The National Academies of SCIENCES ENGINEERING MEDICINE

BOARD ON SCIENCE EDUCATION

Science and Engineering in Preschool through Elementary Grades:

The Brilliance of Children and the Strengths of Educators

Sponsors:
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Why science and engineering for every children?

- Oriented to the future
  - Solid foundation (enthusiasm & knowledge) for later success
  - Become informed decision-makers
  - Access to high-paying STEM-related jobs
  - Involvement of broader range of identities and backgrounds

- Oriented to the present
  - Deserve to experience wonder of science and satisfaction of engineering
  - Children deeply curious about the world
  - Opportunities to ask and answer authentic questions and solve real-world problems that are important to them

The Committee's Commitments

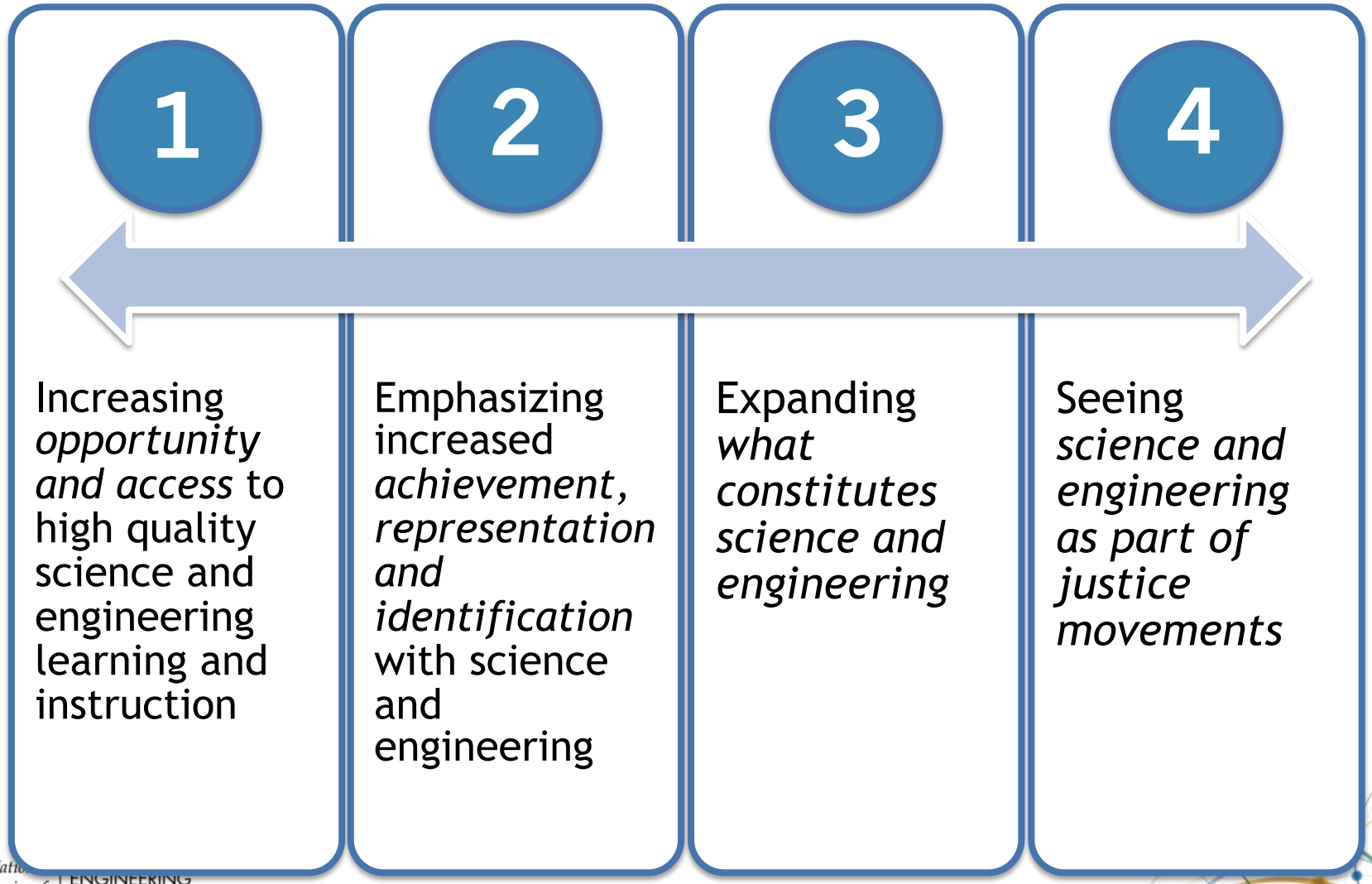
- Acknowledge that science and engineering are not neutral
  - Situated within complex historicized system
  - Antiracism and justice central elements of educational system that works to redress social inequities and oppressions.
- Recognize strengths of children, communities, families and educators
  - Use asset-based language in describing these actors & settings.
  - Attend to how learning environments could draw on, build, and attend to these strengths and needs.
- Hold vision for science and engineering learning as intentionally combining science and engineering practices, disciplinary core ideas, crosscutting concepts, identities, and interests.

