The STEM Evidence-Building Ecosystem at ED

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Thanks for having me!
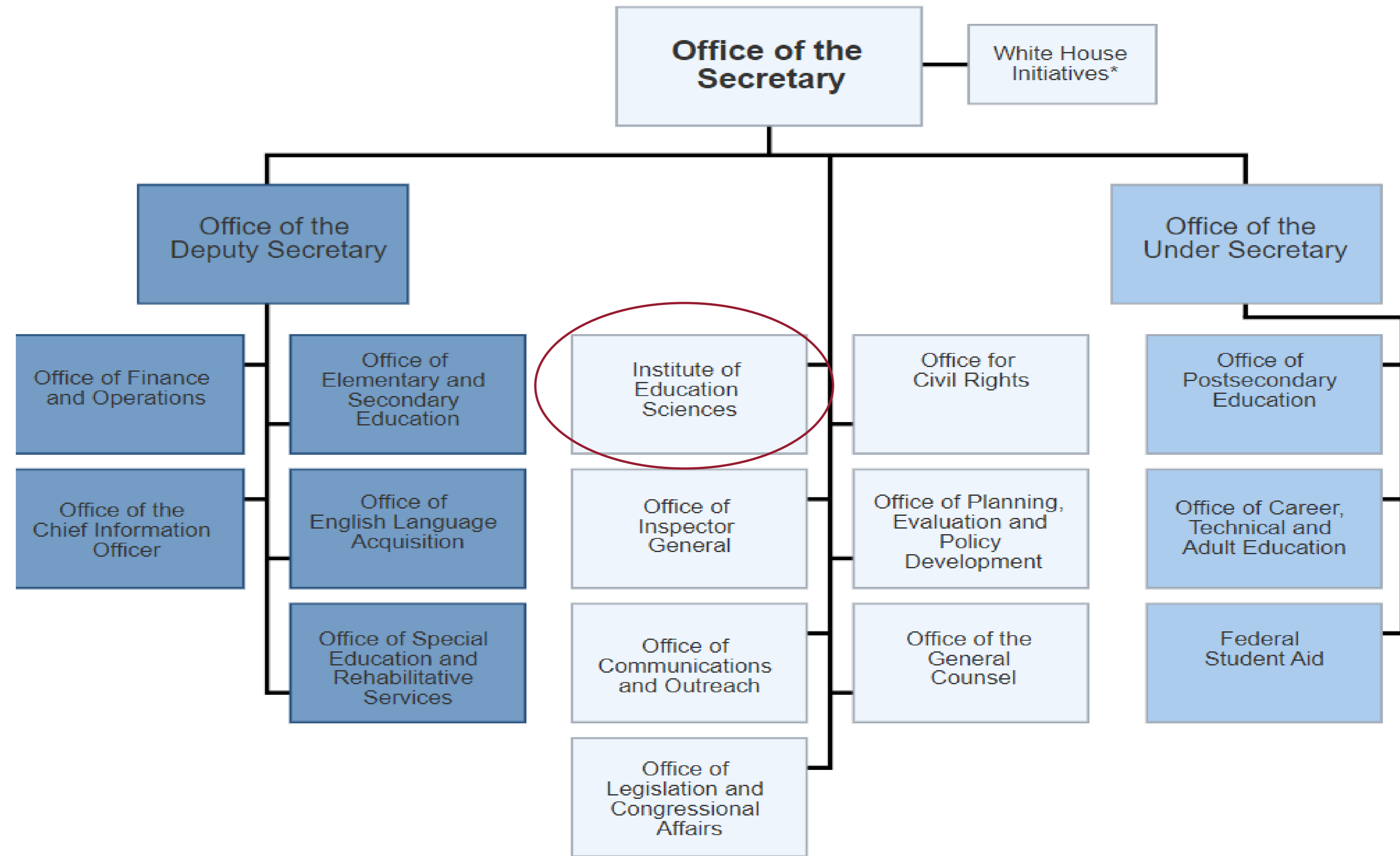
And the usual federal disclaimer ...
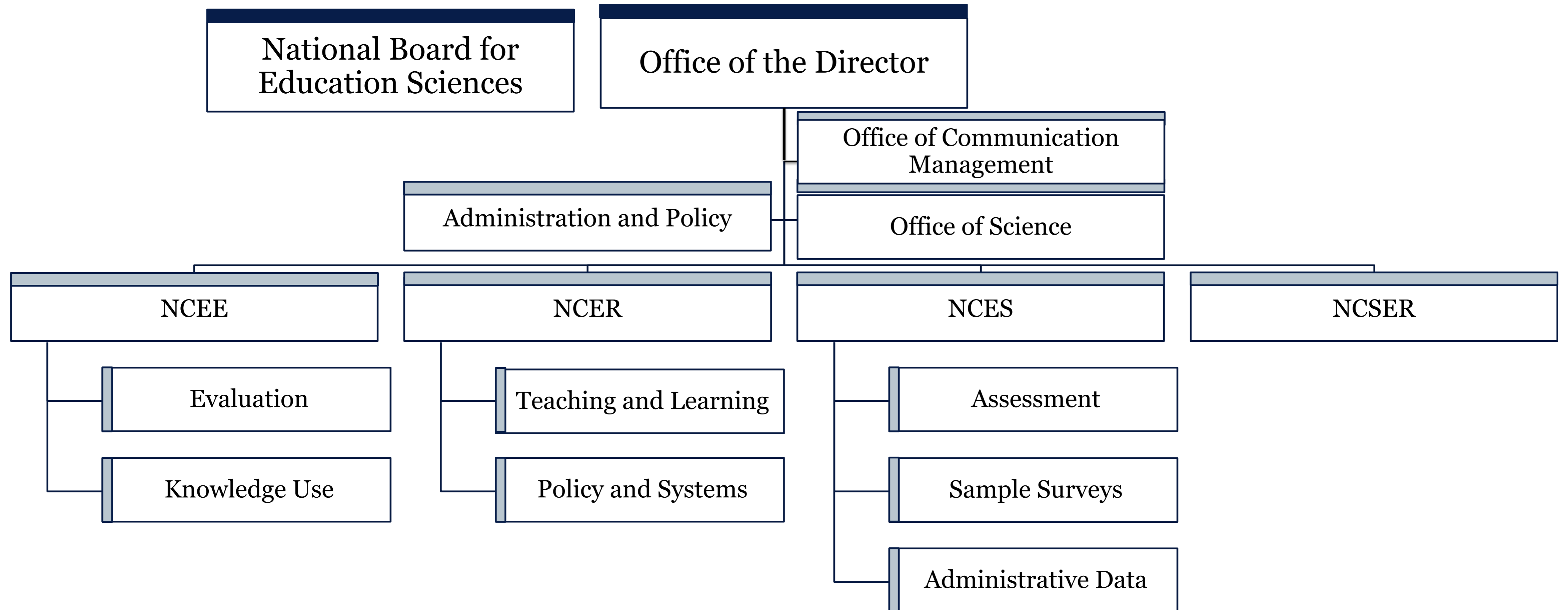
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Agenda

