The National Academies of
SCIENCES · ENGINEERING · MEDICINE

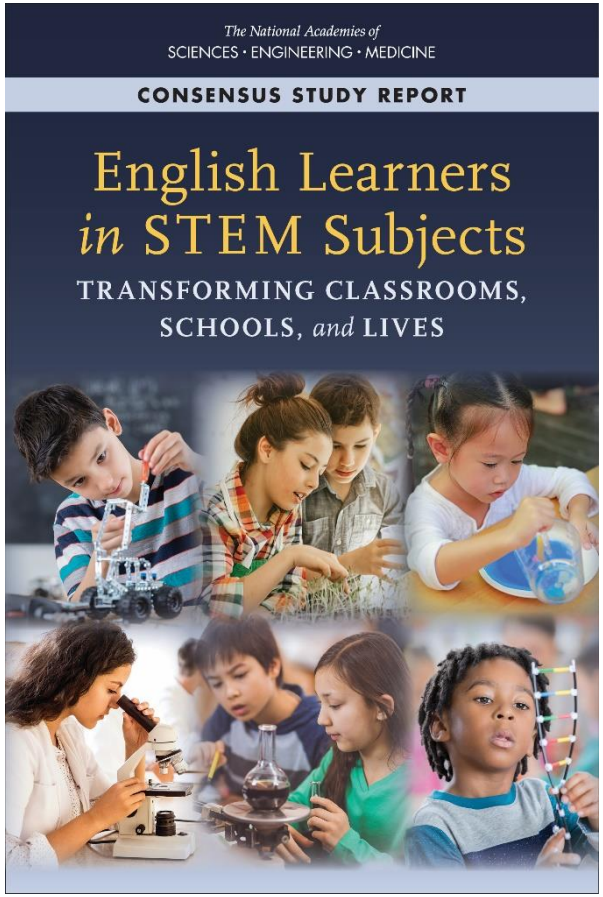
BOARD ON SCIENCE EDUCATION

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

Sponsor: National Science Foundation

#ELSTEM

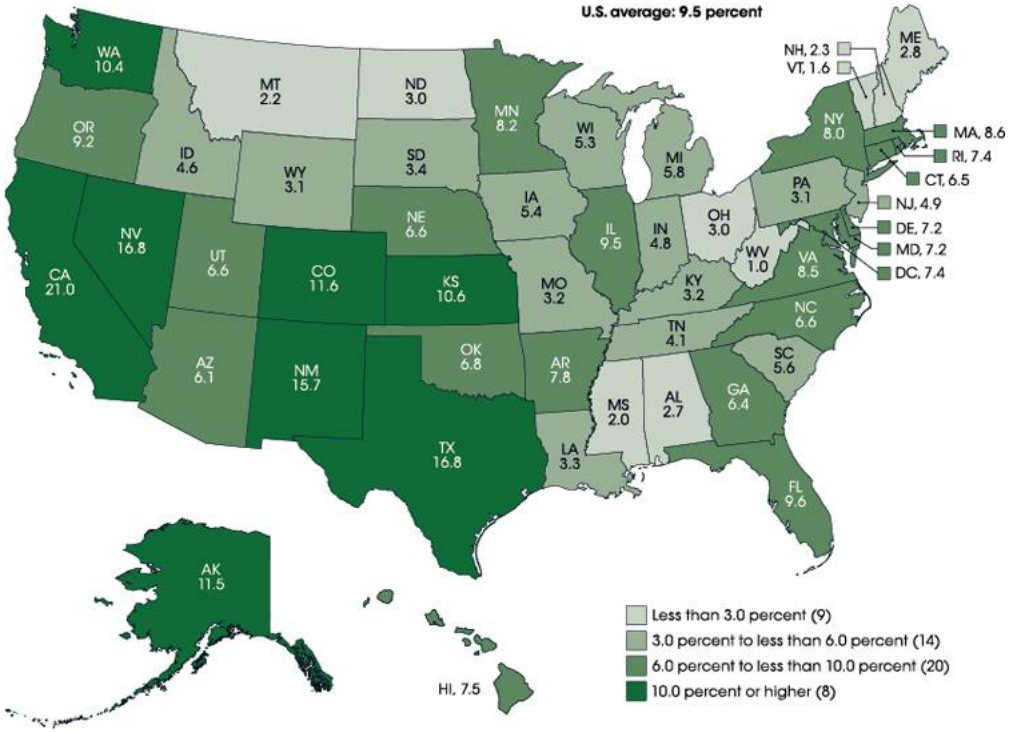
Scope



- 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.

Issues of Access

ELs lack access to STEM learning opportunities

- Limited opportunity to engage with challenging, grade-appropriate science & mathematics content & disciplinary practices.
- Exclusion from rigorous science or mathematics courses, placement in remedial courses, & poor advising regarding course selection.
- Little info about ELs in technology & engineering-based instruction.

High School Course Completion: Mathematics and Science

Highest Mathematics Course Completion

	Bilingual EL Student (N=550)	Bilingual Not in ESL (N=3000)	Native English Speaker (N=16,900)
No Math	4.8%	2.8%	2.4%
Basic Math	1.1%	0.5%	0.5%
Pre-Algebra	1.1%	0.3%	0.3%
Algebra	9.7%	5.2%	4.7%
Geometry	14.5%	9.5%	8.3%
Algebra II	23.6%	17.6%	20.8%
Trigonometry	16.3%	21.6%	24.7%
Beyond Trigonometry	21.2%	19.9%	22.6%
Calculus	2.8%	4.6%	5.6%
Advanced Calculus	4.9%	18.0%	10.1%

- ≈5% ELs have no math compared to 2.4% of native speaking peers
- ≈5% enrolled in advanced courses → less than half of other peers

Science Course Completion

	Bilingual EL Student (N=550)	Bilingual Not in ESL (N=3000)	Native English Speaker (N=16,900)
No Science	0.2%	0.0%	0.0%
Integrated Sciences	32.7%	26.6%	23.7%
Earth Science	63.2%	57.0%	63.8%
Biology	89.6%	93.3%	93.9%
Chemistry	52.0%	72.4%	70.4%
Physics	26.8%	44.5%	36.5%
Any AP, IB, or Honors	11.8%	29.3%	20.1%

