The National Academies of SCIENCES · ENGINEERING · MEDICINE

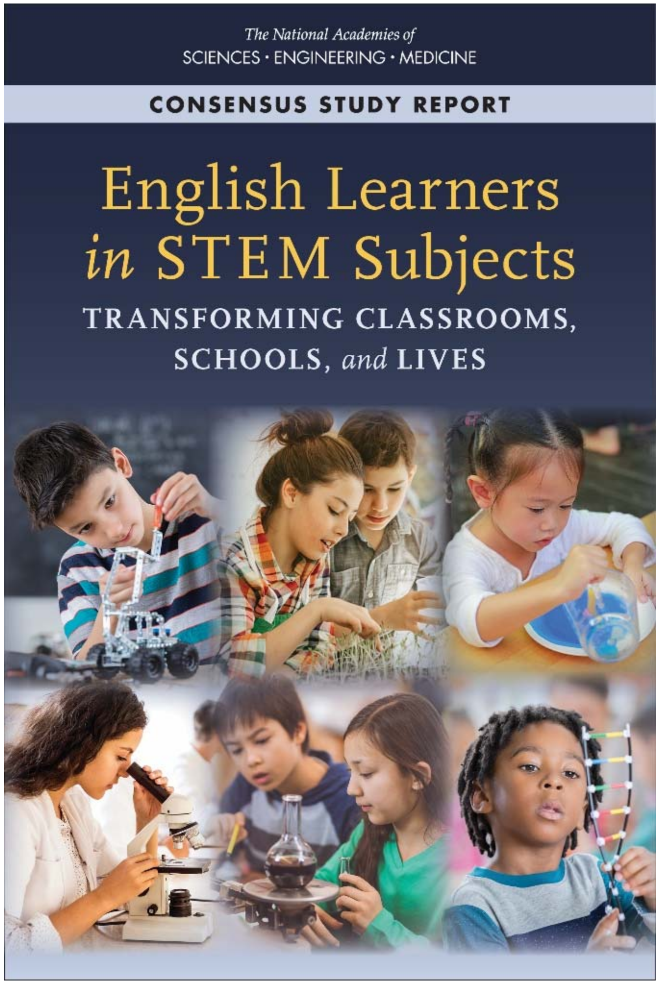
BOARD ON SCIENCE EDUCATION

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

Sponsor: National Science Foundation

#ELSTEM

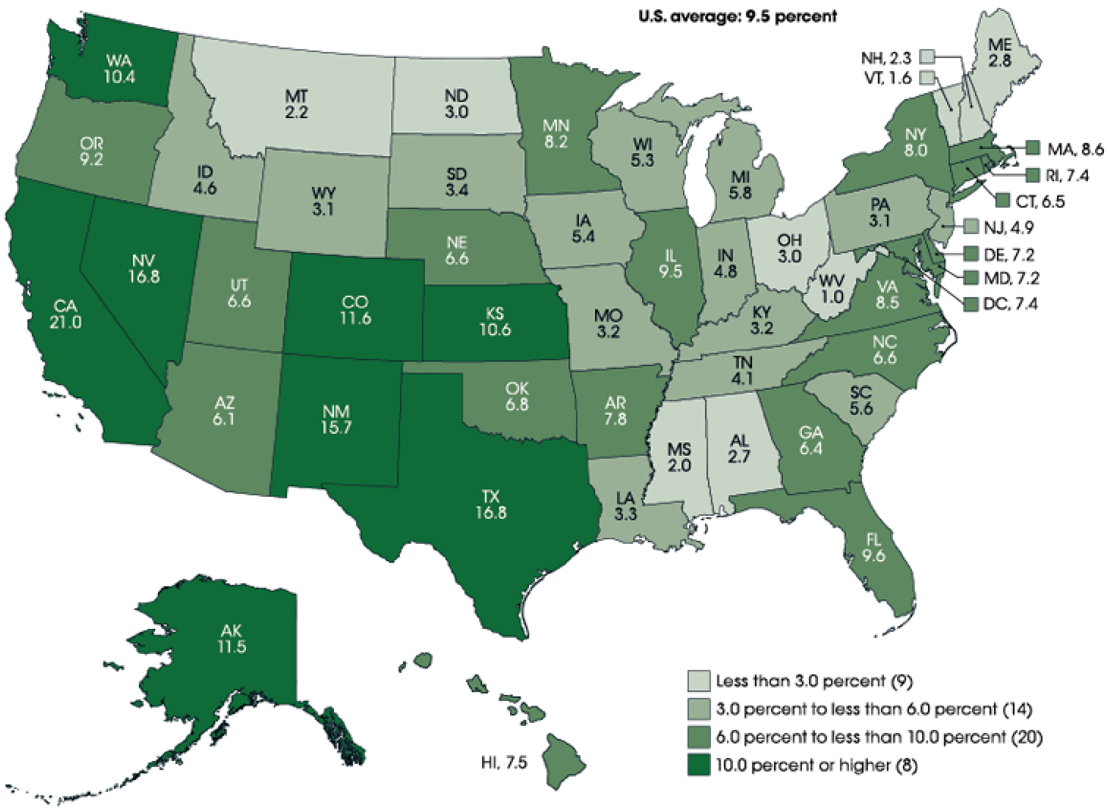
Scope



- ELs pre-K-12th grades
  - Promising approaches to support ELs in learning STEM
  - Role of families & communities
  - Teachers preparation & development
  - Assessments in STEM
  - Policies and practices for capacity building
- Recommendations & gaps in current research base

Definition 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.

Figure 7-1: STEM Assessment and English Learners in U.S. Schools

Macro-level Assessment*	**Types:** ***Large-scale summative assessment*:** • NAEP Mathematics and Science assessments • State standards-based mathematics assessments (e.g., SBAC & PARCC) • NGSS science and engineering assessments (new and in development)**	**Intended Uses:** ***Accountability*** • ESSA funding to states • District and school performance evaluation ***Cross-state/district/school comparisons*** ***Population-level decisions*** • Monitoring of annual progress and achievement ***Student-level decisions*** • Monitoring of annual progress and achievement • Promotion, retention, placement	**Key Considerations for ELs:** • Validity of score interpretation • Test accommodations and accessibility resources • Test design/development	**Guiding Questions:** • *What do large-scale assessment systems reveal about EL students' STEM learning?* • *What are the limitations of large-scale STEM assessment practices and policies?* • *How can large-scale assessment of STEM be improved for EL students?*
Micro-level Assessment	**Types:** ***Classroom summative assessment:*** • Curriculum-based assessments • State or district interim assessments • Teacher created tasks ***Formative assessment:*** • Informal: ➢ Moment-to-moment observations, conversations with teachers, peers, etc. (short-cycle)*** • Formal: ➢ Periodic probes and tasks (medium-long cycles)***	**Intended uses:** ***Classroom summative assessment:*** • Monitoring progress and achievement • Tracking/placement • District/parent reporting • Diagnostic ***Formative assessment:*** • Generate feedback to teachers (contingent instruction) and students (to guide