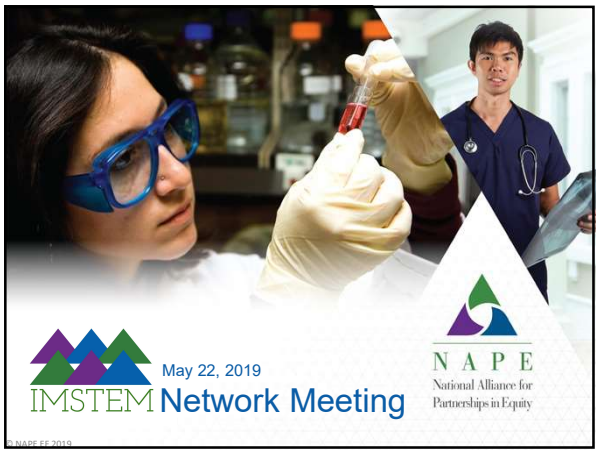

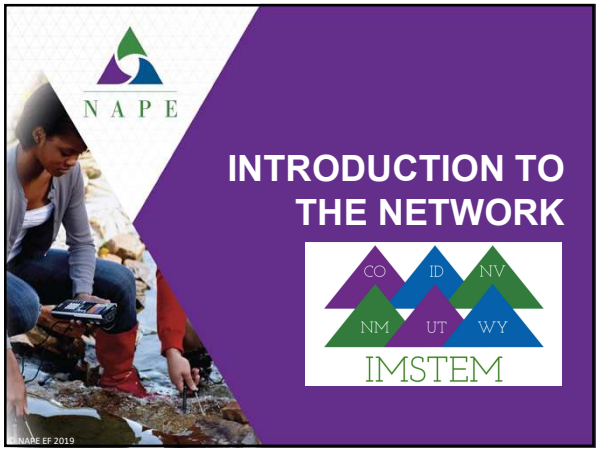

Mission/Common Agenda

IM STEM's mission is to broaden participation and close achievement gaps in 7-12 and undergraduate STEM education, by scaling effective practices that close these gaps at the critical junctures that currently limit participation of underrepresented students in STEM pathways.

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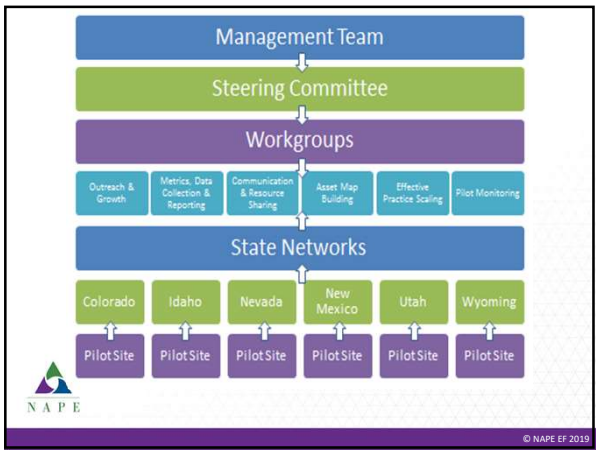
IMSTEM



What we do

NAPE

Foster new partnerships

Support and grow a robust network

Develop an asset map

Identify, share and scale best practices

Share lessons learned from pilot projects

Deliver NAPE's professional development program

Our workgroups

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Metrics, Data Collection, and Reporting	Communications and Resource Sharing	Asset Map Building	Effective Practice Scaling	Pilot Monitoring
•Identify data for a shared data dashboard that will help network members better understand inequities in STEM programming and measure the impact of various approaches on closing equity gaps.	•Establish a regional community where stakeholders can network, share strategies, and leverage effective practices, and engage in a common agenda for expanding equity in STEM.	•Create an asset map to illustrate where opportunities and gaps in programming and resources exist across the network.	•Identify effective practices across the network and design strategies to share them and support sustainability.	•Monitor the implementation and impact of NAPE's Micromessaging PD with a cohort of STEM educators in at least one secondary school district in each of the six participating states.