- Science does not have same linear progression as mathematics
- ELs less likely to take science courses overall

Data from HSLS:2009 High School Transcript Study

Classification and Reclassification

- Classification & reclassification of ELs complex
  - Varies across states & even across districts within states
  - No common definition of ELs & agreement on proficiency standards
  - Proficiency in content achievement as criterion for language proficiency is problematic
- Reclassification challenging
  - Too-early: continued support for success needed & w/out may see attrition in long run
  - Too-late: limited access to STEM learning
  - Common practice: exclude recently designated English-proficient ELs from EL accountability group

EL Designation is Important

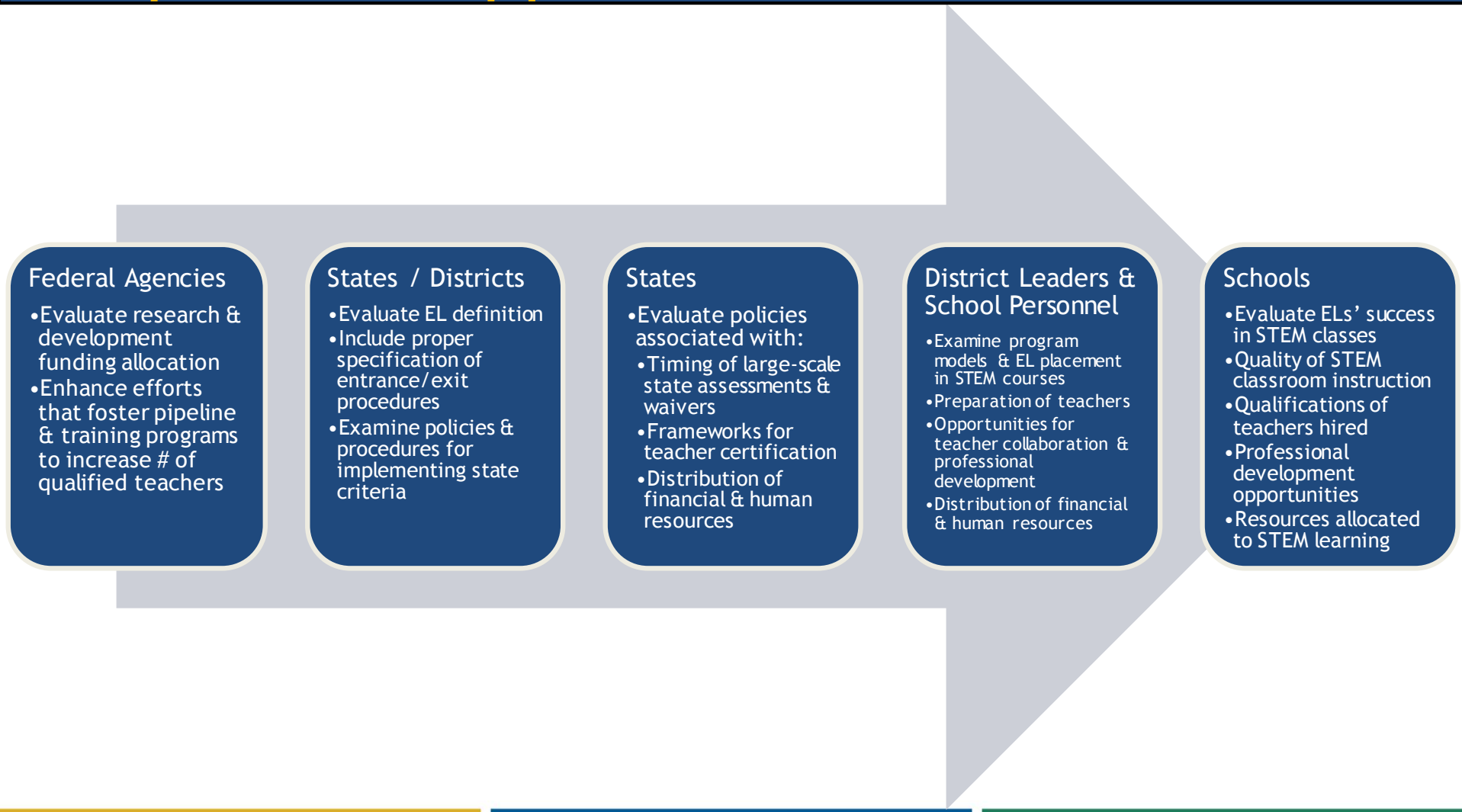
- Clear & consistent designations are needed
  - Reduce misperceptions of ELs' proficiency in STEM academic achievement
  - Enable deeper understanding of
    - academic achievement
    - what program models & instructional strategies work best
    - specific approaches work best for EL subgroups under specific conditions

Impact of Educational Policies

- Policies at *ALL* levels facilitate or constrain STEM teaching/learning opportunities
  - Funding
  - Accountability
  - Assessment
  - District organization
  - Program models
  - Curriculum
  - Staffing

Who's responsible for ensuring access and equity for ELs in STEM?