- A Bit of Context

- The Evolution of Evidence-Building at ED

- Building Evidence: Algebra (and Algebraic Thinking)

- Broadening Participation in STEM

- Gaps in STEM Education Evidence

- Building Research Infrastructure

- Q&A

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U.S. Department of Education

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National Board for Education Sciences

Office of the Director

Office of Communication Management

Administration and Policy

Office of Science

NCEE
- Evaluation
- Knowledge Use

NCER
- Teaching and Learning
- Policy and Systems

NCES
- Assessment
- Sample Surveys
- Administrative Data

NCSER

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The STEM Education Ecosystem

- **S**cience: Earth science; Physical science; Life science; Multi-unit or integrated science; Student practice, inquiry, and reasoning in science; Student perceptions, motivations, attitudes, and anxiety about science; Teacher instruction, pedagogy, and professional development in science; Science assessment; Science policy

- **T**echnology (as content): Computational thinking; Computer science; Computer/Digital literacy; Robotics

- **E**ngineering: Chemical engineering; Civic Engineering; Electrical engineering; Engineering and design-based practices; Mechanical engineering

- **M**athematics: Number and quantity; Algebraic thinking, equations, and algebra; Measurement, data, statistics, and probability; Geometry; Fractions and functions; Multi-unit or integrated math; Student practice, inquiry, and reasoning in math; Student perceptions, motivations, attitudes, and anxiety about math; Teacher instruction, pedagogy, and professional development in math; Math assessment; Math Policy

The Evolution of Evidence-Building at ED

Why Emphasize Evidence?

Students and their families are depending on us to ensure federal education dollars are making a positive impact in their lives.

We use evidence to:

- Improve outcomes for all learners

- Strengthen our supports for states, districts, and colleges

- Redirect effort from lower-value to higher-value work

- Maximize taxpayers' return on investment

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Before 2002

- ED has had a learning and improvement function since its inception in 1979.

- From Section 209 of the *Department of Education Organization Act:*
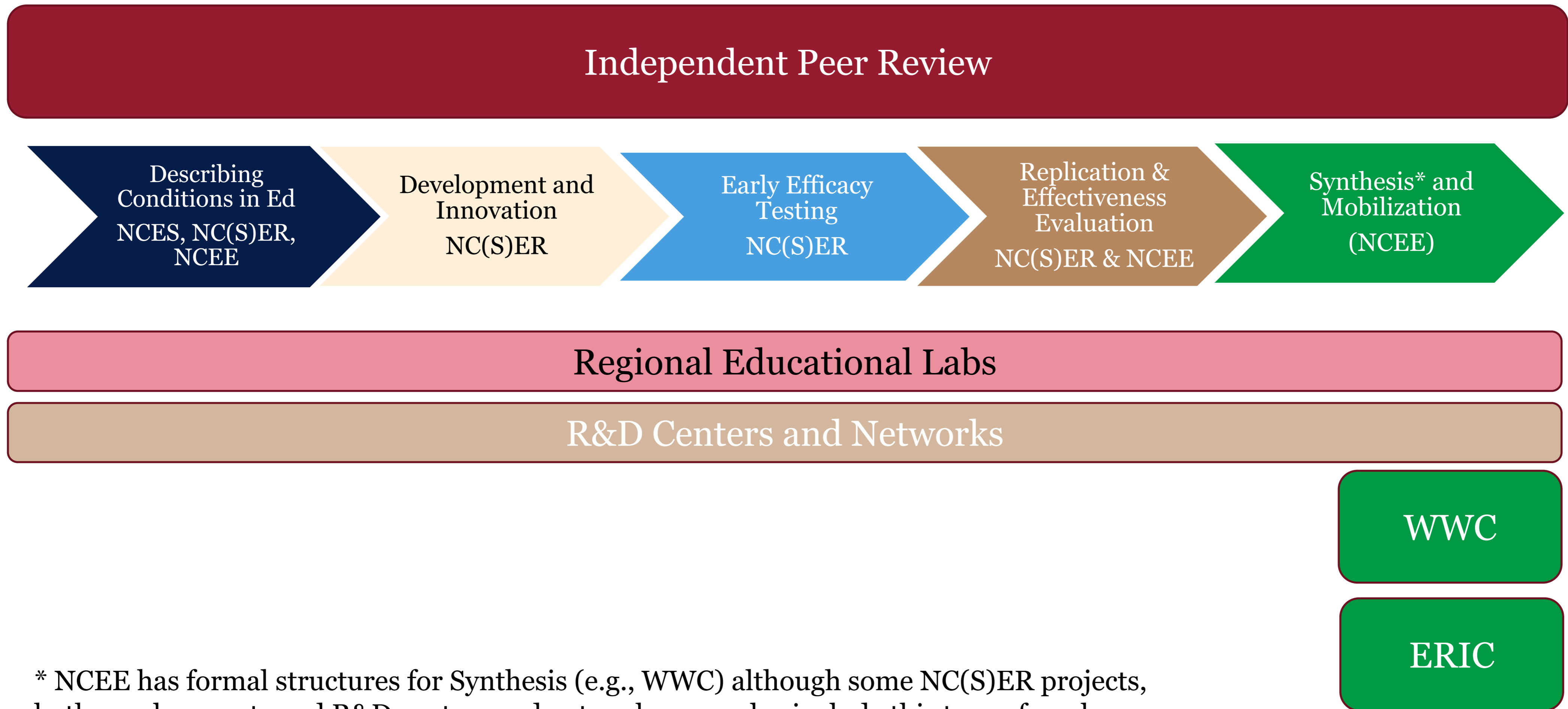
  There shall be in the Department an Office of Educational Research and Improvement ... concerning research, development, demonstration, dissemination, evaluation, and assessment activities ...

After 2002

- Parallel to the enactment of NCLB, the *Education Science Reform Act of 2002* was passed.

IES Theory Of Action

Independent Peer Review

Describing Conditions in Ed NCES, NC(S)ER, NCEE	Development and Innovation NC(S)ER	Early Efficacy Testing NC(S)ER	Replication & Effectiveness Evaluation NC(S)ER & NCEE	Synthesis* and Mobilization (NCEE)

Regional Educational Labs

R&D Centers and Networks

WWC

ERIC

* NCEE has formal structures for Synthesis (e.g., WWC) although some NC(S)ER projects, both regular grants and R&D centers and networks, may also include this type of work.

A Key Engine of Evidence Building: IES Research

The National Center for Education Research (NCER) and the National Center for Special Education Research (NCSER) generate evidence and accumulate knowledge intended to improve learning from birth to adulthood.

IES-NSF Common Guidelines for Education Research and Development (2013)

Build Core Knowledge
- Foundational
- Early-Stage or Exploratory

Develop Solutions
- Design and Development

Determine Impact
- Efficacy
- Effectiveness
- Scale-up

https://ies.ed.gov/pdf/CommonGuidelines.pdf

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Most Recently: The Evidence Act (2018)

One Hundred Fifteenth Congress
of the
United States of America

AT THE SECOND SESSION

Begun and held at the City of Washington on Wednesday,
the third day of January, two thousand and eighteen

An Act

To amend titles 5 and 44, United States Code, to require Federal evaluation activities, improve Federal data management, and for other purposes.

