The National Academies of
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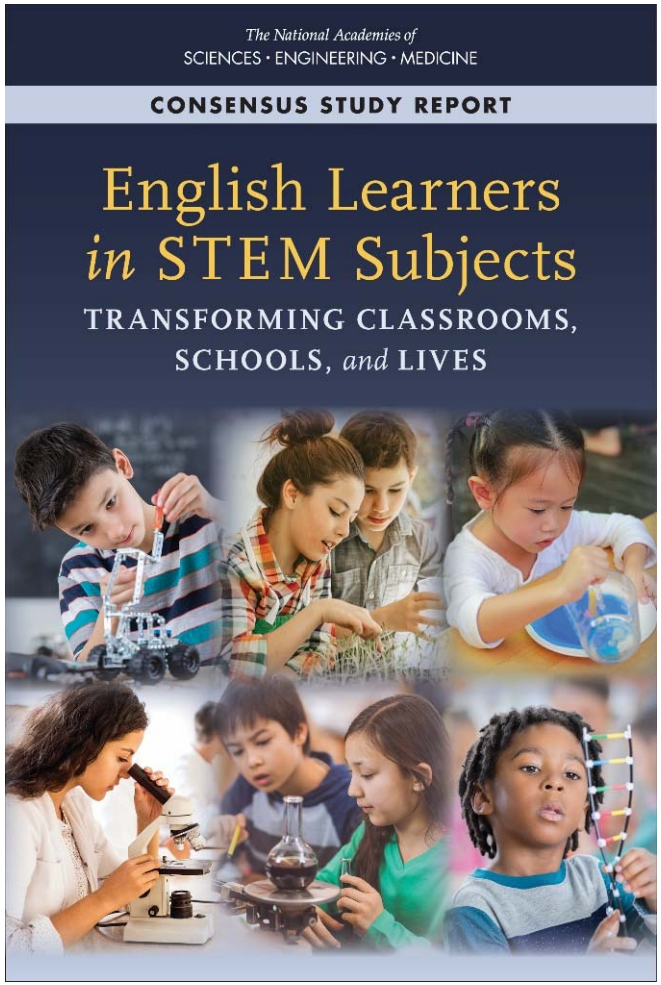
BOARD ON SCIENCE EDUCATION

English Learners in STEM Subjects: Preservice and In-service Educator Preparation