Recommendation 1: Evaluate current policies, approaches, and resources



Recommendation 1: Federal Agencies

- Evaluate research & development funding allocation
- Enhance efforts that foster pipeline & training programs to increase # of qualified teachers

Recommendation 1: States/Districts

- Evaluate EL definition
- Include proper specification of entrance & exit procedures
- Examine policies & procedures for implementing state criteria

Recommendation 1: States

Evaluate policies associated with:

- Timing of large-scale state assessments & waivers
- Frameworks for teacher certification
- Distribution of financial & human resources

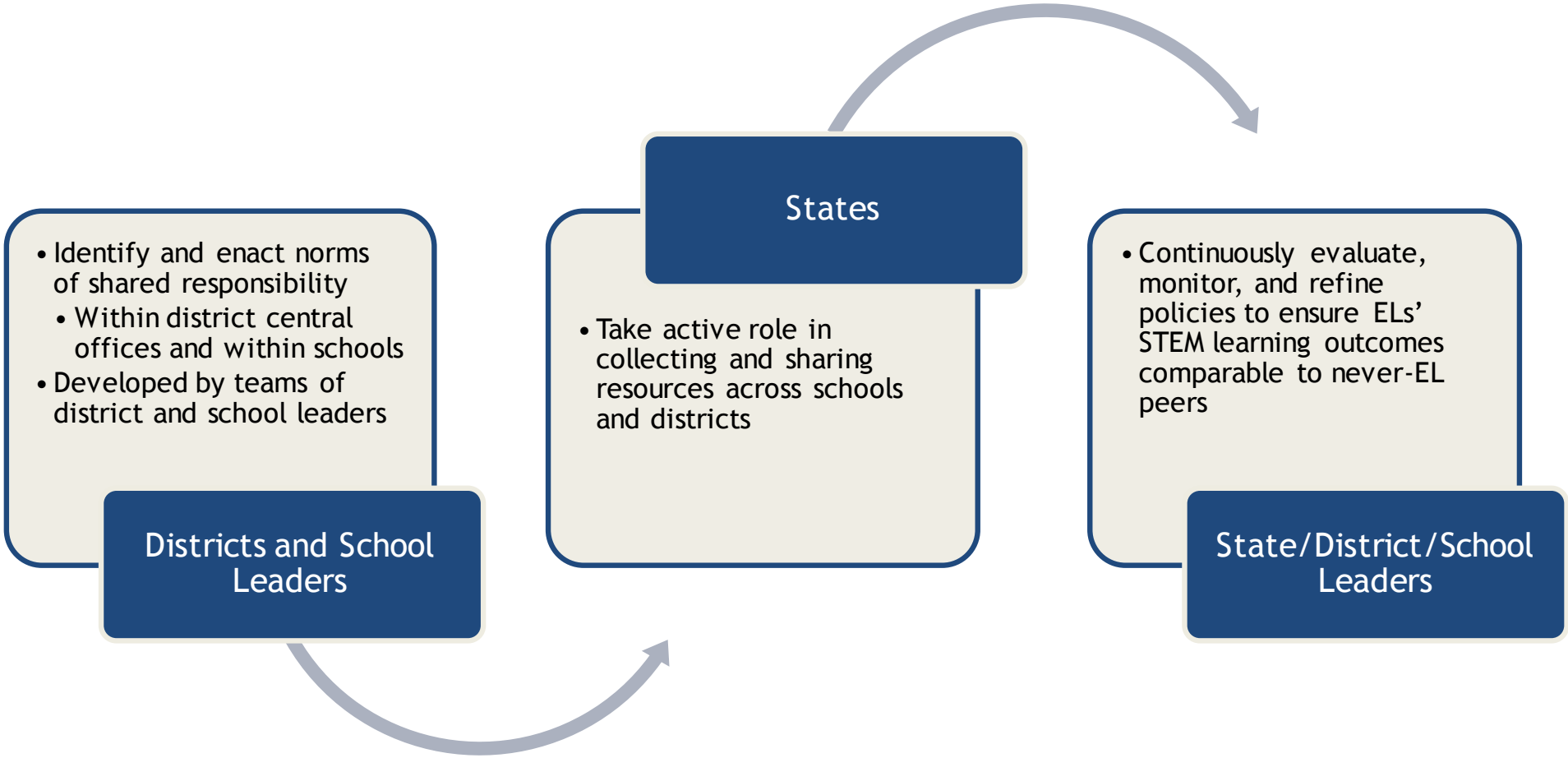
Recommendation 1: District Leaders & School Personnel

- Examine program models & EL placement in STEM courses
- Preparation of teachers
- Opportunities for teacher collaboration & professional development
- Distribution of financial & human resources

