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BOARD ON SCIENCE EDUCATION

Science and Engineering for Grades 6-12: Investigation and Design at the Center

Webinar on Pre-service and In-service Professional Learning
March 28, 2019

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nas.edu/Science-Investigation-and-Design

Study Sponsors: Amgen Foundation and
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The **Board on Science Education** and the **National Academy of Engineering ran this study.**

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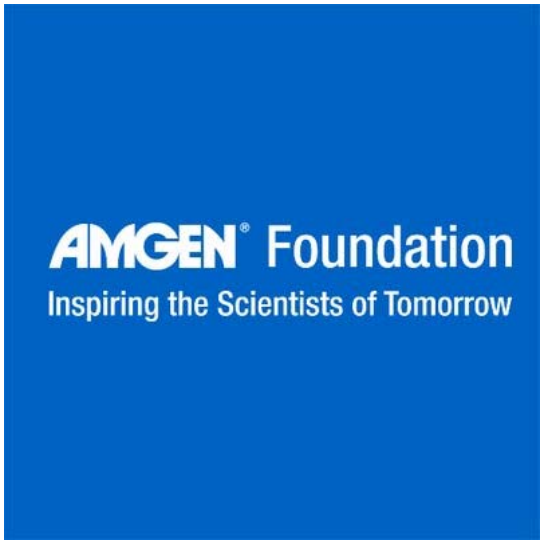
Study Sponsors:



Committee Members

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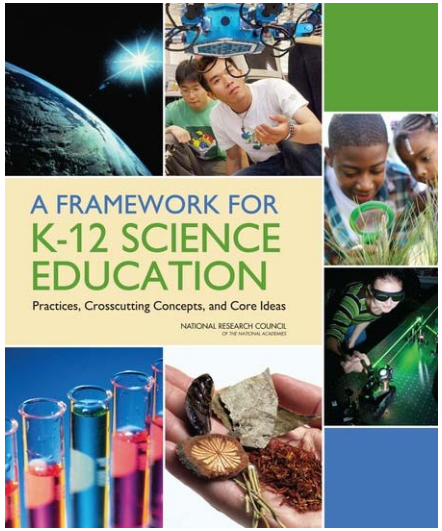
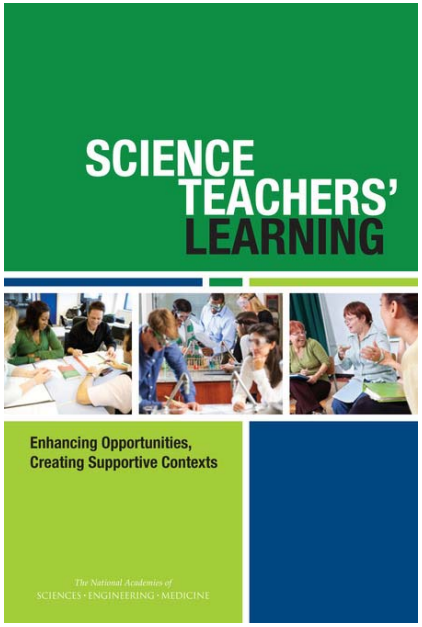
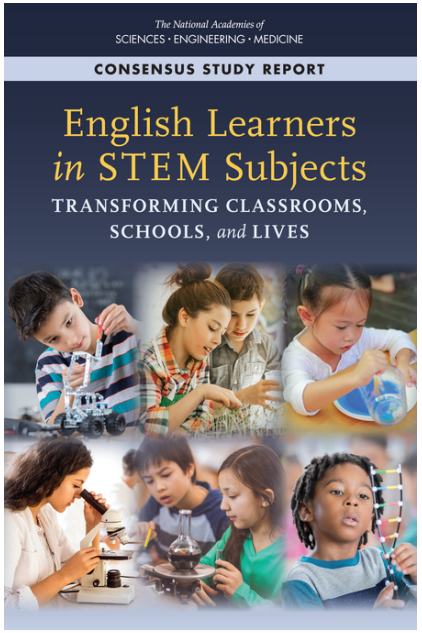
Committee Charge