Be it enacted by the Senate and House of Representatives of
the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "Foundations for Evidence-Based Policymaking Act of 2018".

(b) TABLE OF CONTENTS.—The table of contents for this Act is as follows:

Sec. 1. Short title; table of contents.

TITLE I—FEDERAL EVIDENCE–BUILDING ACTIVITIES

Sec. 101. Federal evidence-building activities.

TITLE II—OPEN GOVERNMENT DATA ACT
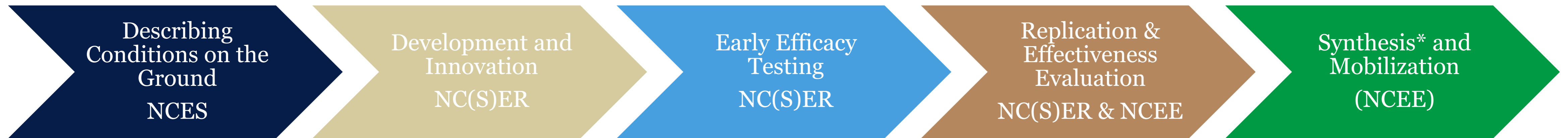
Sec. 201. Short title.
Sec. 202. OPEN Government data.

Grew out of work done by the bipartisan *Commission on Evidence-Based Policymaking*, chaired by Rep. Paul Ryan and Sen. Patty Murray.

Encourages agencies to use evidence to improve results as they work to <u>meet their mission</u> and <u>strengthen agency operations</u>. When evidence isn't available, agencies are to build it.

Implementation overseen by multiple offices within the Office of Management and Budget (OMB).

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A Growing Cadre of Evidence-Building Partners @ ED

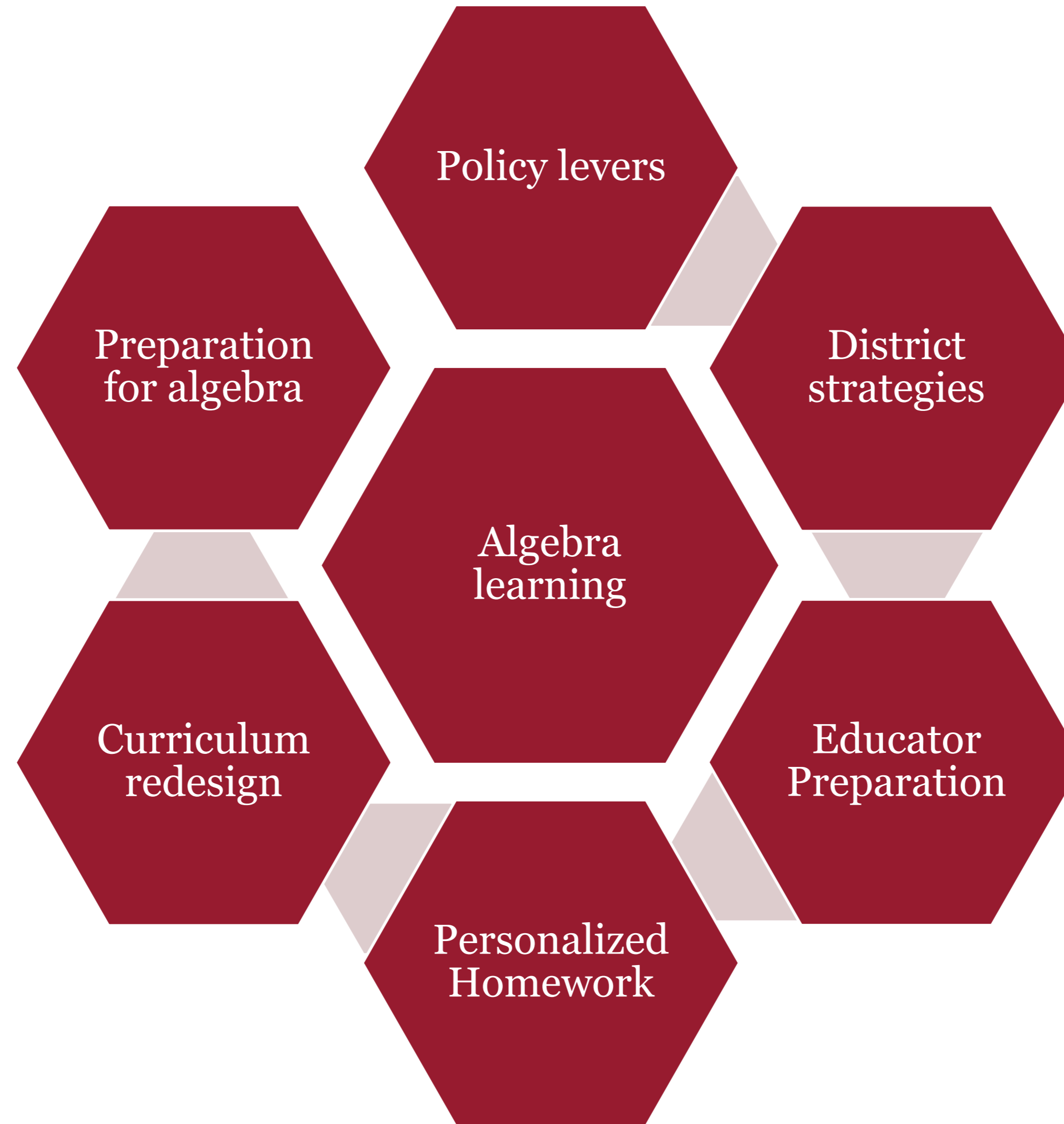| Describing Conditions on the Ground NCES | Development and Innovation NC(S)ER | Early Efficacy Testing NC(S)ER | Replication & Effectiveness Evaluation NC(S)ER & NCEE | Synthesis* and Mobilization (NCEE) |

Education Innovation and Research (EIR)

Supporting Effective Educator Development (SEED)

Postsecondary Student Success Grants (PSSG)

and other programs at ED

Building Evidence: Algebra (and Algebraic Thinking)