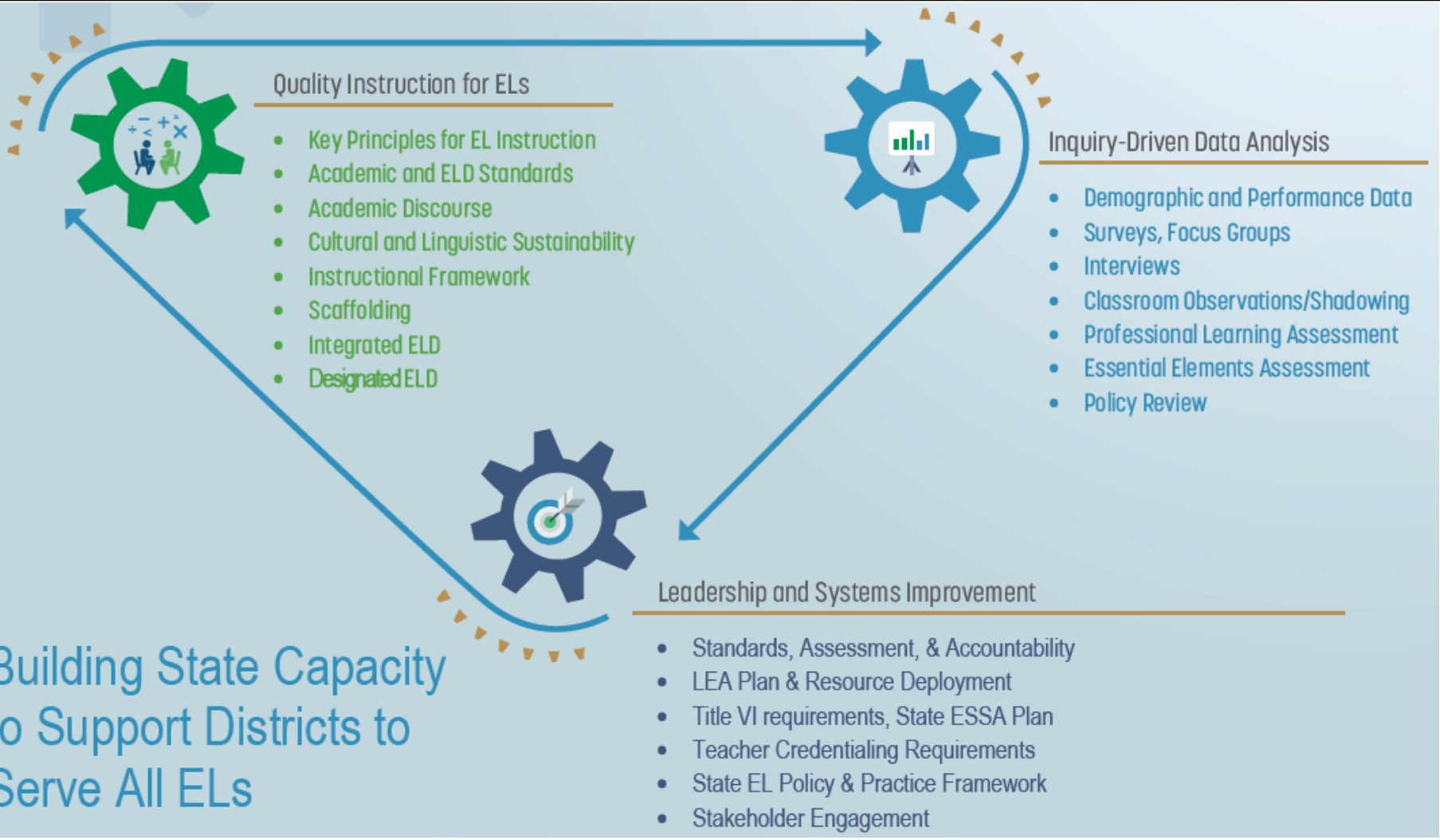
Recommendation 1: Schools

- Evaluate ELs' success in STEM classes
- Quality of STEM classroom instruction
- Qualifications of teachers hired
- Professional development opportunities
- Resources allocated to STEM learning

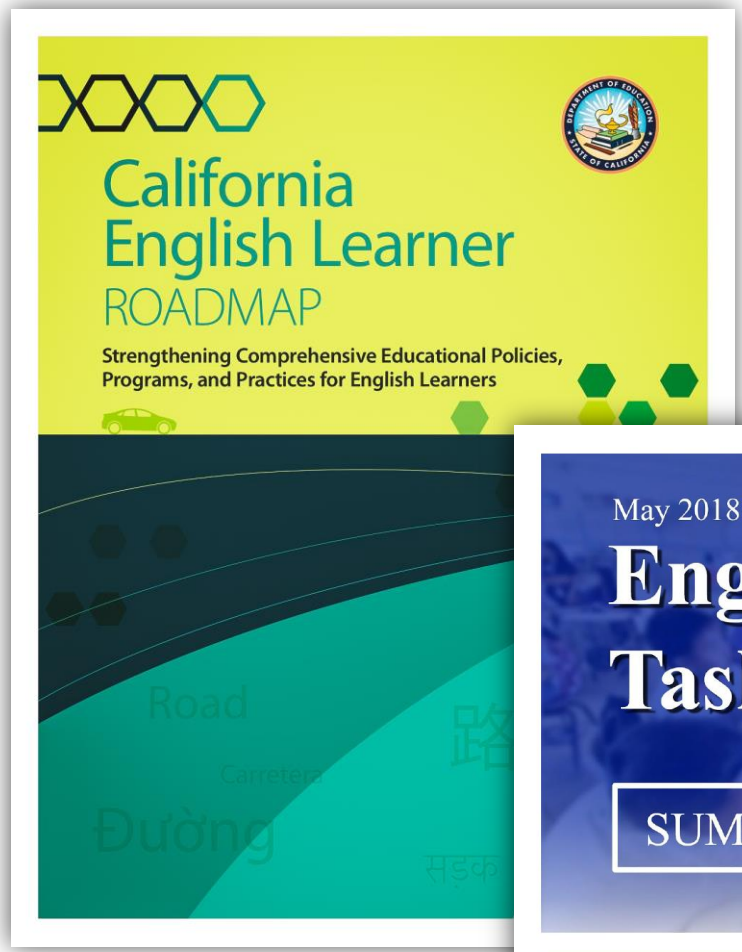
Recommendation 2: Develop high-quality framework to identify and remove barriers