IMSTEM

Sign up at www.napequity.org/imstem

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

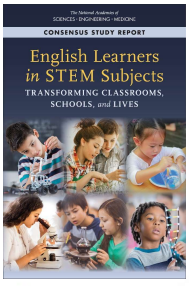
Sponsor: National Science Foundation

David Crowther
Past President, NSTA
University of Nevada, Reno

Rita MacDonald
WIDA Research and Development
University of Wisconsin-Madison

Amy Stephens
The National Academies of
Sciences, Engineering, and Medicine

Scope



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

Committee and Study Staff

COMMITTEE

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University of California, Los Angeles

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University of Michigan

CORY BUXTON
Oregon State University

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HEIDI SCHWEINGRUBER
Director, Board on Science Education

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Significance of Report

1. ELs at the center, starting with a description of the EL student population and performance in STEM subjects
2. First report that integrates language and STEM subjects with ELs in preK-12 grades
3. Contemporary views on language and each of the STEM subjects and how children, especially ELs, learn these subjects
4. An asset-oriented view of ELs

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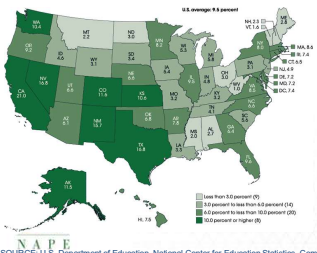
Definition and Distribution of ELs
(Data from Fall 2016)

Percentage of public school students who were ELs by state;
9.5% of student population is ELs (4.8 million students)



Federal Law defines ELs as:

- 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

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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.

Heterogeneity of ELs

- **Terms for the student population**
  - Limited English proficient (LEP) students – old federal term
  - English learners (ELs) – current federal term
  - Language minority students
  - Dual language learners
  - Emergent bilinguals
  - Multilingual learners
- **Terms for subpopulations, e.g.,**
  - Hispanic
  - Latino/a
  - Latin@
  - Latinx

Poll

True or False

The majority of ELs in the country are U.S. born.

TRUE!

Heterogeneity of ELs

The majority of ELs in the country are U.S. born.

- **Long-term ELs**
  - Have been receiving English language development/English as a second language (ELD/ESL) services in U.S. schools for at least 6 years
- **Newcomers**
  - Foreign-born ELs who have recently arrived in the U.S.

Inconsistency of Educational Policies with ELs

1. There is no common definition of ELs across states.
2. There is no common approach to the classification and reclassification of ELs across states, and even across districts within states.
3. Excluding recently English-proficient ELs from the EL accountability group leads to (a) overestimation of academic achievement gaps in STEM between ELs and non-ELs and (b) underestimation of ELs' STEM proficiency.

"Ever-EL framework"

Language, S, T, E, & M

First report that integrates language and STEM subjects with ELs in preK-12 grades

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

Barriers to Access

- Limited opportunity to engage w/challenging, grade-appropriate content & disciplinary practices
  - No full participation in classroom activities
  - Excluded from content instruction w/non-ELs
- Course placement & poor advising on course selection
  - Excluded from rigorous courses
  - Placed in remedial courses

Approaches to Reimagine

- Vocabulary is a precursor or prerequisite: Pre-teach and frontload vocabulary
  - Instead, language is a product
- Disciplinary vocabulary is disciplinary language
  - Instead, language is more than vocabulary and includes using language to engage in disciplinary practices and learn disciplinary content
- Separate content objectives and language objectives
  - Instead, the focus is on functional use of language to engage in disciplinary practices and learn disciplinary content

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Classroom Culture

Better outcomes for ELs in STEM achieved when teachers consistently support and actively incorporate ELs in classroom activities and disciplinary discussions.

Teachers support positive social interactions among peers and incorporate explicit talk about language in disciplinary learning.

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Promising Instructional Strategies

Language and STEM integration is achieved through *functional use of language* in STEM instruction.