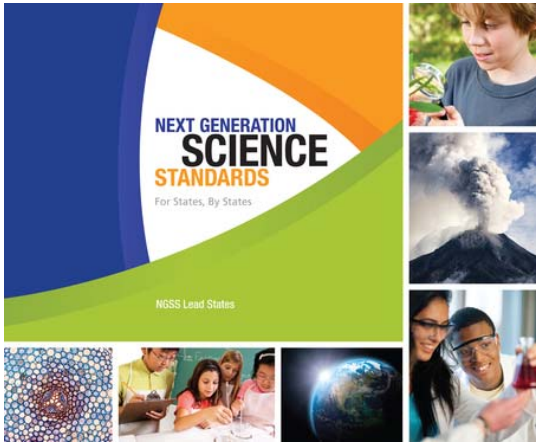
- Review research on science investigation and engineering design for middle and high school students conducted since publication of *America's Lab Report* (National Research Council, 2006)
- Review will include research and evaluations of innovative approaches, such as computer modeling or use of large on-line data sets that have become more widely available since publication of the original report.
- Provide guidance for designing and implementing science investigation and engineering design for middle and high school students taking into account the new vision for science education embodied in the *Framework for K-12 Science Education* (National Research Council, 2012) and standards based upon it.

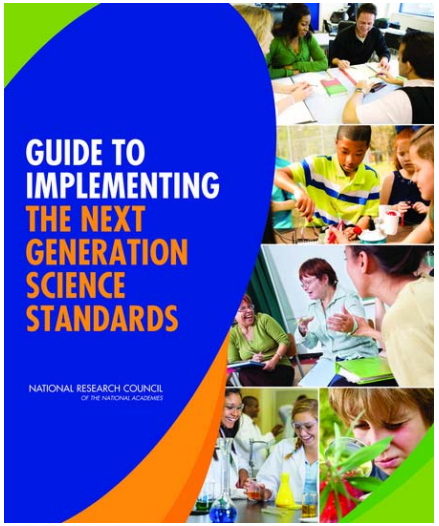
Context of our Study

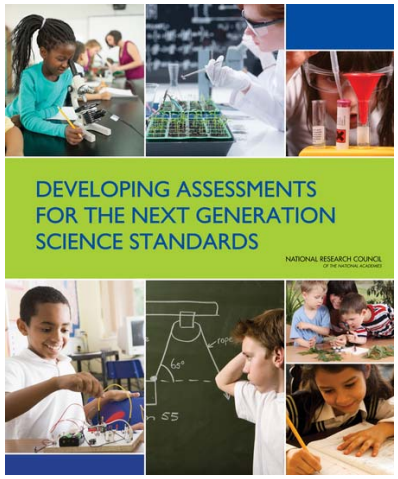


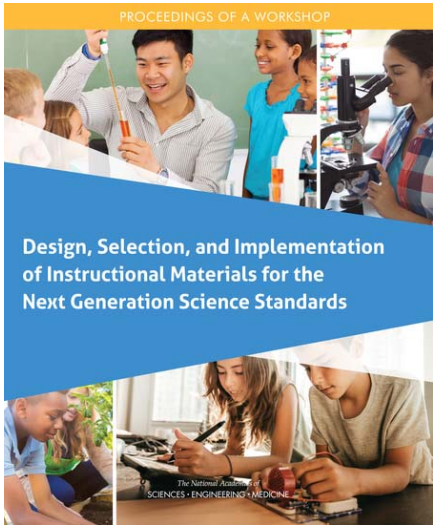












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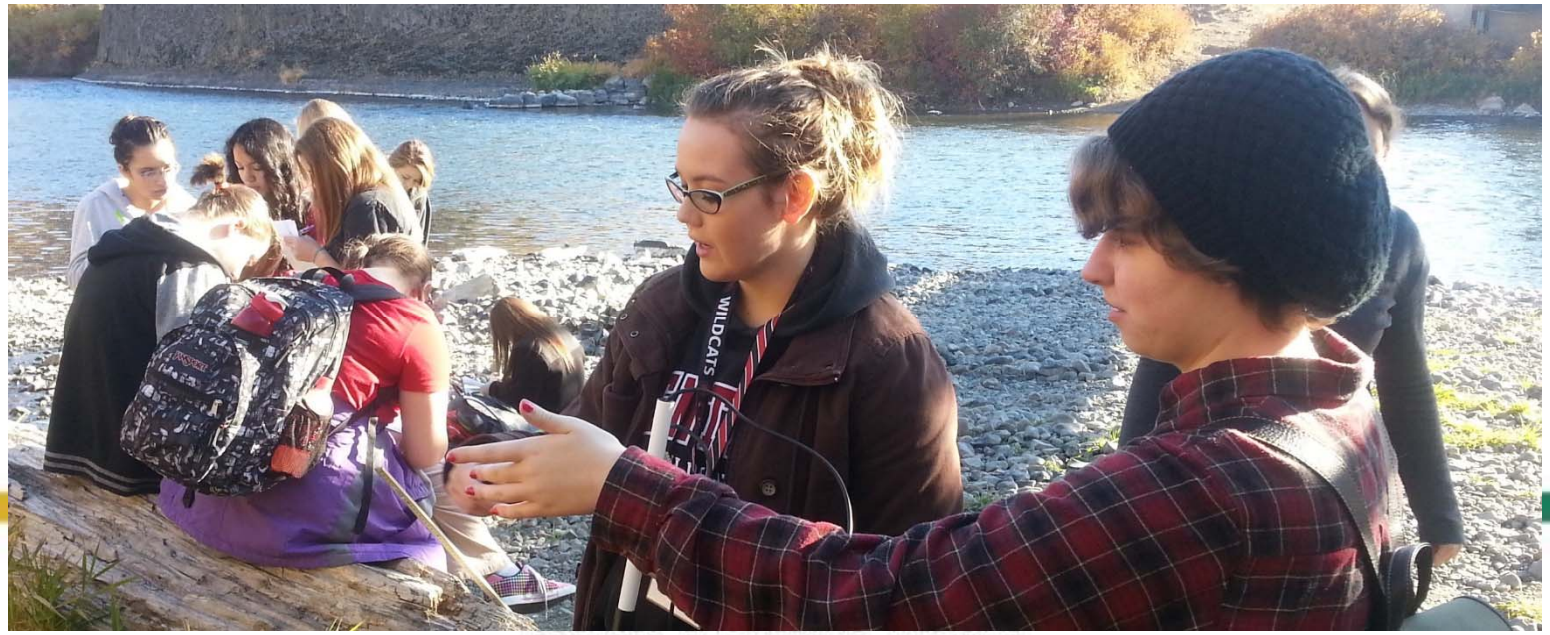
Primary conclusion:

Investigation and design are more effective for supporting learning than traditional teaching methods.

What does this mean?

- Students work to make sense of phenomena or solve challenges in a way that integrates all three dimensions of the *Framework*
- Over time, students' sense-making increases in depth and sophistication, as they make connections between concepts.



Report Chapters

- K-12 Science Education Past and Present
- Learning and Motivation
- How Students Engage with Investigation and Design
- How Teachers Support Investigation and Design
- Instructional Resources for Supporting Investigation and Design
- Preparing and Supporting Teachers to Facilitate Investigation
- Space, Time, and Resources
- The Education System and Investigation and Design
- Conclusions, Recommendations, and Research Questions

Why investigation and design?

- Teachers can use students' curiosity to **motivate learning** by choosing phenomena and design challenges that are interesting and engaging to students, including those that are locally and/or culturally relevant.

- Inclusive pedagogies can **support the learning of all students** by situating differences as assets, building on students' identities and life experiences.