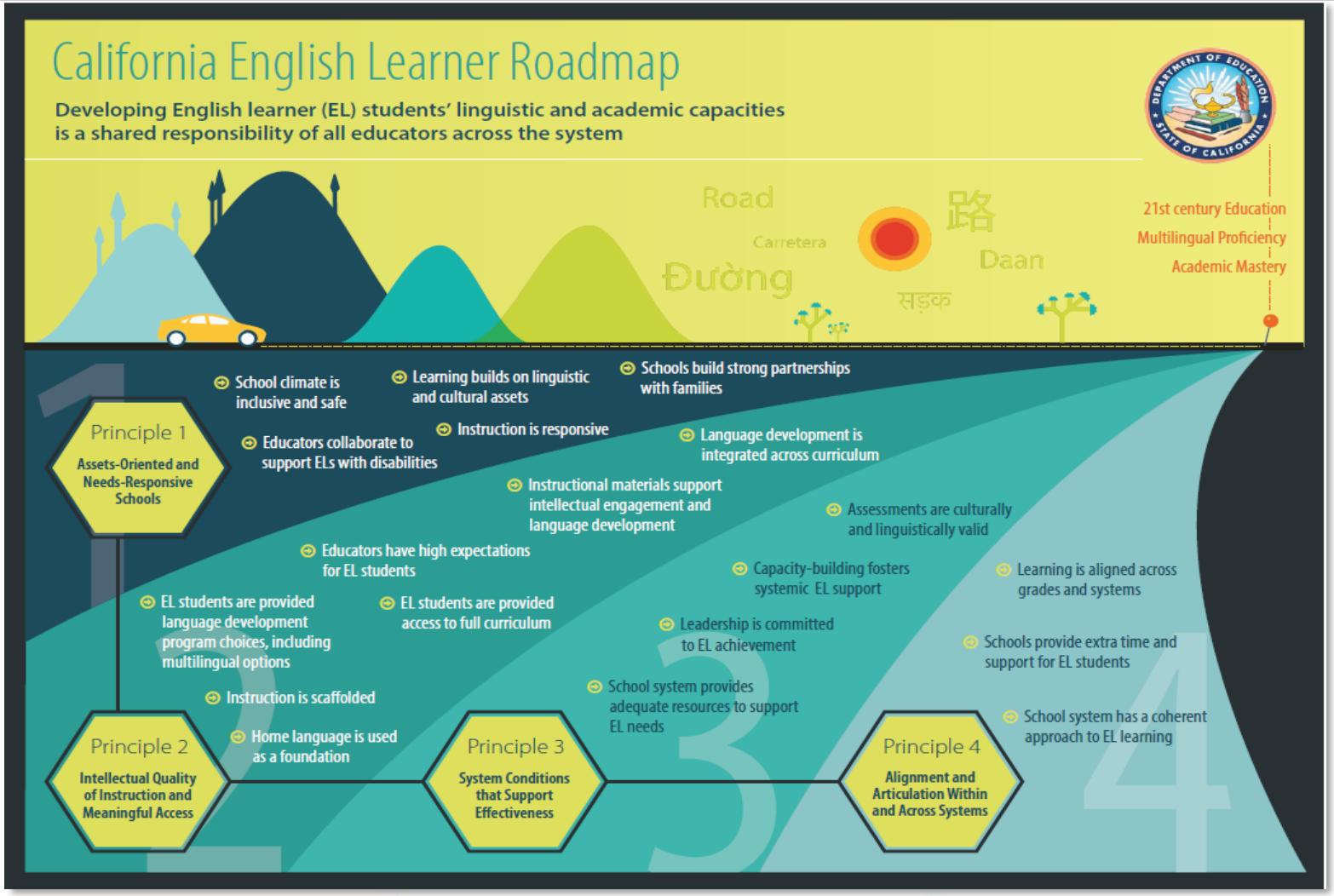
State Capacity Example



Policy Strategies



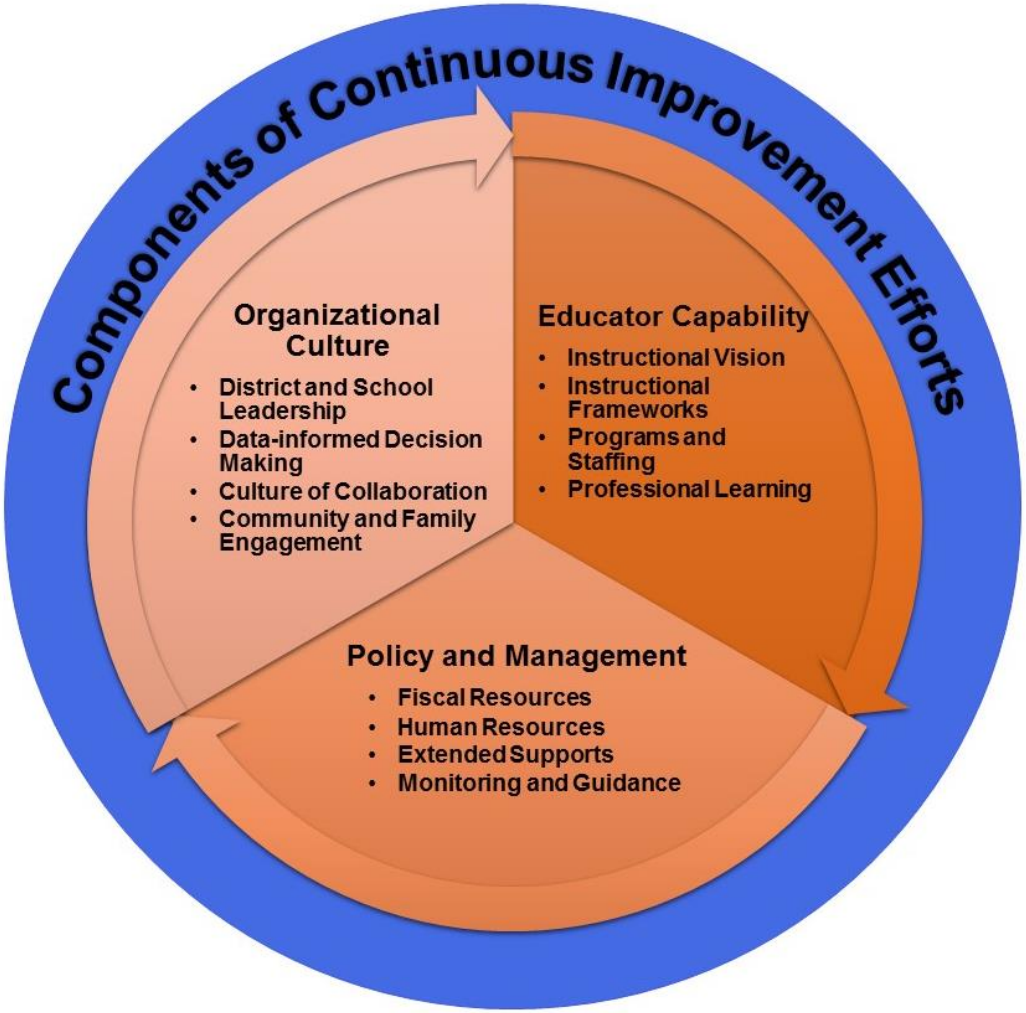
State Capacity: California



Actions Taken by Districts Transforming STEM Learning for ELs

- Examine ELs' access to and performance in STEM
- Frame efforts around an ambitious vision for ELs and guiding principles for quality instruction
- Share responsibility across their systems
- Design/implement structures that afford multiple and diverse opportunities to integrate language & content
- Consider appropriate PD for teachers
- Build partnerships
- Think flexibility about fiscal & human resources
- Communicate progress & results

Capacity Building: District/School Level



Organizational Culture

- Local norms, routines, & practices that shape district/school culture
- Expectations for educator professionalism, collaboration, & reflection
- **Components**
  - District and School Leadership
  - Data-informed Decision Making
  - Culture of Collaboration
  - Community and Family Engagement