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

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Preservice and In-service Teachers

- **Limited access to adequate preparation** to provide ***appropriate*** STEM-related learning opportunities to ELS
- **Few opportunities** to learn how to **integrate language into STEM learning** or how to enhance curricula
- When **content teachers & ESL teachers** have **shared professional development** both groups of teachers more likely to **learn knowledge & competencies that benefit ELs**
- Teachers need opportunities to **reflect on personal assumptions** about diversity & **have authentic interactions** with families from different backgrounds

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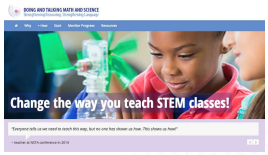
Promising Instructional Strategies

NSF-funded research

Open-access resources
- videos
- teaching tips
- discourse support tools
- reflection questions for students and teachers



Doing and Talking Math and Science
http://stem4els.wceruw.org

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Reimagining Approaches

Science is about much more than facts

Equity is about much more than language

Language is not vocabulary

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Science is about much more than facts

The Wonders of Science!

- Children are born with an innate curiosity about the natural world.
- Historically, school systematically removed that curiosity out of children.
- It is our job to as educators, at all levels, to bring back and foster that natural curiosity for learning about the natural world.

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NSTA Mission: "To promote excellence and innovation in science teaching and learning for ALL"

NSTA Position Statement on Science and ELLs:
The National Science Teachers Association (NSTA) asserts that **all students**, including those identified as English language learners (ELL), **can and should have every opportunity to learn and succeed in science**. Teachers play a critical and central role in this process and should receive necessary support. Likewise, it is important for schools and school systems to devote time and resources to effective professional development for all K–12 teachers of science, including those who teach English language learners (NSTA 2006).

NSTA National Science Teachers Association

The National Academies of SCIENCES ENGINEERING MEDICINE

NSTA Science and ELLs

- It is important that educators who teach science to students identified as English language learners be well versed in science content and pedagogy, and also skilled in pedagogical approaches for integrating language acquisition and science learning. Standards by both WIDA and TESOL support this integration and promote academic language proficiency—the language of school—in core content areas, including science (TESOL 2006, WIDA 2012).
- Research on instructional interventions—such as culturally responsive teaching, guided inquiry, and sheltered English instruction—has shown promise for improving achievement outcomes in both science and literacy, as well as narrowing achievement gaps for students identified as English language learners (Lee et al. 2005, 2008, 2012, 2013; 2017 Thomas & Collier 2002).

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1996 2000 2002 2006 2012 2014 2018

"English learners (ELs) develop science, technology, engineering and mathematics (STEM) knowledge and Language proficiency when they are engaged in meaningful interaction in the classroom and participate in the kinds of activities in which STEM experts and professionals regularly engage" (NASEM, 2018, p55).

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Classroom Scenario A

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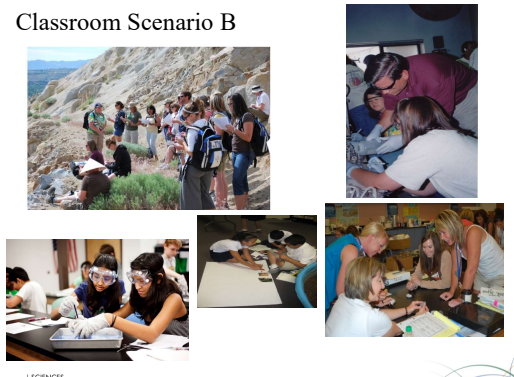
Classroom Scenario B



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Quiz Question

Which classroom scenario do you think works best for learning science?

A
B

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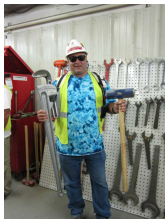
The Answer is BOTH!

Current research in K-12 Science Classrooms reveals that earlier debates about such dichotomies as "direct instruction" and "inquiry" are **simplistic, even mistaken**, as a characteristic of science pedagogy (Framework for K-12 Science Education, 2011, p 10-9)

The process of theory development and testing is iterative, uses both inductive and deductive logic, and **incorporates many tools** besides direct experimentation.
(Taking Science to School ,2007, NSF p.27)



Teachers need more than one "tool" in their teaching tool boxes

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Instructional Continuum

Direct Instruction (Behaviorist)					Inquiry (Constructivist)
		X			
Lecture	Demonstration	Skills Practice	Structured	Guided	Open

Teacher Role:
(Sage- teacher centered)
Student Role:
(Kinesthetically & Cognitively Passive)

Teacher Role:
(Guide - student centered)
Student Role:
(Kinesthetically & Cognitively Active)

Continuum of Inquiry has been well documented in Science Education:
(Schwab, 1960; Atkins & Karplus, 1962; Herron, 1971; Bybee, 2002; Banchi & Bell, 2008)

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Direct Instruction

Inquiry Instruction

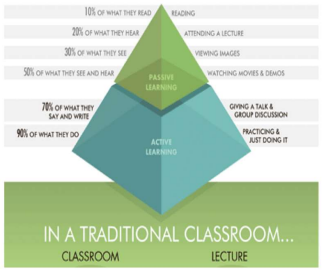
Figure 1.