The Ecosystem of Teaching and Learning Algebra

Policy levers

Preparation for algebra

District strategies

Algebra learning

Curriculum redesign

Educator Preparation

Personalized Homework

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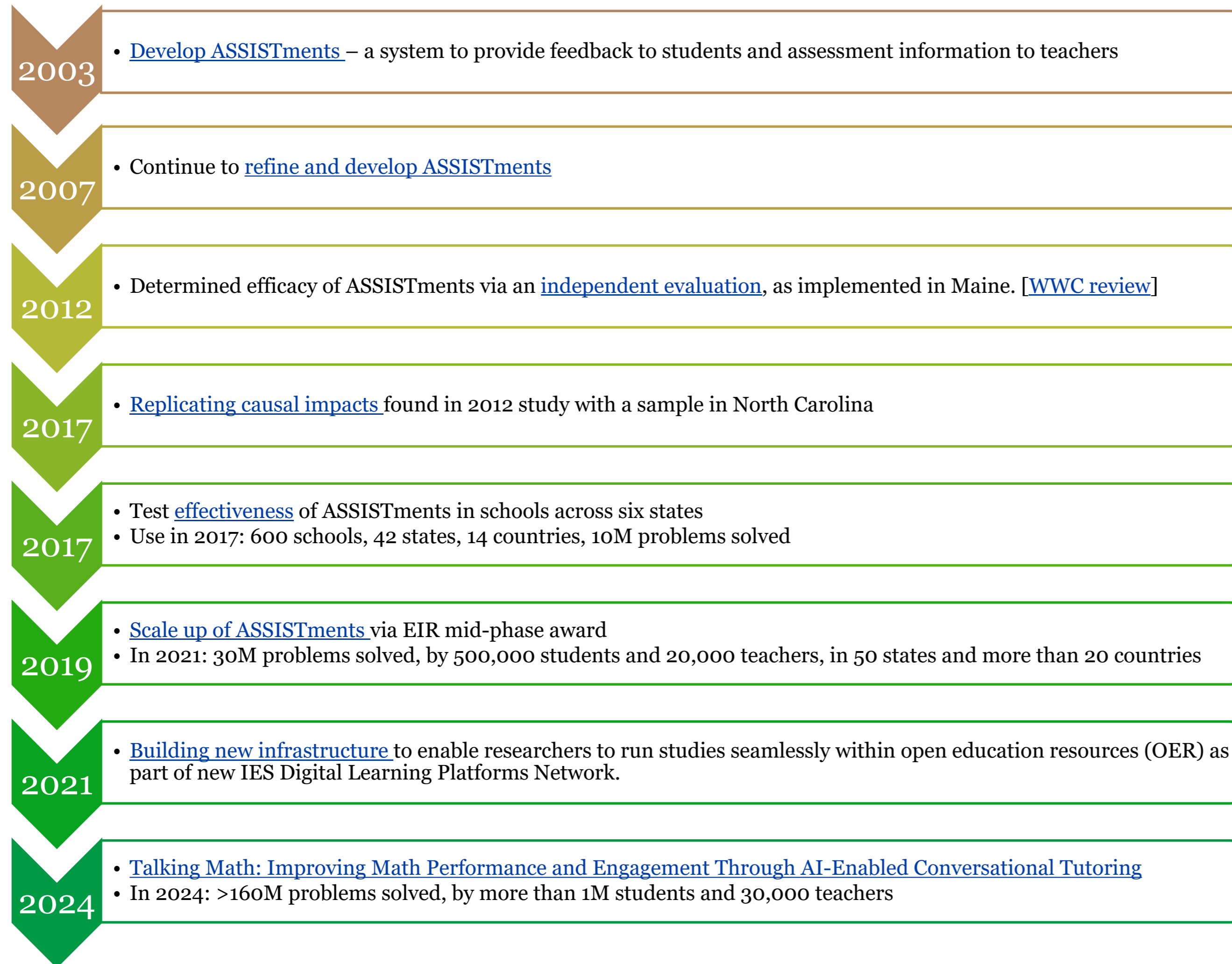|	
Policy Levers	• Charlotte-Mecklenburg Schools accelerated entry into algebra coursework • Worsened Algebra I test scores & reduced access to Geometry & Algebra II
District Strategies	• Chicago Public Schools implements *Double Dose Algebra* • Students were more likely to stay in, and complete, college
Educator Preparation	• IMPACT Iowa Mathematics Partnership in Algebra • Collaborating with teachers to increase # students completing Algebra I
Personalized Homework	• *ASSISTments* • Feedback improved outcomes for students and helped teachers
Curriculum Redesign	• *Connected Mathematics Project* (CMP) + cognitive science principles • Improved student outcomes in six of eight unit post-tests
Preparation for Algebra	• *MathByExample:* Addressing mathematics misconceptions before students begin to learn algebra

Increasing Achievement in Middle School Math

2003
- Develop ASSISTments – a system to provide feedback to students and assessment information to teachers

2007
- Continue to refine and develop ASSISTments

2012
- Determined efficacy of ASSISTments via an independent evaluation, as implemented in Maine. [WWC review]

2017
- Replicating causal impacts found in 2012 study with a sample in North Carolina

2017
- Test effectiveness of ASSISTments in schools across six states
- Use in 2017: 600 schools, 42 states, 14 countries, 10M problems solved

2019
- Scale up of ASSISTments via EIR mid-phase award
- In 2021: 30M problems solved, by 500,000 students and 20,000 teachers, in 50 states and more than 20 countries

2021
- Building new infrastructure to enable researchers to run studies seamlessly within open education resources (OER) as part of new IES Digital Learning Platforms Network.

2024
- Talking Math: Improving Math Performance and Engagement Through AI-Enabled Conversational Tutoring
- In 2024: >160M problems solved, by more than 1M students and 30,000 teachers