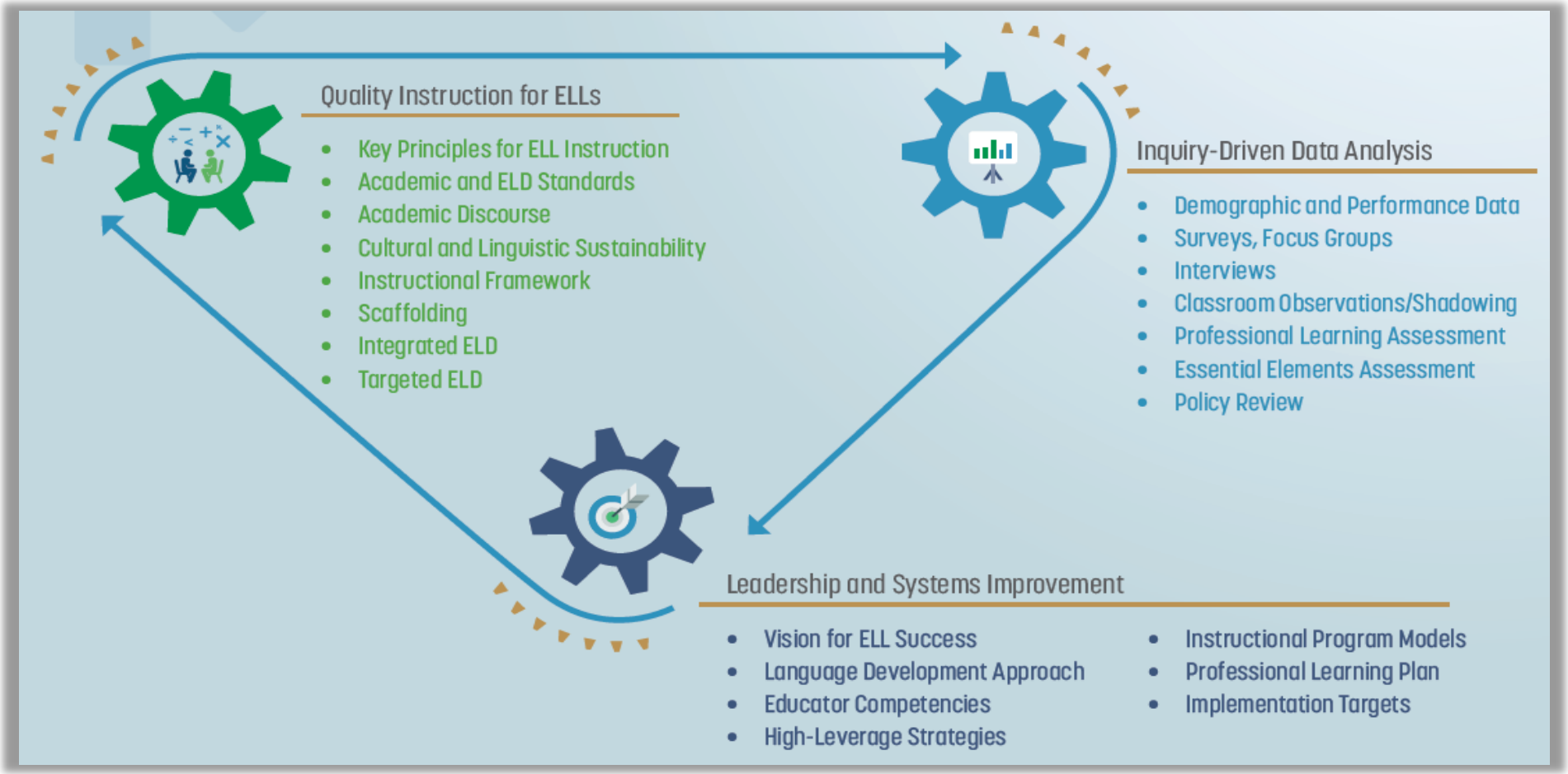
Educator Capability

- Educators' beliefs & expertise influence ability to implement curriculum, strategies, & other practices
- **Components**
  - Instructional Vision
  - Instructional Frameworks
  - Programs and Staffing
  - Professional Learning

Policy & Management

- Appropriate funding, resources, scheduling, staffing, & allocation of responsibility
- **Components**
  - Fiscal Resources
  - Human Resources
  - Extended Supports
  - Monitoring and Guidance