How is the classroom different?

Science investigation and engineering design entail a **dramatic shift** in the classroom dynamic.

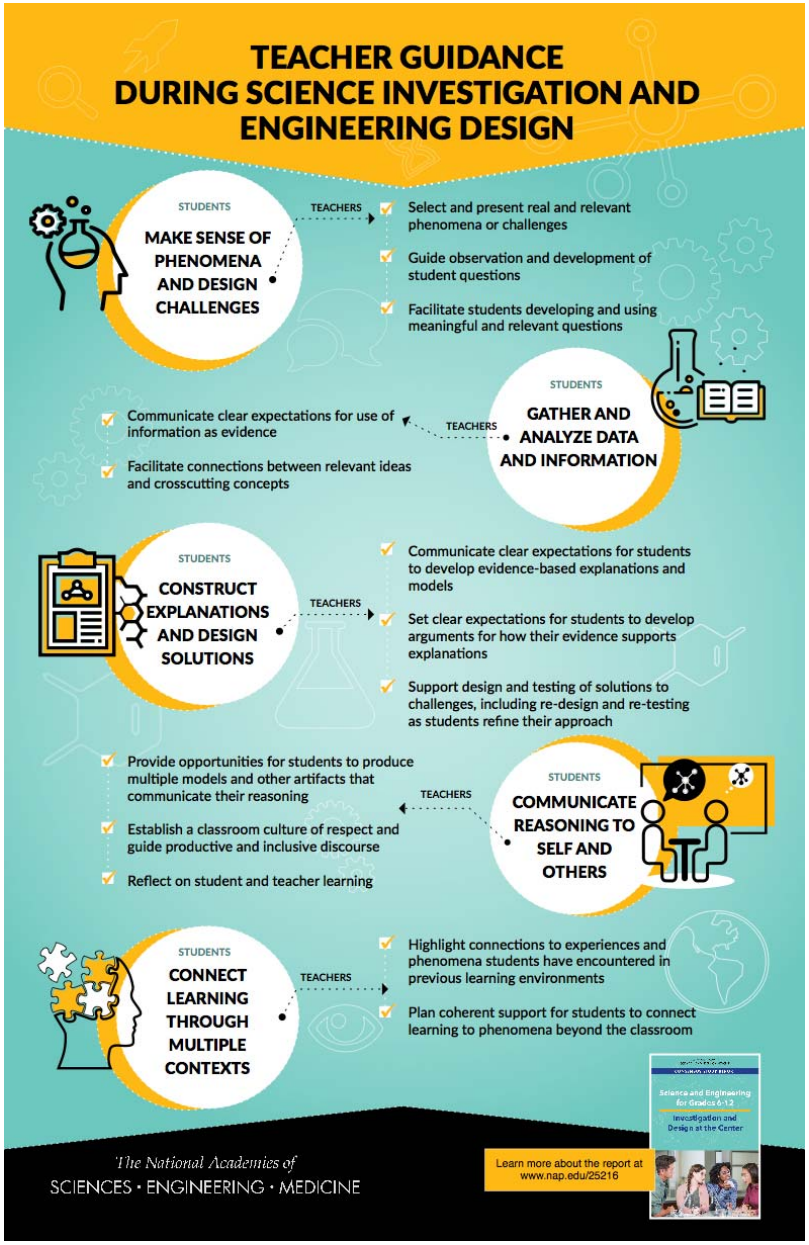
- Students ask questions, participate in discussions, create artifacts and models to show their reasoning, and continuously reflect and revise their thinking.

- Teachers guide, frame, and facilitate the learning environment to allow student engagement and learning.

How is assessment different?

