The National Academies of
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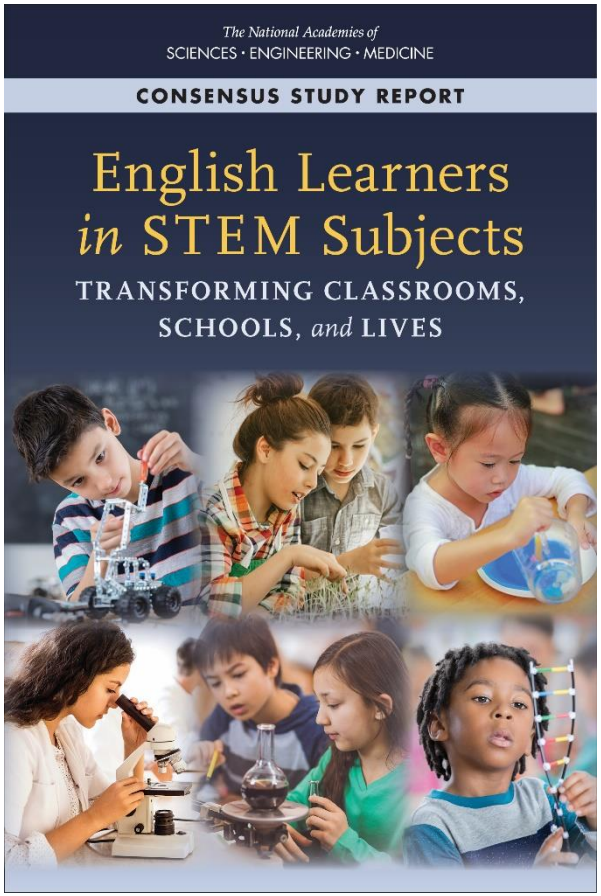
BOARD ON SCIENCE EDUCATION

English Learners in STEM Subjects: Promising Classroom Instructional Strategies and Assessment

Sponsor: National Science Foundation

#ELSTEM

What Does the Report Address?



- ELs pre-K-12th grades
  - **Promising approaches to support ELs in learning STEM**
  - School-family-community
  - Assessments
  - Teacher preparation and professional development
  - Policies and practices
  - Gaps in current research base

Topics for Presentation

1. Framing of issues
2. Promising approaches to support ELs in learning STEM
3. Teacher preparation and professional development across STEM and language

Topic 1:
Framing of Issues

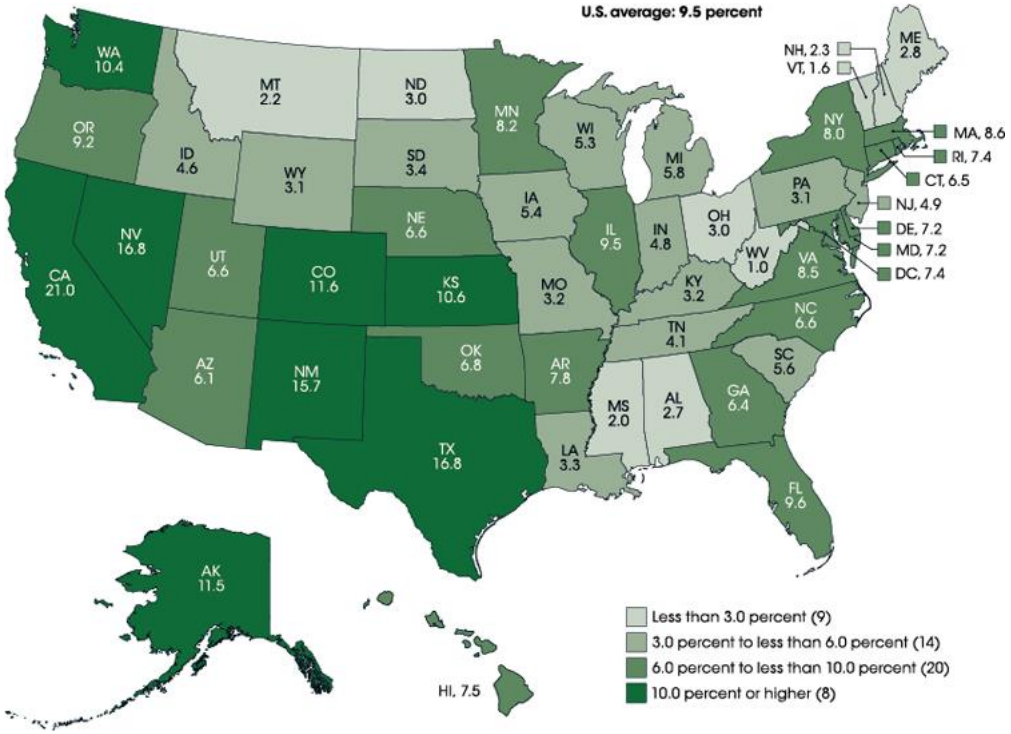
1. Language, S, T, E, & M (5 subjects) coming together to support and challenge ELs
2. Defining ELs
3. Language and STEM disciplines
4. Asset-oriented view