District Systemic Improvement Plan Development Approach



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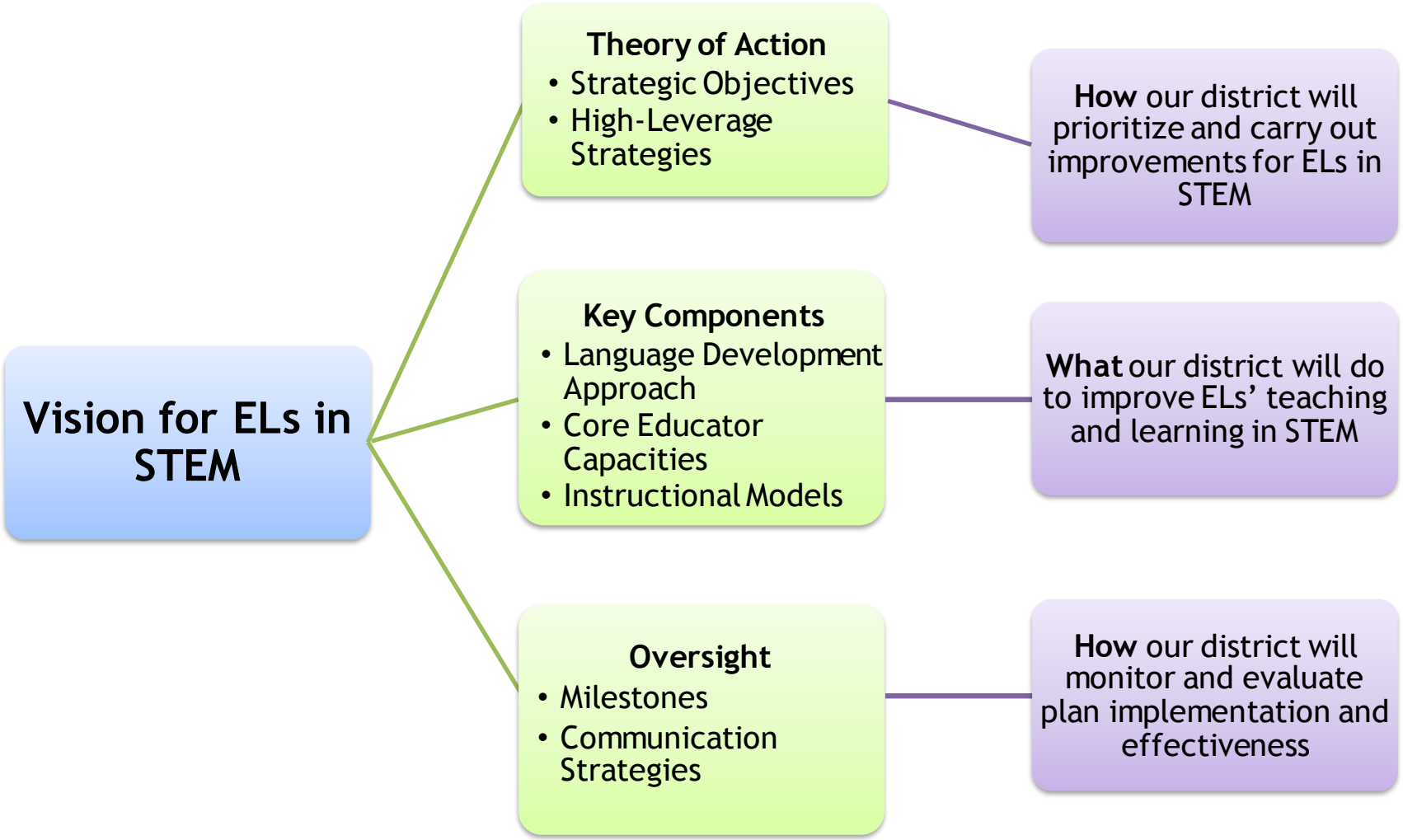

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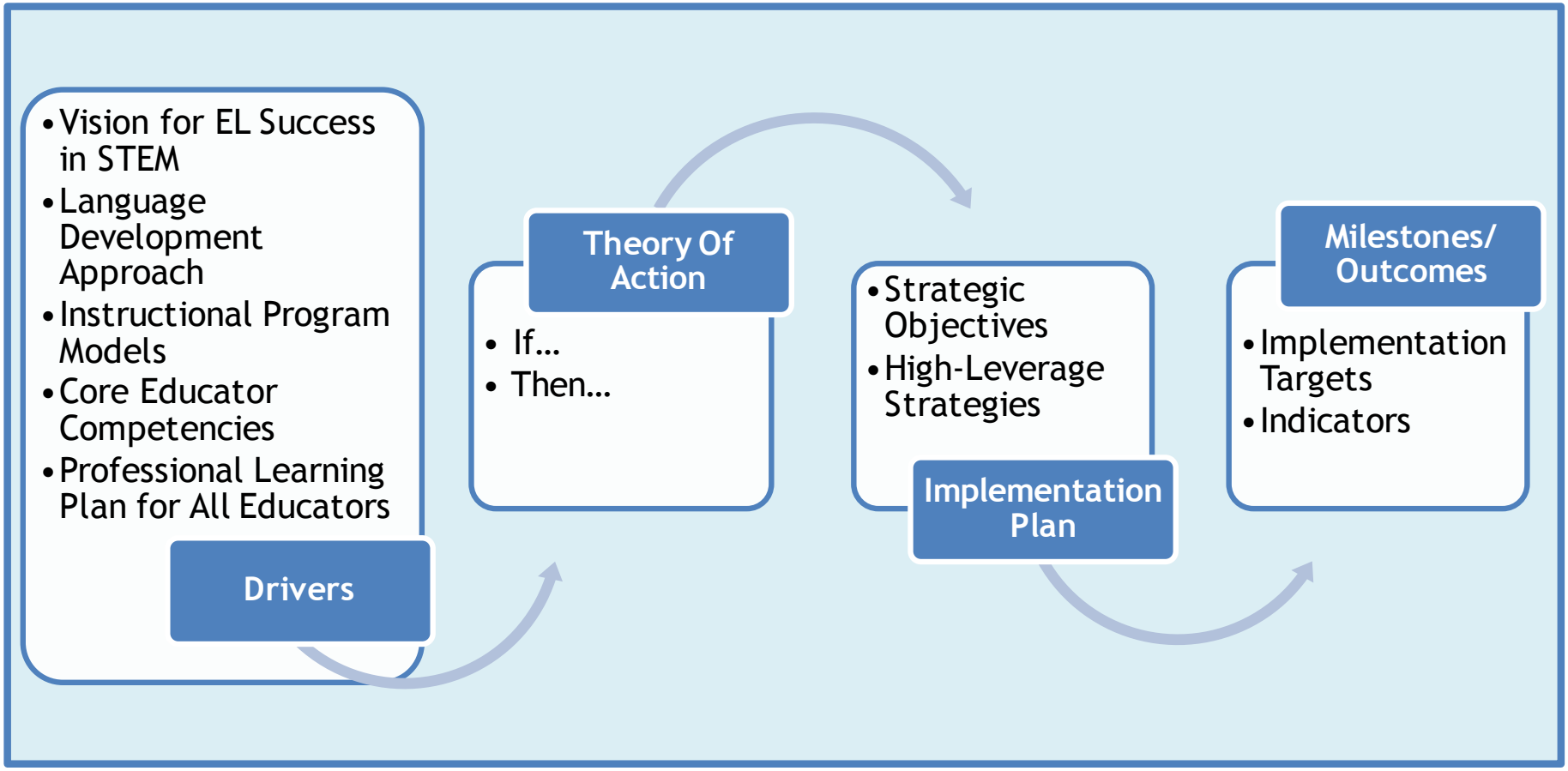