Definitions of Equity and Justice

- **Equity:** address ways—through changing policies and practices—to remove barriers to participation in science and engineering and increase achievement, representation, and identification

- **Justice:** addressing the systemic oppressions that cause those barriers, seeking fair treatment of all people and supporting opportunities for self-determination and thriving

Four Approaches for Equity and Justice



What Do We Know

- Children engage in meaningful science and engineering from a very young age, across multiple contexts and settings
- Science and engineering instruction is under-resourced and not highly prioritized in preschool through elementary schools

What Can Teachers Do

Arrange instruction around phenomena and design problems

Enact learning experiences that establish norms for a caring, collective culture

Position children as active thinkers and doers

Include formative assessment processes that gather multiple forms of evidence at multiple timepoints

Seek opportunities to continue to build expertise in working toward equity and justice

Curriculum and Content Integration

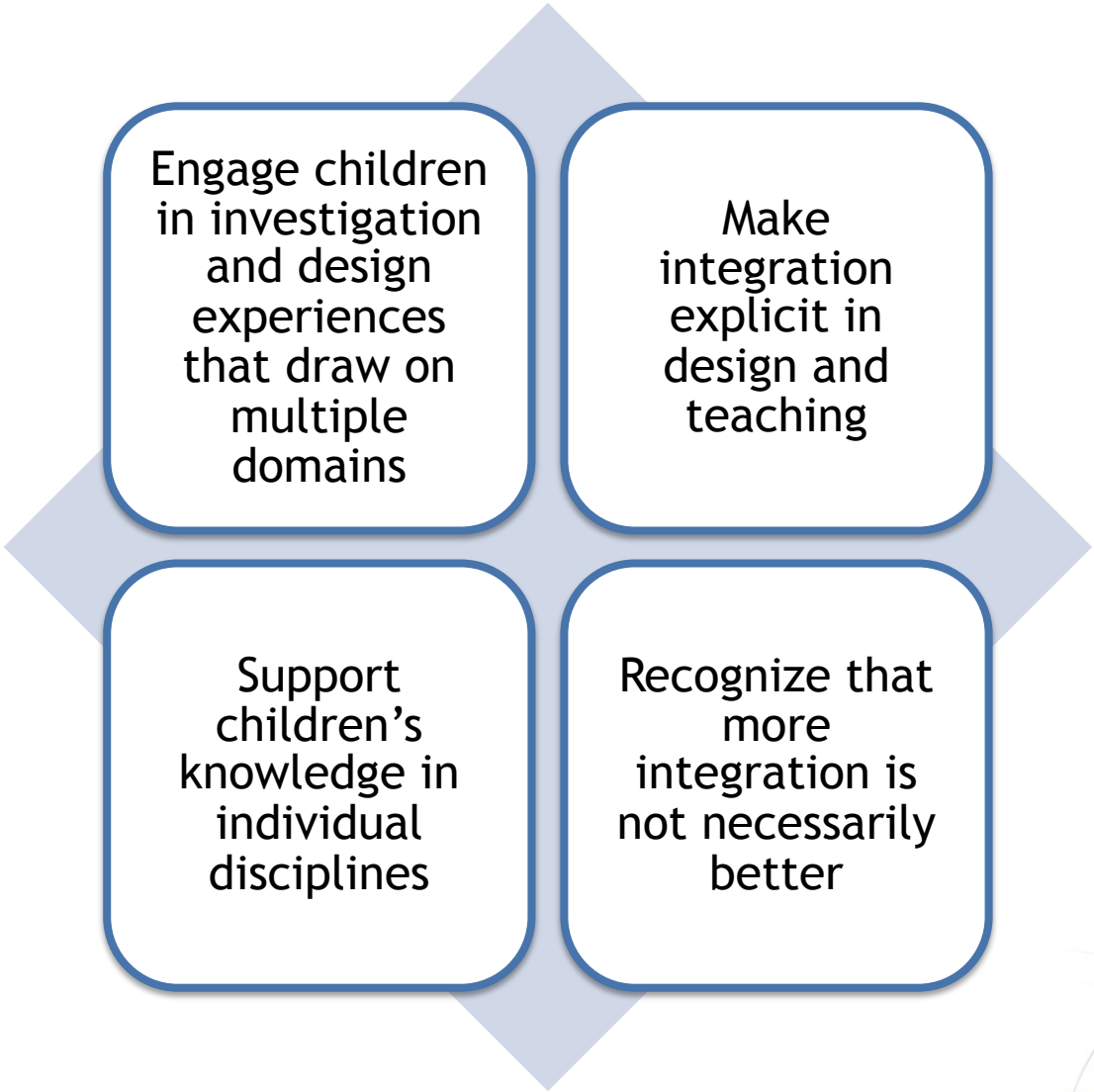
- Educators' use and adaptation of science and engineering curriculum materials is influenced by
  - knowledge, beliefs, and attitudes about the disciplines, teaching science and engineering, and learners;
  - characteristics of the materials themselves;
  - school and classroom contexts in which materials are used.