Strong Theory
Cognitive Science of Feedback

+

Rigorous Research
Well-designed Randomized Trials

+

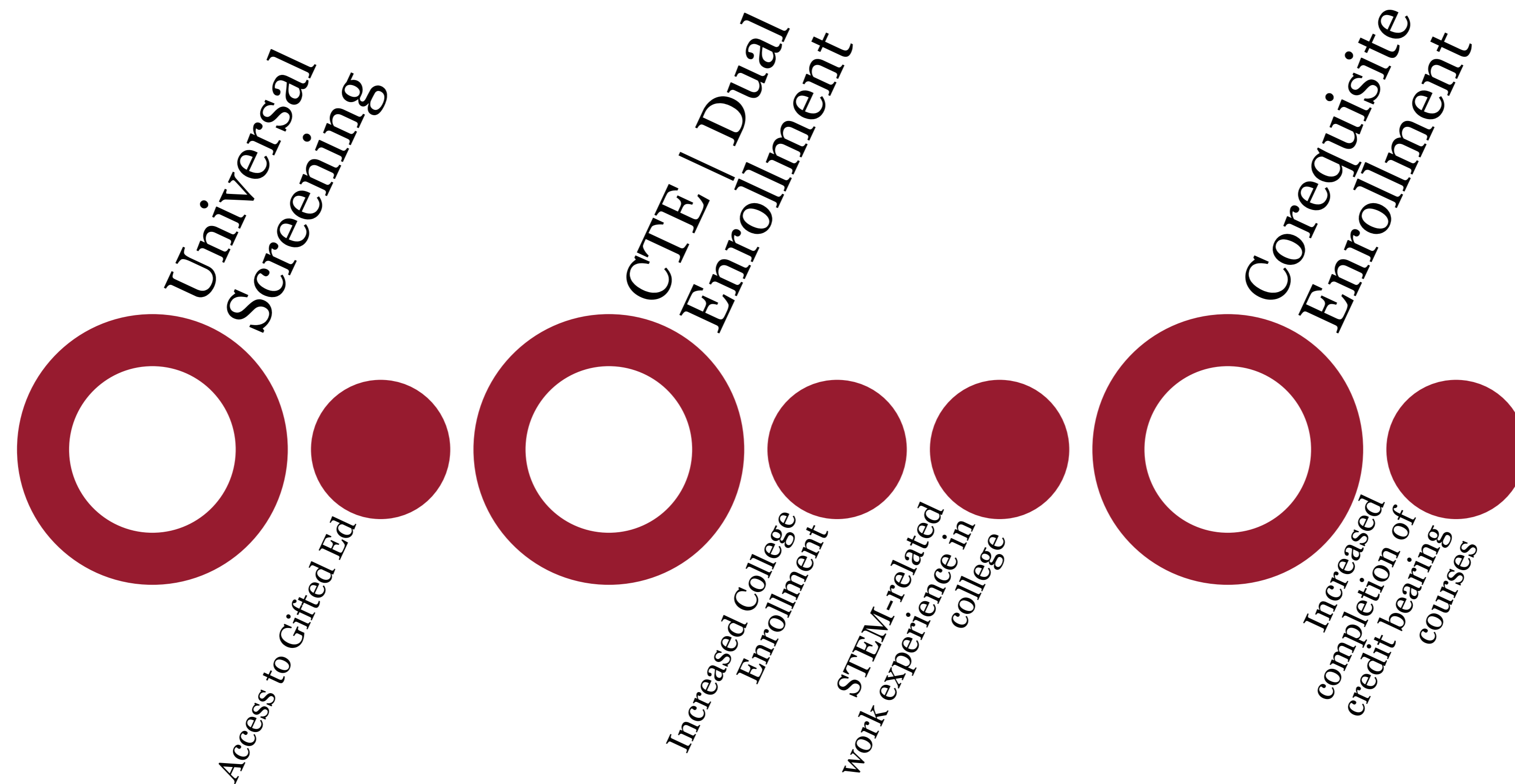**Usable Solution to Problem of Practice**
Personalized Learning and Practice

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Scaling and Transformation