District Systemic Improvement Plan Development Process

Data Gathering & Analysis

- Demographic & performance data
- Surveys and EL shadowing and/or classroom observations

Preliminary Recommendations

- Drawn from assessment of practices & policy

Drafting the Plan

- Vision
- Language Development Approach
- Program Models
- Educator Competencies
- Professional Learning Plan
- Theory of Action
- Objectives, Action Steps, Milestones
- Oversight Structure

Vetting & Refining the Draft Plan

- Stakeholder input and feedback

Plan adopted by Board

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School Capacity Example: Manhattan Bridges

Seven Design Elements

School Capacity Example: Unified Language Development Approach

Policy:

- Integrate language development and STEM
- Spanish and English development throughout STEM curriculum

Practice:

- Regular collaboration between ESL and STEM teachers
- STEM is the driver with strong linguistic supports
- Language-rich environments throughout the school
- Students draw from assets in the two languages in making sense of what the are learning or to express their thoughts

School Capacity Example: Family & Community Partnerships

To offer students experiences aligned to their STEM focus, Manhattan Bridges works with partners to:

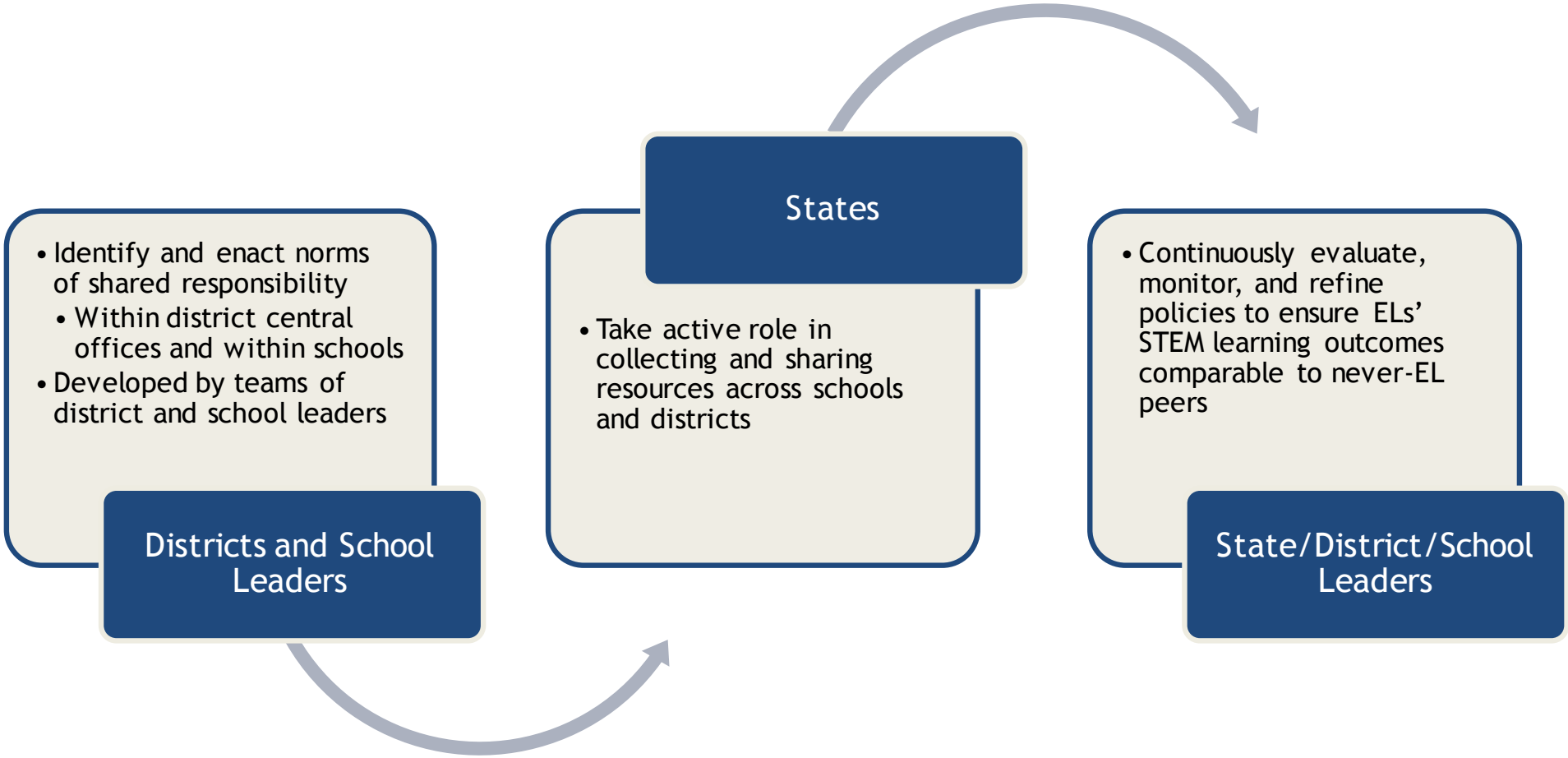
- Bolster the academic and extracurricular opportunities they offer to students
- Offer college-level courses, so that students often graduate with college credits
- Provide mentoring or internship opportunities (Cornell University's Hydroponics Program and Internships, paid internships for students)
- Provide intensive college counseling and guidance including college visits, application support, and mentorships

School Capacity Example: Mission-Driven Leadership

Leaders develop an infrastructure based on shared values:

- Ambitious vision and mission that guides ALL decisions
- Strong sense of pride in & respect towards ALL cultures & cultural ways of knowing in STEM
- School community:
  - Holds mindset of Continuous Improvement
  - Shares responsibility for students' success in STEM
  - Is highly attuned to students' needs & capacities in STEM

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



Questions?

UPCOMING ACTIVITES

- Webinar Series
  - Feb 22: Large-scale & Classroom Assessment
- Release Events
  - DC: February 12, 2019

FIND OUT MORE

www.nas.edu/ELinSTEM

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