, as well as educators, as they work collaboratively to support ELs' learning in STEM subjects. Below are the key considerations aimed at providers of professional learning opportunities.

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

- Preservice teacher education programs should require courses that provide teacher candidates with an understanding of 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 for teachers to engage in field experiences that include ELs in both classroom settings and informal learning environments.

- English as a second language 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 promoting ELs’ learning in STEM.
- 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.
- 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.



English Learners in STEM Subjects: Transforming Classrooms, Schools, and Lives (2018)

Available:

<https://nationalacademies.org/ELinSTEM>

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For More Information . . . This Highlights for District and School Leaders 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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