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Practice Guides | Knowledge Synthesis for Educators
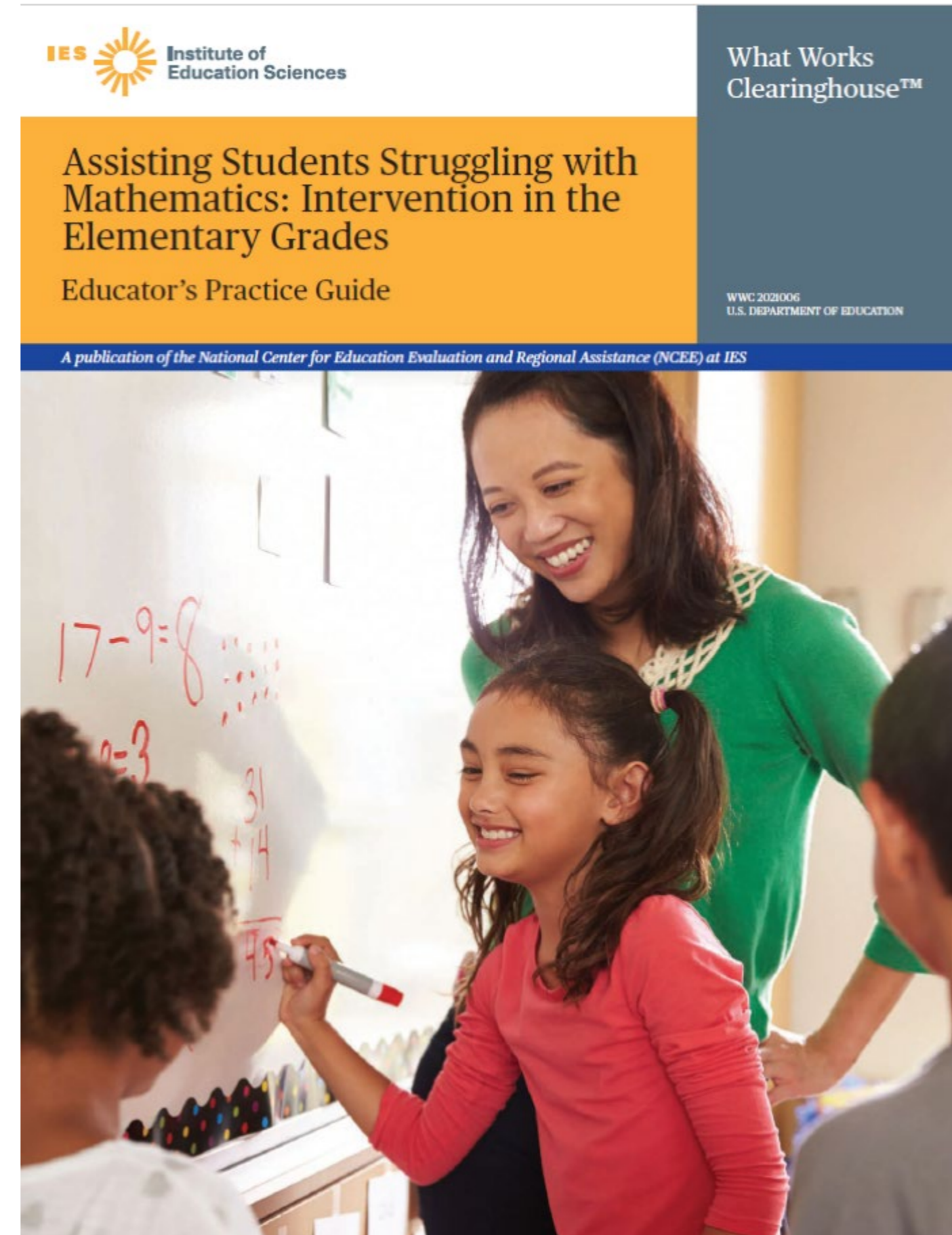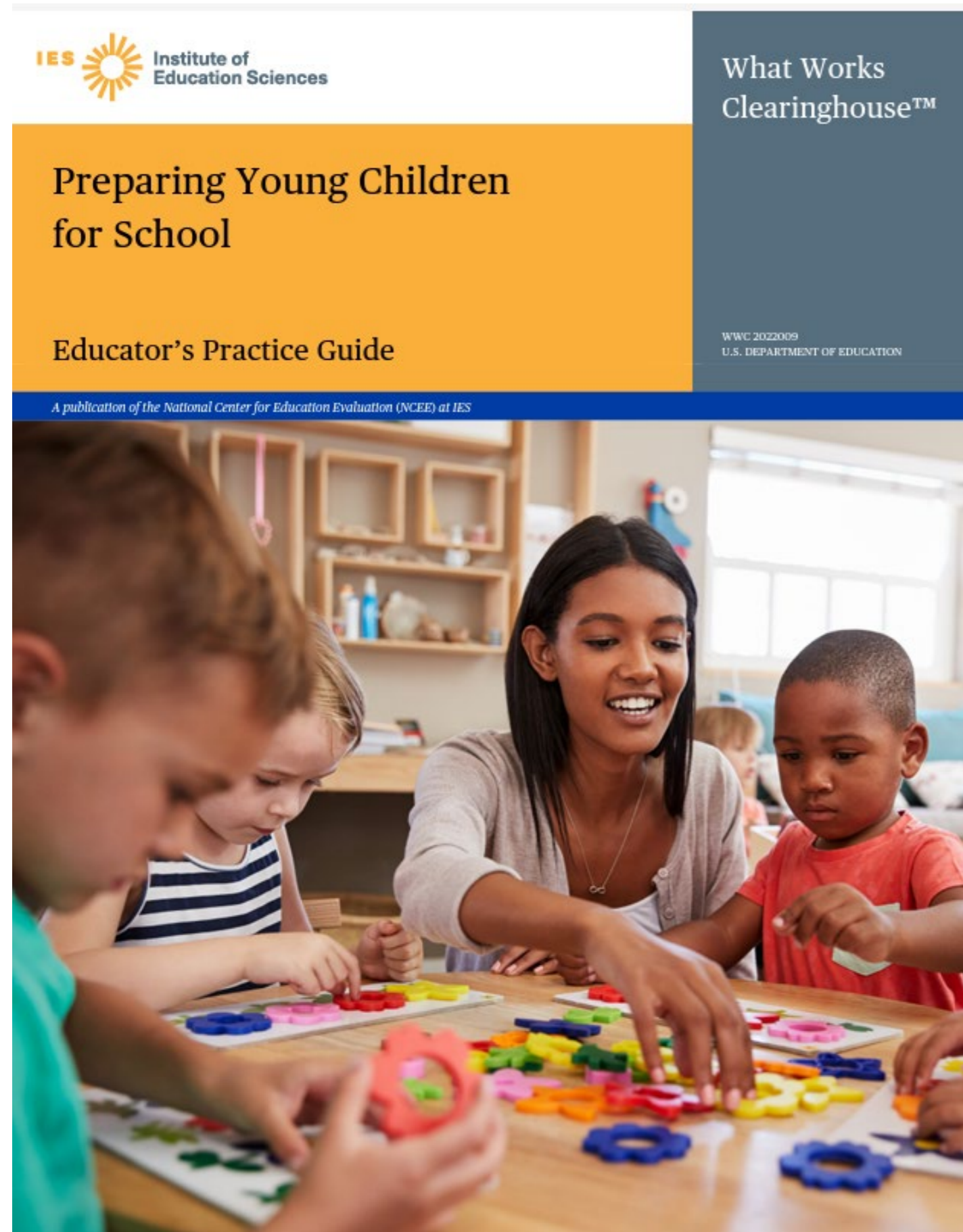
Building Evidence: Broadening Participation in STEM