Sponsor: National Science Foundation

#ELSTEM

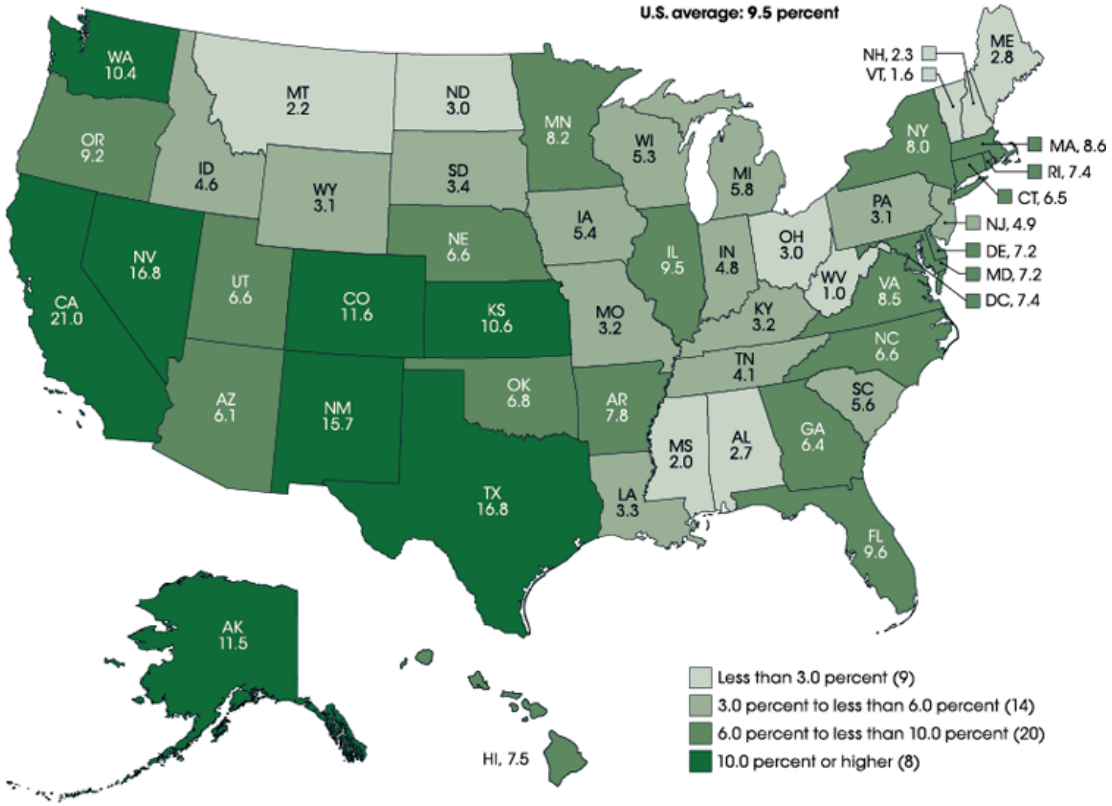
Scope



- ELs pre-K-12th grades
  - Promising approaches to support ELs in learning STEM
  - **Role and preparation of teachers**
  - Assessments in STEM
  - Policies and practices
  - Gaps in current research base
- Role of Families & Communities

Defining and Distribution of ELs
(Data from Fall 2015)

Percentage of public school students who were ELs by state
9.4% of student population is ELs (4.6 million students)



- 3–21 years old enrolled in elementary/secondary school
- Native language not English
- Proficiency may limit or deny ability to achieve in English-only classrooms

SOURCE: U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD) See *Digest of Education Statistics 2017*, table 204.20.

Role of Teachers of STEM Content

- Construct safe & welcoming classroom communities and effectively implement instructional strategies
- Requires teachers to have adequate preparation and continued support
- Multifaceted issue with common themes but substantive differences
  - Grade-level
  - Disciplines
  - Program models
  - Teacher experience
  - Classroom makeup (EL variability)

Preservice and In-service Teachers Lack Adequate Preparation Opportunities

- Most teachers have not received adequate opportunity to prepare to provide *appropriate* STEM-related learning opportunities to ELs

- Few opportunities to learn how to integrate language learning and STEM learning or how to enhance curricula

Teacher Educators

Few opportunities to learn how to prepare teachers to teach STEM to ELs.

- Need professional development with other teacher educators with expertise in supporting teachers learning to work with ELs
- Collaborate with teachers who successfully teach ELs
- Professional development that focuses on: leveraging student thinking in STEM; disciplinary practices and discourse; and curriculum materials that teachers will use in teaching

Crosscutting Themes

Explicit Integration of STEM Content & Disciplinary Language

Use & Adaptation of Reform-based Curriculum

Shared Professional Learning Experiences for ESL & Content Teachers

Facilitation of Multilingual Instructional Approaches in STEM Classrooms

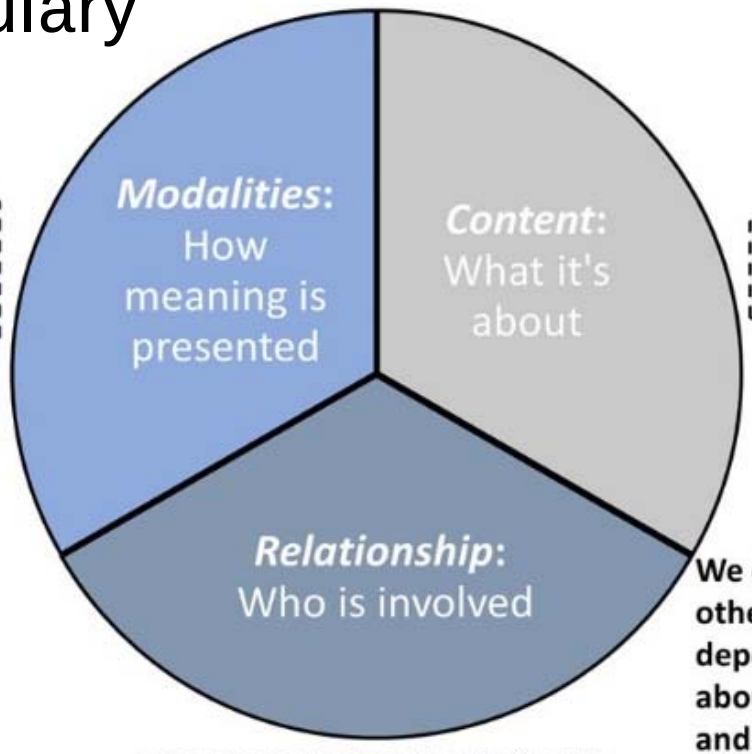
Engagement with Families

Use of Culturally Sustaining Pedagogies & Explicit Attention to Equity

Targeted Teacher Learning Around Common Societal Biases & Beliefs

Explicit Integration of STEM Content and Disciplinary Language

- Language → Sense-making
  - Explicit knowledge about intentional use of language
  - More than vocabulary



Modalities: Gesture, speech, writing, drawing, graphing, choice of language or language variety

Content: Choices shaped by the topic, process, activity, discipline

Relationships: Shaped by role, status, formality, grouping

We draw on different language and other meaning-making resources depending on what we are interacting about, whom we are interacting with, and the modalities available in a particular context.