learning) *during* instruction	**Key Considerations for ELs:** • Teacher professional development for implementation and unbiased interpretation • Innovative practices, including: ➢ bilingual assessment; ➢ implementation of learning progressions • Social interaction of ELs and social inclusion of ELs in the classroom	**Guiding Questions:** • *What does effective classroom assessment of the STEM disciplines look like for EL students?* • *What should teachers know and be able to do to serve EL students through classroom assessment?*

* Black, P., Wilson, M., and Yao, S. Y. (2011). Road maps for learning: A guide to the navigation of learning progressions. *Measurement: Interdisciplinary Research & Perspective*, *9*(2-3), 71-123.

** For example, Washington Comprehensive Assessment of Science (operational 2017-18), California Science Test (operational Spring 2019), Massachusetts Comprehensive Assessment System. See also, National Research Council (2014). *Developing Assessments for the Next Generation Science Standards.* Washington, DC: The National Academies Press.

*** Wiliam, D. (2006). Formative assessment: Getting the focus right. *Educational Assessment, 11*(3-4), 283-289.

Macro-level Assessment Types and Intended Uses

Types:

Large-scale summative assessment:

- NAEP Mathematics and Science assessments
- State standards-based mathematics assessments (e.g., SBAC & PARCC)
- NGSS science and engineering assessments (new and in development)**

Intended Uses:

Accountability

- ESSA funding to states
- District and school performance evaluation

Cross-state/district/school comparisons

Population-level decisions

- Monitoring of annual progress and achievement

Student-level decisions

- Monitoring of annual progress and achievement
- Promotion, retention, placement

Macro-level Assessment Considerations and Guiding Questions

Key Considerations for ELs:

- Validity of score interpretations
- Test design/development
- Test accommodations and accessibility resources
- Reporting and documentation

Guiding Questions:

- *What do large-scale assessment systems reveal about EL students' STEM learning?*
- *What are the limitations of large-scale STEM assessment practices and policies?*
- *How can large-scale assessment of STEM be improved for EL students?*

Key Considerations: Validity of interpretations of scores

Issues:

- Measurement error due to uncertainty of classifications
- Large test score variation due to linguistic variation due to heterogeneity
  - multiple patterns of English proficiency and language dominance
  - multiple cultural and first language backgrounds
- Contextual information used in test items may be unfamiliar to many EL students

Actions:

- In assessing EL students on STEM subjects
  - Use information from multiple assessment sources in combination
  - Do not depend on one single test
- In evaluating the technical quality of STEM subjects tests
  - Make sure to disaggregate data by linguistic group

Key Considerations: Test Design and Development

Issues:

- The process of test development is critical to validity in EL testing
- Tests are tremendously sensitive to language
- A great deal of the work developing and refining test items has to do with refining their wording to ensure that students understand them as intended

Actions:

- Test developers should always try out draft versions of items to refine their wording
- EL students should always be included in pilot student samples by
  - providing information on words or phrases they do not understand
  - providing written responses
  - participating in cognitive interviews
- Limited proficiency in English does not prevent ELs from communicating with interviewers

Key Considerations: Test Accommodations and Accessibility Resources

Issues:

- Limited effectiveness in supporting ELs to gain access to the content of items
- Poor implementation
- Blanket accommodations (the same form accommodation for all ELs) are not sensitive to individual EL student needs
- Some blanket accommodations may be harmful for students who do not need them

Actions:

- Use and select accommodations that
  - operate on language
  - pose no challenge for effective implementation
  - are sensitive to students' individual needs
- Pop-up glossaries in computer-based testing are promising
- Do not assume that all validity and fairness issues in EL testing will be resolved

Key Considerations: Reporting and Documentation

Issues:

- Reports focused solely on scores are difficult to interpret
- Reports do not pay much attention to the heterogeneity of EL populations
- Aggregated data may mask limitations of tests
- Results from tests may underestimate the performance of ELs

Actions:

- Provide information on performance on specific topics
- Disaggregate data by level of English proficiency
- Ensure educators are properly supported to learn to interpret reports

Guiding Question: *What do large-scale assessment systems reveal about EL students' STEM learning?*

- EL students perform lower than their peers on STEM subjects.
- These differences speak to the difficulties of learning and demonstrating knowledge in a second language HOWEVER, to a large extent the differences are due to limitations of
    - procedures used to measure English proficiency and identify and classify ELs
    - actions intended eliminate language proficiency as a confounding factor in STEM tests

Guiding Question: *What are the limitations of large-scale STEM assessment practices and policies?*

- ELs are not adequately included in the process of test development to obtain information needed to properly reefing the wording of items
- The majority of testing accommodations are ineffective and poorly implemented
- The technical quality of tests is not always reported; if reported, information for ELs and non-ELs is not reported separately

Guiding Question: *How can large-scale assessment of STEM be improved for EL students?*

- Include representative samples of ELs in the process of test development to refine the wording of items
- Disaggregate by level of English proficiency to examine the technical quality of test items
- Include testing accommodations that are sensitive to EL students' individual needs
- Allocate more time for the completion of activities intended to serve ELs:
    - development of accommodations
    - test adaptations
    - test review

Classroom Assessment

There are *"inherent limits of large-scale assessments as accountability tools for ELLs as a means for directly informing a deep understanding of students' learning capabilities and performance…."*

(Durán, 2008,p. 294)

Micro-level Assessment Types and Intended Uses

Types:

Classroom summative assessment:

- Curriculum-based assessments
- State or district interim assessments
- Teacher created tasks

Formative assessment:

- Informal:
  - ➢Moment-to-moment observations, conversations with teachers, peers, etc. (short-cycle)***
- Formal:
  - ➢Periodic probes and tasks (medium-long cycles)***

Intended uses:

Classroom summative assessment:

- Monitoring progress and achievement
- Tracking/placement
- District/parent reporting
- Diagnostic

Formative assessment:

- Generate feedback to teachers (contingent instruction) and students (to guide learning) *during* instruction

Micro-level Assessment Considerations and Guiding Questions

Key Considerations for ELs:

- Teacher professional development for implementation and unbiased interpretation
- Innovative practices, including:
  - bilingual assessment;
  - implementation of learning progressions
- Social interaction of ELs and social inclusion of ELs in the classroom

Guiding Questions:

- *What does effective classroom assessment of the STEM disciplines look like for EL students?*
- *What should teachers know and be able to do to serve EL students through classroom assessment?*

Guiding Questions: *What does effective classroom assessment look like & what should teachers know and do?*

Classroom Summative Assessment

- Incorporate static visuals (e.g., graphics, pictures)
- Incorporate dynamic visuals (e.g., video)
- Divide tasks into multiple parts
- Engage students in collaborative tasks
- Make language of rubrics and feedback understandable and culturally sensitive
- Represent concepts within a familiar context