Evidence-based Strategies to Broaden Participation in STEM

Universal Screening

Access to Gifted Ed

CTE | Dual Enrollment

Increased College Enrollment

STEM-related work experience in college

Corequisite Enrollment

Increased completion of credit bearing courses

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Office of Postsecondary Education

- [Postsecondary Student Success Grant (PSSG) Program](#)

- New awards include:
  - Georgia State University: to integrate personalized, course-specific chatbot communication into gateway postsecondary math and English courses
  - Colorado State University System: to transform the system's data strategy, develop a systemwide advising network, and expand and adapt U-Behavior which leverages retrieval practice activities
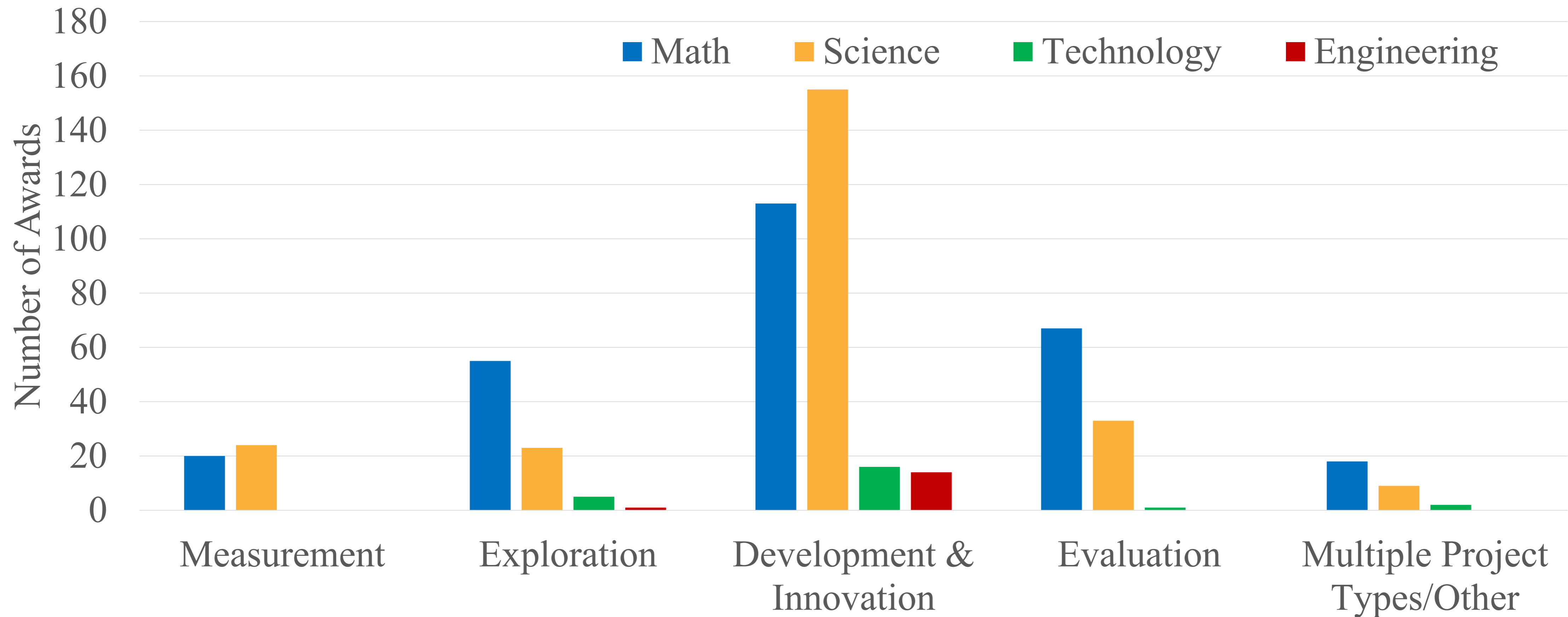
Evidence-Based Pathways to College and Career
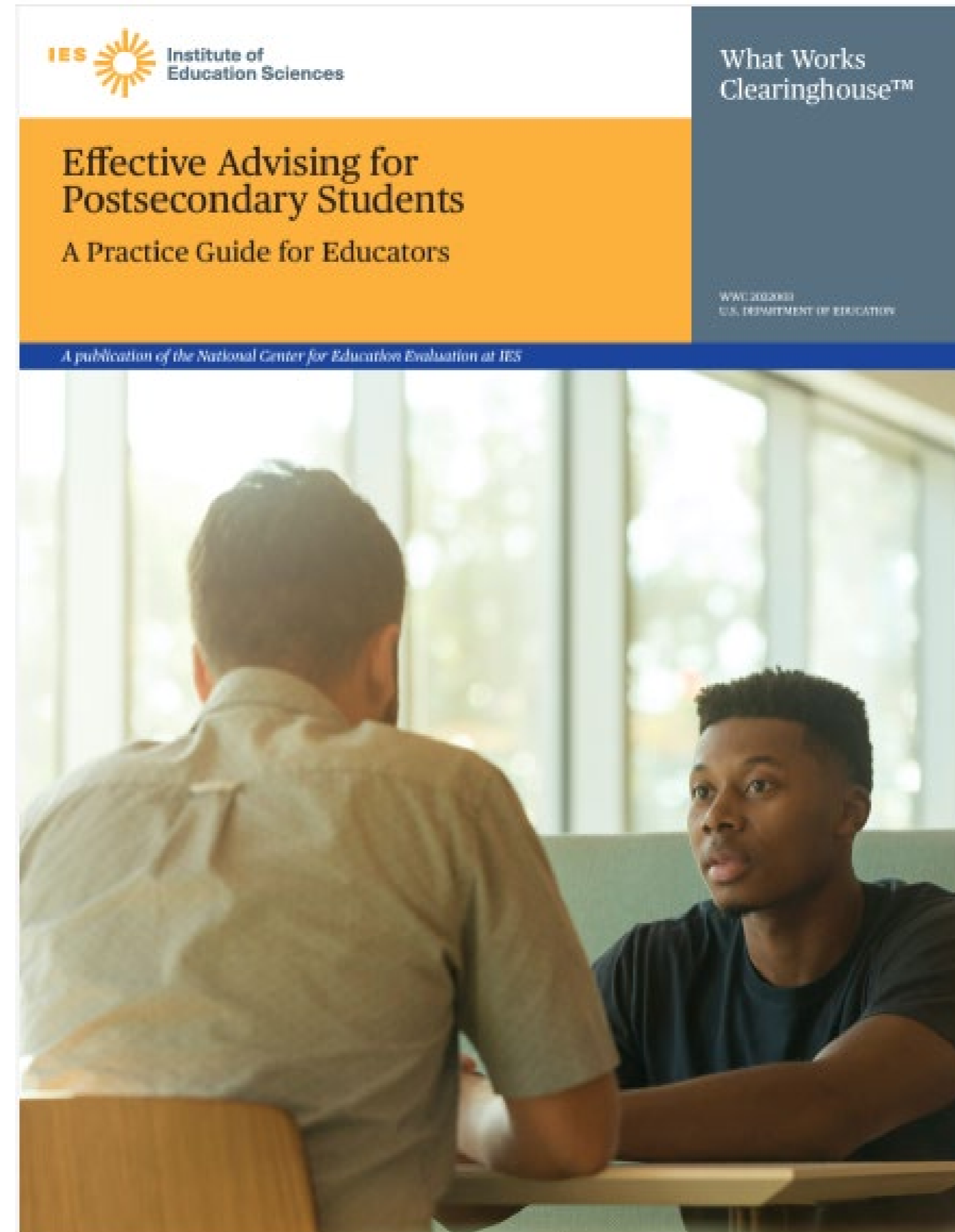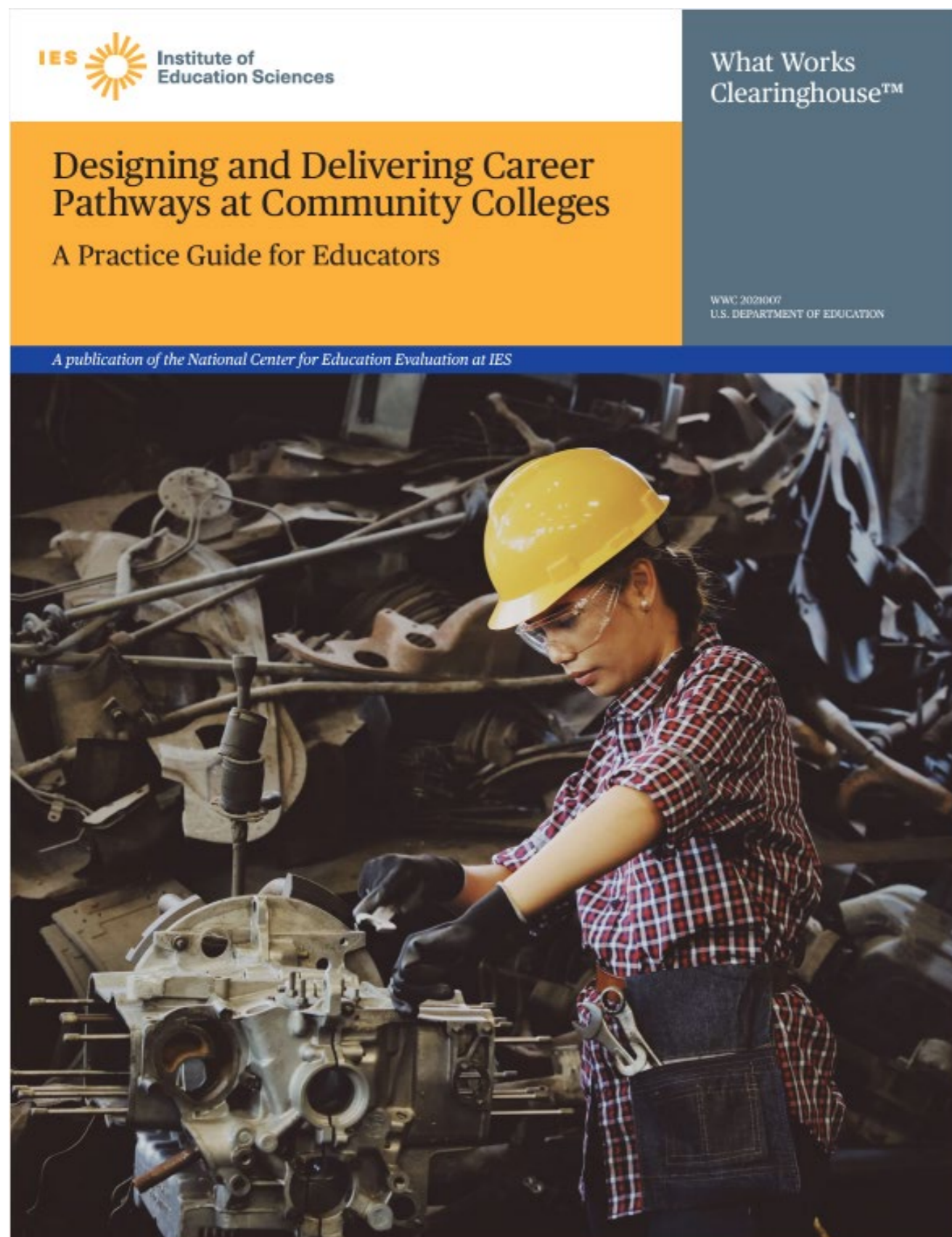
What Does the Field of STEM Education Research Need?