Example: Shifting Language Registers

Context	Context 1	Context 2	Context 3	Context 4
Modalities	Spoken by a small group of students with accompanying action or gesture	Spoken by a student about the action, after the event	Written by a student	**Written using equations in the textbook**
	S1: Mark it like this S2: No, try this way S1: Ok, count those…30 S2: the tarts all need 2; 30 divided by 2 S1: 15	S1: We drew the ten peaches and then cut each one into three parts. Then we counted all the parts. So it was thirty parts, and each tart had to have two parts, so we divided thirty by two and got fifteen tarts.	When you want to find how many thirds there are, you can divide each peach into three. When you count how many thirds, you get 30. Since each tart needs two thirds, you can divide 30 by two and get 15. That means that Sophia can make 15 tarts.	**To divide a whole number by a fraction, multiply the whole number by the reciprocal of the fraction.** **10 ÷ (2/3) = 10 * (3/2)** **= (10*3) /2)** **= 15**
Relationship	Peer-to-peer, face-to-face interaction	Reporting on behalf of a small group	Individual written production for the teacher	**Author writing for a remote audience of learners**
Content	**Solving a fractions division problem**			

Shared Professional Learning Experiences for ESL and STEM Content Teachers

"ESL professional development for mainstream teachers must go beyond activities designed to increase comprehensible input and provide a welcoming environment. It must target more informed attitudes towards teaching linguistically and culturally diverse students, deeper understandings of second language and literacy development and of the language demands of content area texts and tasks, and more sophisticated approaches to integrating language and content instruction" (Harper & de Jong, 2009, p. 147).

Shared Professional Learning Experiences for ESL and STEM Content Teachers

- When content teachers & ESL teachers have shared professional development both groups of teachers are more likely to learn knowledge & competencies that benefit ELs.
  - Facilitate collaboration: formally articulated procedures, trust, mutual respect of expertise
  - Barriers to collaboration: lack of knowledge of other's skills, lack of coordination & communication, rigid decision making (Pawan & Ortloff, 2011)

Engagement with Families of ELs

- Persistent family-school connections are essential for promoting all students' educational attainment
- When teachers have positive expectations and beliefs about ELs in STEM, they are less likely to have a remedial view of their ELs. Engaging in experiences with families of ELs can increase these positive expectations of ELs and their families
- Benefits of co-constructed community-based experiences rather that solely school-based

Other Benefits of Teachers Engaging with Families of ELs

- Supports disrupting outdated ideas about language interference when teachers and families engage in *translanguaging* practices together
- Supporting STEM academic and occupational pathways – families of ELs often express deep interest in STEM careers but may lack information
- Venue for teachers to explore their own implicit biases and beliefs about English learners

Use of Culturally Sustaining Pedagogies and Explicit Attention to Equity

- Culturally sustaining pedagogies support ELs "in sustaining the cultural and linguistic competence of their communities while simultaneously offering access to dominant cultural competence" (Paris, 2012, p. 95).
- From this perspective, adding more diverse literature to the classroom or celebrating some cultural holidays is not enough; more must be done to sustain—rather than repress or oppress—students' culture.

Use of Culturally Sustaining Pedagogies and Explicit Attention to Equity

- Teachers play a critical role in positioning ELs as competent members in STEM classrooms.
  - Providing meaningful STEM learning opportunities for ELs can increase teachers' comfort working with diverse students
  - Capitalize upon students' interests and passions
  - Teachers that engage with families more likely to have an appreciation for their cultural & linguistic differences
  - Make assessments more culturally relevant

Recommendation 3: Equip *all* teachers with requisite tools and preparation

Preservice Teacher Education Programs

Require courses that include learning research-based practices for supporting ELs in learning STEM subjects

Preservice Teacher Education Programs/In-service Professional Development Providers

Provide opportunities to engage in field experiences that include ELs in both classroom settings and informal learning environments

ESL Teacher Education Programs/In-service Professional Development Providers

Design programs that include collaboration with teachers of STEM content to support ELs' grade-appropriate STEM content and language learning

Teacher Educators and Professionals involved with Pre- and In-service Teacher Learning

Develop resources for teachers, teacher educators, and school/district leaders that illustrate productive, research-based instructional practices

Preservice Teacher Education and Teacher Credentialing Programs

Measure teacher knowledge of large-scale STEM assessment interpretation, classroom summative task design, and formative assessment practices with ELs

Questions?

UPCOMING ACTIVITES

- Webinar Series
  - Jan 10: Classroom Instruction & Assessment
  - Jan 24: Building Capacity
  - Feb 22: Large-scale & Classroom Assessment
- Release Events
  - CA: January 14, 2019
  - DC: February 12, 2019

FIND OUT MORE

www.nas.edu/ELinSTEM

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