Content Integration

- Integration has potential to…
  - enhance connections between subjects (science and engineering to, e.g., ELA, math, computational thinking) and
  - effectively increase amount of instructional time for science and engineering.

- Integration can benefit all domains if design…
  - respects unique content and disciplinary practices of all domains,
  - leverages meaningful and mutually supportive connections among subject areas, and
  - is developmentally, culturally, and linguistically appropriate.

Principles Guiding Effective Integration



Opportunities for Effective Integration

ELA

- Incorporate text to help children develop and deepen explanations and situate reading in conceptually coherent, meaningful pursuits of understanding and solutions.
- Incorporate text describing doing and using science/engineering to expand views of science/engineering and help children develop identities and interests.
- Support children in producing texts and inscriptions to represent reasoning.

Mathematics

- Help children engage in quantification (distinguishing and developing measures for attributes).
- Support children in transforming & analyzing data, and understanding foundational concepts of data representation and statistics.

Computational Thinking

- Use science/engineering contexts to highlight computational thinking practices
- Use computational thinking as method for exploring science/engineering concept

Potential Pitfalls of Integration

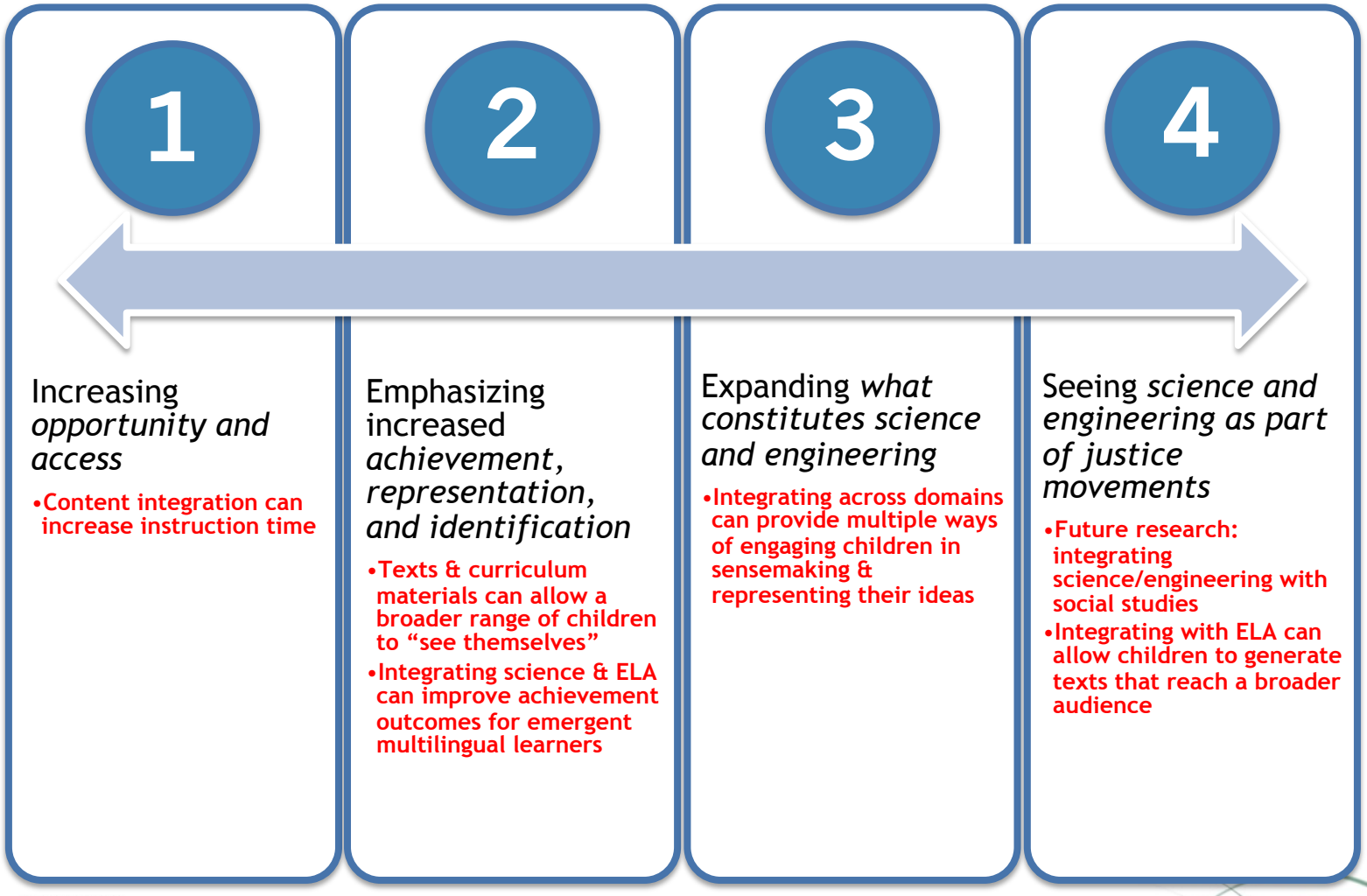
ELA

- "I Do, We Do, You Do" model: Teachers can use interactive modeling to guide learning to engage in science or engineering practices while still allowing children to drive the investigation or design.
- Vocabulary first instruction: An "activity before concept, concept before vocabulary" approach is generally useful in science and engineering.

Mathematics

- Sequencing: STEM integration can lead to trivializing math concepts or, alternatively, expecting use of math concepts before children understand their conceptual underpinnings.
- Utilitarian understandings: Sometimes easy-to-measure numerical attributes (e.g., distance) are used in lieu of more powerful conceptual values (e.g., rate).
- Mathematical practices at the early grades are dealt with unevenly in NGSS

Equity and Justice in Content Integration

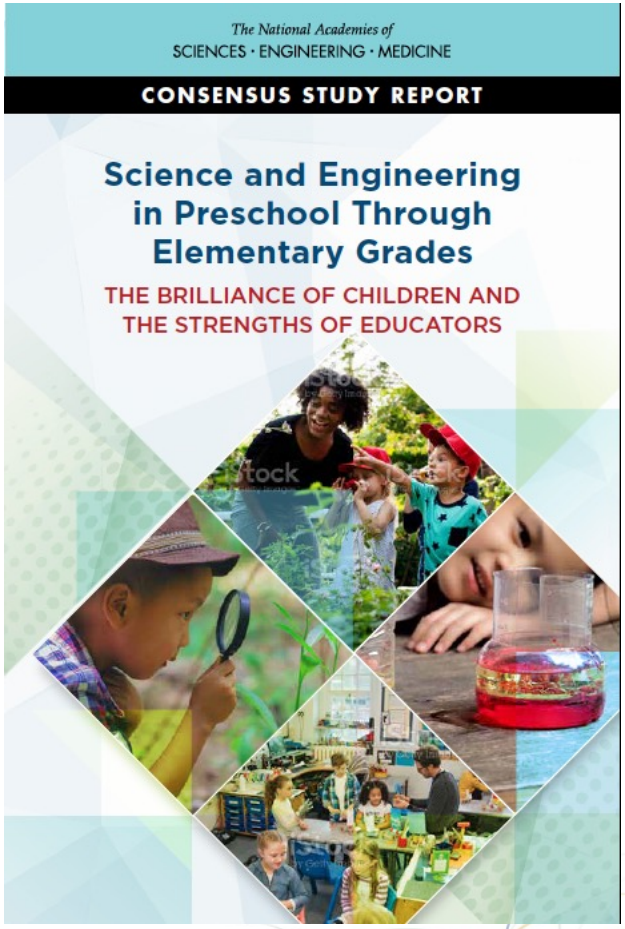


Questions and Discussion

Thank you for your engagement!

If you're interested in reading the report, you can obtain a PDF (for free!) or order the book at nap.edu — search for Science and Engineering in Preschool through Elementary

Practitioner companion volume coming in Fall 2022!



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