The four levels of inquiry and the information given to the student in each one.

Inquiry Level	Question	Procedure	Solution
1–Confirmation Inquiry *Students confirm a principle through an activity when the results are known in advance.*	✔	✔	✔
2–Structured Inquiry *Students investigate a teacher-presented question through a prescribed procedure.*	✔	✔	
3–Guided Inquiry *Students investigate a teacher-presented question using student designed/selected procedures.*	✔		
4–Open Inquiry *Students investigate questions that are student formulated through student designed/selected procedures.*			

Bachi & Bell (2008). The Many Levels of Inquiry. Science and Children (October)

ACTIVE LEARNING
& STUDENT PERFORMANCE



Pedagogical / Instructional Shifts required by the framework for K12 Science Education:

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A Vision for Science Education

"To ensure that by the end of 12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology."

(Framework for K-12 Science Education)

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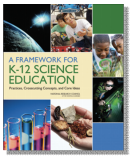
Three Dimensions (3-D) of the Framework & NGSS

- Disciplinary Core Ideas (DCI)
- Science and Engineering Practices (SEP)
- Cross Cutting Concepts (CCC)



NEXT GENERATION SCIENCE STANDARDS For States, By States

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Three Dimensions (3-D) of the Framework & NGSS

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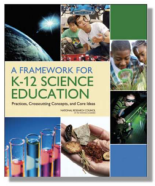
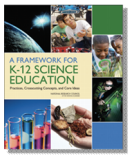


NEXT GENERATION SCIENCE STANDARDS For States, By States

Science and Engineering Practices

Crosscutting Concepts

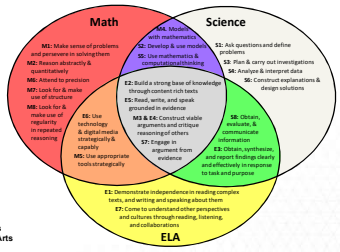
Performance Expectation



Disciplinary Core Ideas
Life Science
Physical Science
Earth and Space Science
Engineering

NEXT GENERATION SCIENCE STANDARDS
For States, By States

This session shares how language acquisition and science work together to optimize learning for EL and ALL students utilizing the CCSS, NGSS and WIDA standards.



Commonalities Among the Practices in Science, Mathematics and English Language Arts

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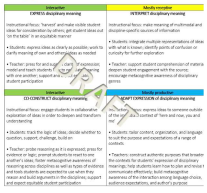
Based on work by Tina Chuek
ell.stanford.edu

New ELD Standards – New Potential

"…Language development and concept development occur simultaneously; in humans, language development and concept development are inextricable" (NRC, 2000. in NASEM 2018 p.57.)

Understanding Language
Stanford | GRADUATE SCHOOL OF EDUCATION

WIDA™



California Department of EDUCATION

Equity is about much more than language

- Who is positioned as a contributor of ideas, a generator of new thinking?—versus a responder to others' ideas?
- Whose ideas are elicited?
- Whose ideas get to be 'on the table' for group deliberation?
- Whose ideas do teachers follow and devote class time to?

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Classroom practices for equity

- Present something interesting to reason about

- Use accessible phenomena to provide shared experiences to explore and explain
- Use good anchoring phenomena that can anchor several lessons and provide a 'story line' through the DCIs and CCCs, and can provide practice in the SEPs

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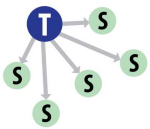
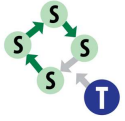
Classroom practices for equity

- Move away from Inquiry-Response-Evaluation interactions
- Focus on students' thinking, not answers
- Prompt idea-focused conversations among students
- Probe and press for reasoning and evidence





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Classroom practices for equity

- Questions that push toward big ideas
- Teacher Discourse Moves
  - Uncover ideas
  - Make ideas public
  - Press for reasoning and evidence

- Student Discourse Moves
  - Express ideas, clarify others' ideas
  - Build on ideas, compare ideas
  - Challenge, question, debate

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Classroom practices for equity

Work equitably with student ideas

Reflection questions for Teachers:

- Were there ideas I didn't know how to handle? Did I make a note to go back to those?
- Have I heard the ELs in my class initiate ideas and exchanges?