Language, S, T, E, & M (5 Subjects) Coming Together

1. Language as meaning-making, functional use of language
2. Science as making sense of phenomena by engaging in science practices and using language
3. Technology with limited research
4. Engineering with emerging research
5. Mathematics as mathematical proficiency, practices, and discourse

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.

Language and STEM Disciplines

- Mathematics & Science
  - Disciplinary practices allow ELs to learn disciplinary content while engaging in meaningful language use
  - Developmental in nature leading to sophisticated understandings & capabilities → implications for structuring & implementing instruction in early grades
- Language
  - ELs need opportunities to use ***all*** of their meaning-making resources that are essential for STEM learning

Asset-Oriented View

- ELs bring rich perspectives and resources to the classroom that can promote STEM learning
  - ELs bring multicompetence to STEM classrooms
- Language as a resource for STEM learning
  - ELs have the capacity to engage in STEM disciplinary practices and learn disciplinary content while simultaneously developing English proficiency

Topic 2:
Promising Approaches to support ELs in Learning STEM

1. Promising instructional strategies
2. School-family-community

Classroom Culture: Teachers' Beliefs and Expectations

- Teachers' attitudes, beliefs, & expectations about ELs' capacity for grade-appropriate STEM learning influence teachers' approaches to & engagement of ELs in STEM instruction.
  - Teachers tend to hold a deficit view of ELs, but an asset-oriented view promotes learning.
  - When teachers have positive expectations, they are more likely to provide meaningful STEM learning opportunities for ELs.
  - Teachers support and challenge ELs.

Approaches to Reimagine

- Vocabulary is a prerequisite: Pre-teaching and frontloading of vocabulary
  - Instead, language is a product
- Separate content objectives and language objectives
  - Instead, functional use of language to engage in disciplinary practices and learn disciplinary content
- Simplify content, simplify language
  - Instead, keep content, amplify language

Promising Instructional Strategies

- Engage Students in Disciplinary Practices
- Engage Students in Productive Discourse and Interactions with Others
- Utilize and Encourage Students to Shift Registers and Use Multiple Modalities
- Leverage Multiple Meaning-Making Resources
- Provide Some Explicit Focus on How Language Functions in the Discipline
- Use Culturally Sustaining Pedagogies

Integration of STEM content & language learning can be achieved when teachers recognize *functional use of language* in STEM instruction.