Teachers

- Provide multiple opportunities for students to demonstrate their reasoning and show understanding of scientific explanations about the natural world.
- Observe student learning and embed assessment into the flow of learning experiences
- Allow students (and themselves) to reflect on learning



Teacher Guidance

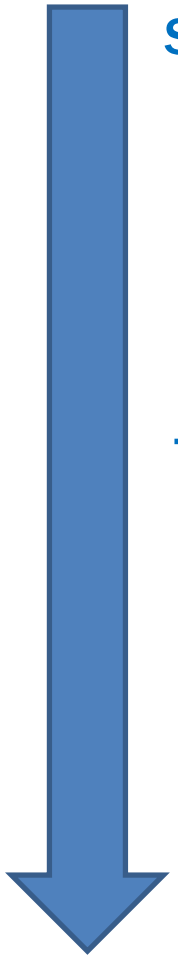
The full Interactive Infographic is available at

https://www.nap.edu/resource/25216/interactive/

How do we support teachers in making this shift?

The professional learning continuum

- From preservice programs…
- …to summer and school-year professional development sessions…
- …to a teacher's experience in his or her classroom…
- …to formal and informal work between colleagues



Student perspective

Teacher perspective

Leader perspective

Teacher Professional Learning

1. Professional **learning changes throughout a teacher's career.** Professional development should be specific to the learner.
2. Engaging educators in making sense of science phenomena and engineering challenges should **model classroom instruction,** while addressing the needs of adult learners.
3. **Reflection on teaching and learning** is essential to move from professional development to implementation in the classroom.
4. **Application** of professional development instructional strategies and resources enhances teacher learning.
5. Professional development should address the specific **needs of each teacher's student population.**
6. **Teachers are professionals** who learn throughout their career and implement research based strategies that best meet their student needs.

RECOMMENDATION 4:

High-quality, sustained, professional learning opportunities are needed to engage teachers as professionals with effective evidence-based instructional practices and models for instruction in science and engineering

- Administrators should identify and encourage participation in sustained and meaningful professional learning opportunities for teachers to learn and develop successful approaches to effective science and engineering teaching and learning.
- Professional development leaders should provide teachers with the opportunity to learn in the manner in which they are expected to teach, by using *Framework* aligned methods during professional learning experiences.
- Teachers should receive feedback from peers and other experts while working throughout their career to improve their skills, knowledge, and dispositions with these instructional approaches.
- Professional development leaders should prepare and empower teachers to make informed and professional decisions about **adapting lessons to their students and the local environment.**
- Administrators and education leaders should provide opportunities for teachers to implement and reflect on the use of *Framework*-aligned approaches to teaching and learning.

- **Engage teachers as professionals**
  - Honor and respect expertise teachers bring to PD
  - Establish appropriate learning environments
  - Respect teachers as adult learners
- **Sustained professional learning opportunities**
  - Duration of learning episodes
  - Coherence with evidence-based approaches
- **Practices**
  - Instructional practices & strategies
  - Use appropriate practices for the PD
- **Models** for instruction in science and engineering
  - Engage teachers in investigation and design
  - Models quality science teaching and learning
  - Provide resources for teachers to try out the advocated instructional approaches in own classroom

Supporting Professional Learning

- **Application of instruction consistent with the professional development** is essential for professional learning.
  - Sustained professional learning resides with the individual teacher and extends beyond workshops and professional develop programs.
  - Individual and shared reflection on teaching and learning enhances the application in the classroom
- **Resources** consistent with the professional development approaches help **sustain instructional changes.**
  - Resources include – PPTs from PD sessions, books and articles describing the philosophical approaches of the PD, lessons and/or instructional units formative assessments, and videos showing instruction consistent with advocated instructional approaches.
  - Ongoing access to professional development providers is important for teachers to validate the application of learning.

Questions?

RECOMMENDATION 5:

Undergraduate learning experiences need to serve as models for prospective teachers, in which they experience investigation and design as learners.

- College and university faculty should design and teach science classes that **model** the use of evidence-based principles for learning and **immerse** students in *Framework*-aligned approaches to science and engineering learning.