Reflection questions for Students

- Am I being responsible about expressing my ideas? If not, why am I hesitating? What can I do to change this? What help could I ask for?
- Am I understanding and following everyone's ideas? What could I do to get better at this? What help could I offer if I'm having trouble understanding someone? What could I ask?

Reflection questions for Student Work Groups

- Are we all getting a chance to talk about our ideas?
- Do we all feel as if we're really listening to one another?
- Is anyone having trouble? What could we do to help?

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Language is not vocabulary

- Meaning is not 'in' words.
- Meaning is not stored language; meaning is shared experience … to which we later—gradually and with guidance—attach language.

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Language is not vocabulary

- Language development is a product of science learning, not a prerequisite.
- Everyday language takes students a long way! Students learn more complex or precise language when it benefits their exchange of ideas.
- Students learn language from and with one another. The desire to share and make sense of one another's ideas is the driving force behind language development.

"…Language development and concept development occur simultaneously; in humans, language development and concept development are inextricable" (NRC, 2000, in NASEM 2018 p.57.)

Poll

True or False

Policies at ALL levels facilitate or constrain STEM teaching/learning opportunities.

TRUE!

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Access: What Works

Successful school districts:

- Design/implement structures → integrate language & content
- Examine ELs' access to STEM coursework & content
- Consider appropriate PD for teachers

School district leadership is critical in facilitating coherence

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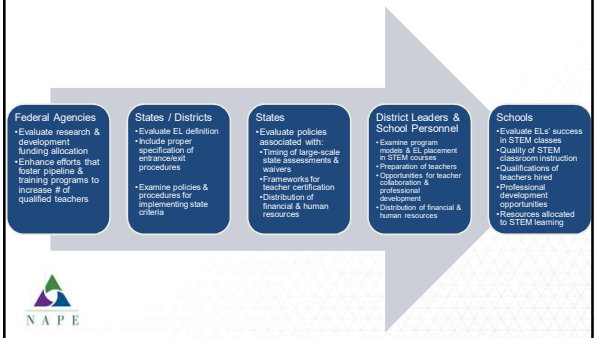
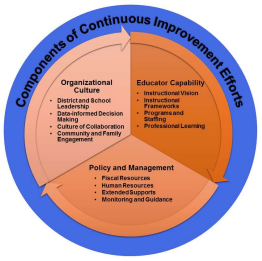
Recommendation 1: Evaluate current policies, approaches, and resources



Capacity Building: District/School Level



- **Organizational Culture**
  - Local norms, routines, & practices that shape district/school culture
  - Expectations for educator professionalism, collaboration, & reflection
- **Educator Capability**
  - Educators' beliefs & expertise influence ability to implement curriculum, strategies, & other practices
- **Policy & Management**
  - Appropriate funding, resources, scheduling, staffing, & allocation of responsibility

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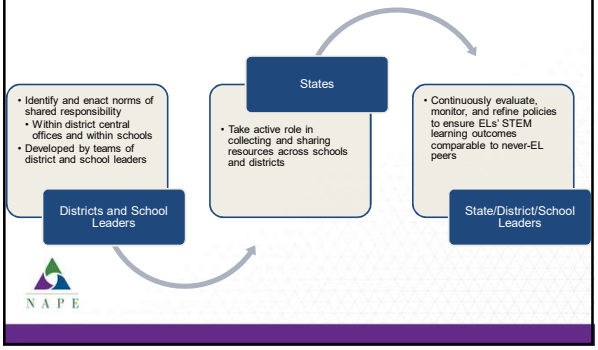
Recommendation 2: Develop high-quality framework to identify and remove barriers



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Questions?

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