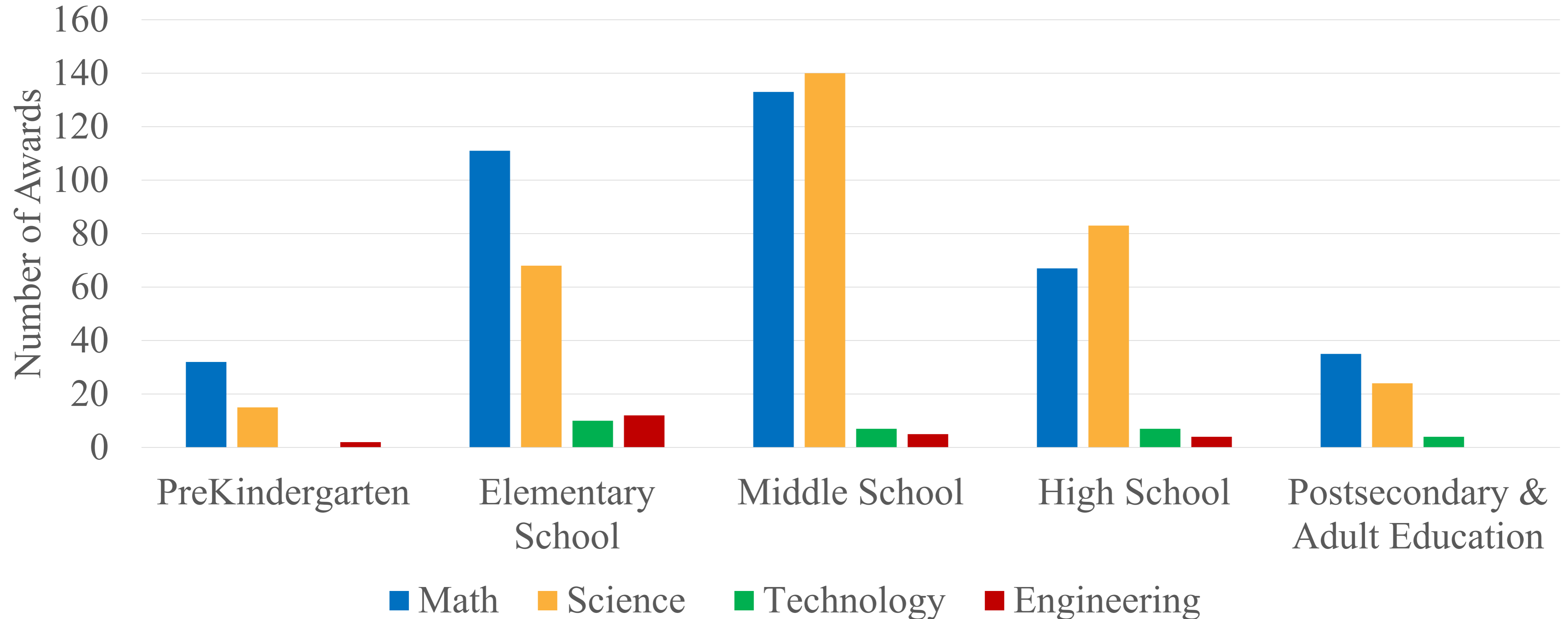Institute of
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Let's start with data

STEM-focused Research: Project Types by Content Areas 2002-2022

Note: Evaluation projects include initial efficacy, effectiveness, scale-up, and replication research

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STEM-focused Research: Age/Grade Level by Content Areas 2002-2022

Note: Projects can focus on multiple age/grade levels.

What are we missing?

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1. High quality measurement

If you can't measure it, you can't improve it.

- Why did I focus on mathematics in my examples?
- Because there are multiple reliable and valid measures available in middle school mathematics

- There is a large need for high quality measurement in many fields, but there is a particular need for measures in science, technology, and engineering – especially measures of more than attitudes.

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2. Rigorous studies of impact

- IES has funded more than twice as many studies of the impact of mathematics programs, practices, and policies than of science, technology, engineering and integrated STEM programs, practices, and policies.

- This is where we need you and your researchers to join us.

- Because preparing a STEM workforce of the future depends upon building evidence in this area.

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3. Development and testing in specific content areas

- Geometry

- Integrated STEM education

- Elementary science/STEM

- Addressing knowledge and skill gaps of postsecondary learners, especially in science

Building a Research Infrastructure

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- Invests in [research training in education](#) and [special education](#)

- Supports innovative statistical and methodological approaches to answer key questions – and address key challenges

- Populates repositories such as [ERIC](#), the [WWC](#), and [EdInstruments](#), with high-quality evidence and information

- Develops high quality tools and resources to support evidence building | [SEER](#)

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IES research training programs

- Pathways to the Education Sciences

- Interdisciplinary Predoctoral Training

- Postdoctoral Training

- Early Career Development and Mentoring

- Methods Training

New Opportunities: Data Science Training

- Data Science for Education (DS4EDU)
  - John Stamper | Carnegie Mellon
  - Apply now - https://www.cmu.edu/simon/projects/flagship-projects/ds4edu/index.html

- Data Science Methods for Digital Learning Platforms Training Program
  - Ryan Baker | University of Pennsylvania
  - https://www.gse.upenn.edu/academics/center-professional-learning/data-science-methods-digital-learning-platforms

- Innovation Science for Education Analytics (ISEA): A Data Science Training Program to Advance Educational Research and Practice
  - Min Sun | University of Washington
  - https://www.amplifylearn.ai/isea/

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Research and Development Infrastructure Grant Program

- In December, the Office of Postsecondary Education awarded $93 Million in Grants to Support Research and Development at HBCUs, TCCUs and MSIs, and Postsecondary Completion for Underserved Students

- Many of these awards are STEM-focused

- https://www2.ed.gov/programs/rdi/index.html

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Upcoming Future Funding Opportunities

Typical Competitions

- Education Research Grants

- Research Training in the Education Sciences

- Statistical and Research Methodology in Education

- Using Longitudinal Data to Support State Education Policymaking

- Transformative Research in the Education Sciences

- Small Business Innovation Research

- Special Education Research Grants

- Research Training Programs in Special Education

https://ies.ed.gov/funding/

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Bookmark this page

- Sign up for the [IES Newsflash](#)

- Funding opportunities are announced in *The Federal Register*

- Find the [funding opportunities page](#)of the IES website

- Review [current Requests for Applications](#)(RFAs)

- Contact relevant Program Officer(s)

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Open Department competitions can be found here

- https://www2.ed.gov/fund/grant/apply/grantapps/index.html?src=ft

Let's build the nation's STEM
education evidence-building infrastructure together.

Thank you

For Questions and More Information

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