Engage Students in Disciplinary Practices

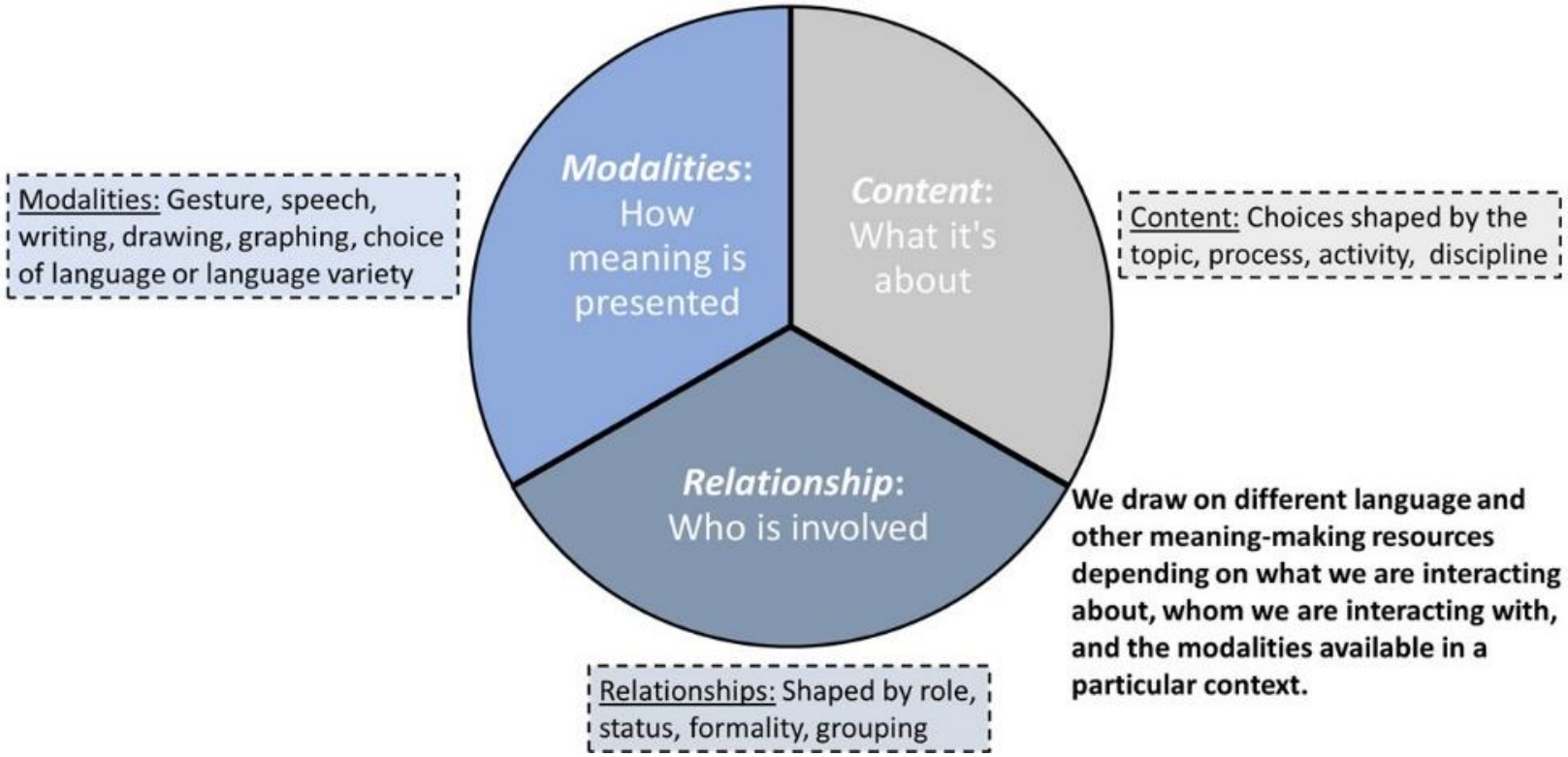
- **Identify Compelling Phenomena and/or Problems**
  - Everyday or community-based phenomena and problems acknowledge and elicit ELs' funds of knowledge.
  - ELs use multiple meaning-making resources, including home language and everyday language, to make sense of phenomena and problems.
- **Build Understanding to Explain Phenomena and/or Problems**
  - ELs engage in disciplinary practices, including reasoning, modeling, arguing, explaining.
  - As disciplinary practices are language intensive, they present both language learning opportunities and demands.
- **Develop Deeper and More Sophisticated Understanding**
  - As ELs develop more sophisticated understanding, they use more sophisticated language.

Engage Students in Productive Discourse

- Scaffolding
  - Different levels, settings, and pedagogical purposes
  - Contingent upon reaction of learner to something new
- Structuring Interaction
  - Teachers plan activities and interactions among students
  - Student Critical Turns and Initiation-Response-Feedback
- Talk Moves and Disciplinary Talk
  - Make explicit types of talk essential for sense-making
  - EXAMPLES: sharing; expanding clarifying reasoning; listening to and understanding others' ideas; provide evidence and examples; asking questions; comments to agree with/add on to/expand others' ideas

Encourage Students to Shift Registers and Use Multiple Modalities

- Register: Meaning-making choices
- Functional use of language



Example: Shifting 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			

Example: Shifting Registers

Students use increasingly specialized registers over time

EWWW! It stinks!