Example: Classroom Summative Assessment

ONPAR **(www.onpar.us)** - multisemiotic approaches to science and mathematics task creation:

- inquiry-based performances
- dynamic visuals
- auditory supports
- interaction with stimuli

Guiding Question: *What does effective classroom assessment look like & what should teachers know and do?*

Classroom Formative Assessment

- Evoke evidence of STEM learning
  - close observation; inferring understanding through questions students ask; conferencing with students to generate formative feedback - reveal ELs' content thinking and learning
- Encourage and model self-assessment and peer-assessment (self-regulated learning)
- Explore learning progressions - "promising approach" - interpretative frameworks for task performances

Box 7-1
Example of Formative Assessment

Conferencing Log

Language Use Observations

Date	Language Feature	Evaluating Sentence Structure	Sentence Structure Modeled: (T) Teacher (P) Peer)	Student Response After Modeling
10/25	Worked on explaining his own work	"Alex 63 and 54 is Audrey so I bring them together and I get 11 tens"	Q: What do we know about Alex and Audrey? (P) Since ___ has ___ and ___ has ___, I decided to decompose both the ___ and ___.	They go trick or treating and got candy. Alex got 63 candies and Audrey got 54 candies. I break the #'s and I got my answer
11/06		"Diego & Tyler collect (collected) rocks from the garden. Diego collected 33 rocks & Tyler collected 66 rocks. Since I have to join the 33 and 66, I first decomposed both the numbers."	Q: What will you do next? Then I joined the ___ and the ___	Then I joined the tens & the ones together and I got my answer
11/14	Worked on Responding to the work of others			

Next Steps:

Still using simple sentences to explain how he solved a problem

NEXT → Simple sentences often need to be expanded w/ modifiers to create a clear picture in the listener's mind

NEXT

Provide more opportunities for the use of complex sentences. Model for support (Partner with Sean)

help with articulation

work on paraphrasing w/ prompts

Examples: Classroom Formative Assessment Initiatives

- *TODOS Mathematics for ALL* **(www.todos-math.org)** - interactive interviews to uncover students' mathematical understanding; develop student agency through problem solving
- *Language-Rich Science Inquiry for English-language Learners* **(www.coe.uga.edu/LISELL)** - "educative [writing] assessments" support diagnosing ELs' emergent understandings of science
- Bilingualism as an assessment resource

Classroom Assessment Challenges

- Teacher bias in assessing student learning - need to build familiarity with culture and different scientific epistemologies of ELs
- Effective classroom summative assessment of STEM learning of students with lower levels of English proficiency is elusive

Classroom Assessment Challenges

- Formative assessment lends itself to creating a "talking classroom" - but takes skill & time investment
- Positive learning outcomes for formative assessment (self-assessment and peer assessment) in literacy - no reasons to suggest will not work for ELs in STEM disciplines
- Little attempt to build a systemic congruence between large-scale and classroom assessment

Recommendation 6: Design comprehensive and cohesive STEM assessment systems

Developers of Large-Scale STEM Assessments

- Develop and use population sampling frameworks that more effectively represent better the heterogeneity of EL populations
- Ensure proper inclusion of statistically representative samples in process of test development

Decision Makers, Researchers, Funding Agencies, and Professionals in Relevant Fields

- Develop standards on numbers and characteristics of students that need to be documented and reported on in projects and contracts involving EL STEM assessment

Recommendation 7: Review accommodation policies and develop accessibility resources

States, Districts, and Schools	•Review existing policies regarding use of accommodations during accountability assessments •Ensure ELs afforded access to linguistic accommodations that best meet their needs during instruction and assessment
States, Districts, and Schools	•Examine implementation of accommodations to ensure implemented with high fidelity for all ELs •Take steps to improve implementation with high fidelity is not realized •Improve poor implementation when present
States and Districts	•Involved in developing new or revising existing computer-administered assessments: •Develop to incorporate accessibility resources rather than rely on accommodations
States developing new STEM assessments	•Apply universal design principles in initial development and consider ELs from the beginning

Recommendation 4: Develop high-quality STEM curricula and formative assessment

Curriculum Developers, Educators, and EL Researchers

- Work together to develop curricular materials & resources that consider diversity as materials are being developed and throughout the design process

EL Researchers, Curriculum Developers, Assessment Professionals, Teacher Educators, Professional Learning Providers, and Teachers

- Work collaboratively to strengthen teachers' formative assessment skills to improve STEM instruction and promote ELs' learning

Questions?

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www.nas.edu/ELinSTEM

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