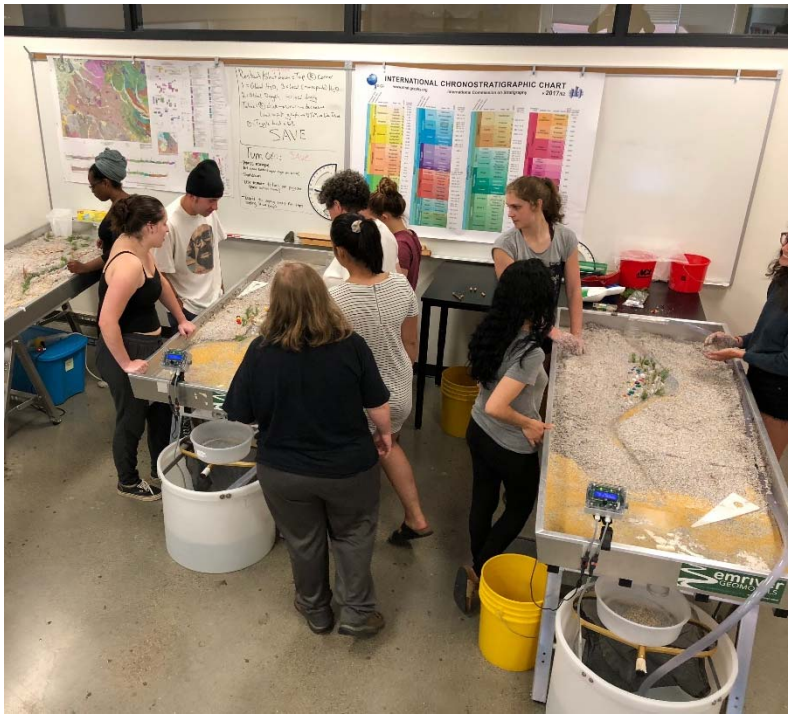
- Faculty should design and teach courses on pedagogy of science and engineering that use instructional strategies consistent with the *Framework*.

- College and university administrators should support and incentivize design of new courses or redesign of existing courses that use evidence-based principles and align with the ideas of the *Framework*.

Implementing recommendation 5:

Science courses for future teachers

- Content drawn from the standards integrated with pedagogical practices
- Currently, primarily effectively implemented for elementary education majors—opportunities to expand to pre-service teachers at middle and high school levels
- Keys to success:
  - Make use of the practices
  - Provide opportunities to reflect on the learning process



Implementing recommendation 5:

Intro/general education courses

- Where most future teachers get their science—engineering is rare
- Not typically designed to align with *Framework*-based standards or teaching methods
- Integrating more investigation and design will benefit future teachers AND future incoming students
- Keys to success:
  - Not known yet

Implementing recommendation 5:

Teacher preparation programs

- Typically do not include science content courses
- Can include course-based research in required courses (UTeach model is an example)
- Can work with science departments to advise students into appropriate courses
- Keys to success:
  - Not known yet

Implementing recommendation 5:

Research experiences for future teachers

- Undergraduate research experiences are a net benefit that engage students in many *Framework*-aligned practices
- Can be targeted for future teachers: STAR program pairs students with a researcher AND a master teacher
- Key components:
  - Reflection on applications to teaching
  - Help for students to integrate research into teaching

Implementing recommendation 5 SUMMARY:

Promising practices

- Lots of opportunities for work in this area to understand how future teachers' undergraduate science learning experiences can influence their teaching.

Summary

- Investigation and design are more effective for supporting learning than traditional teaching methods.
- Putting investigation and design at the center has a big impact on what teachers do in the classroom
- Recommendations 4 and 5 describe ways to support current and future teachers in making this transition
- Changes along the continuum of professional learning:
  - Science learning and research opportunities for pre-service teachers
  - High-quality, sustained professional development opportunities
  - Examples of success in both areas are available and could be more widely adopted

QUESTIONS?

More Information on the report and registration links for the webinar can be found at *nas.edu/Science-Investigation-and-Design*

Today's Presenters for the Webinar on Pre-service and In-service Teaching Professional Learning

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