Smell is something. It's a gas.

Smell is a gas made of particles.

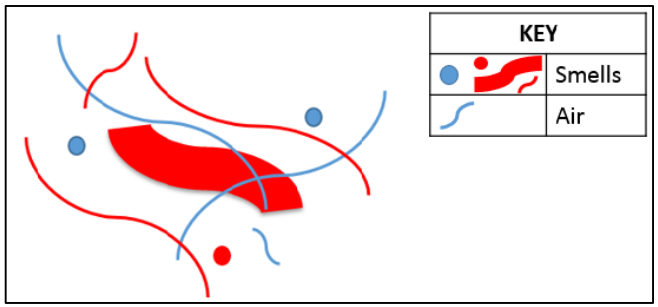
Smell is a gas made of particles too small to see moving freely in space.

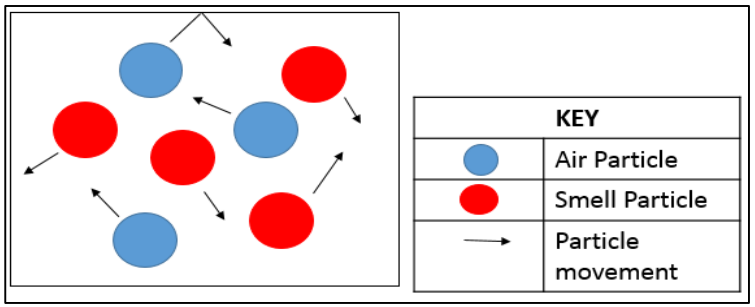
From everyday to specialized registers

Example: Multiple Modalities

Students use multiple modalities in increasingly strategic ways over time

Smell





Talk, text, diagrams, symbols, tables, graphs, etc.

Leverage Multiple Meaning-Making Resources

- First language, everyday language, gestures, and objects
- Attention to how students use everyday language to build more formal ways of using language
- Translanguaging
- Relationships, humor, and cultural ways of knowing

Provide Some Explicit Focus of How Language Functions in Disciplines

- Attention to language beyond a focus on "words"
  - Provide opportunities to develop meaning through participating in disciplinary practices
  - Learn not only individual words, but also how to use them to develop and communicate disciplinary content
- Metalanguage
  - Model how to write or speak
  - Deconstruct what is said or written

Use Culturally Sustaining Pedagogies

- 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 Culturally Sustaining Pedagogies

- 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
  - Teachers need to capitalize on students' interests
  - Teachers who engage with families are more likely to have an appreciation for their cultural & linguistic differences
  - Teachers promote an asset-oriented view of students' cultures.

School-Family-Community

- 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 deficit view of ELs. Engaging in experiences with ELs' families can increase these positive expectations of ELs and their families
- Teachers benefit from co-constructed community-based experiences, rather than solely school-based

School-Family-Community

- When teachers and families engage in *translanguaging* practices together, they disrupt outdated ideas about language interference
- Families of ELs often express deep interest in STEM careers but may lack information
- Teachers need venues to explore their own implicit biases and beliefs about ELs

Topic 3: Teacher Preparation and Professional Development Across STEM and Language

1. Collaboration across STEM and EL educators
2. Preservice and in-service teachers lack adequate preparation opportunities
3. Equip all teachers with preparation and tools

Collaboration Across STEM and EL Educators

- Collaboration involves teachers of STEM subjects and EL teachers to come together for shared professional development about how to advance ELs' STEM learning
- When teachers of STEM subjects and EL teachers have opportunities to collaborate and share their expertise, they are more likely to learn STEM content and competencies that benefit ELs

Preservice and In-service Teachers Lack Adequate Preparation Opportunities

- Most teachers have not received adequate preparation to provide STEM learning opportunities to ELs
- Most teachers have few opportunities to learn how to integrate language learning and STEM learning
- The traditional lack of preparation offers opportunities to reimagine teacher learning

(For details, see the webinar on preservice and in-service educator preparation on December 12, 2017)

Equip *all* Teachers with Preparation and Tools

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

In-service Professional Development Providers

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

Teacher Educators and Professionals

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

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 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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