Teaching and Learning in a STEM Focused World

Materials and Manufacturing Teacher Institute 2019

July 23, 2019

Peter McLaren - *Executive Director*

Next Gen Education, LLC

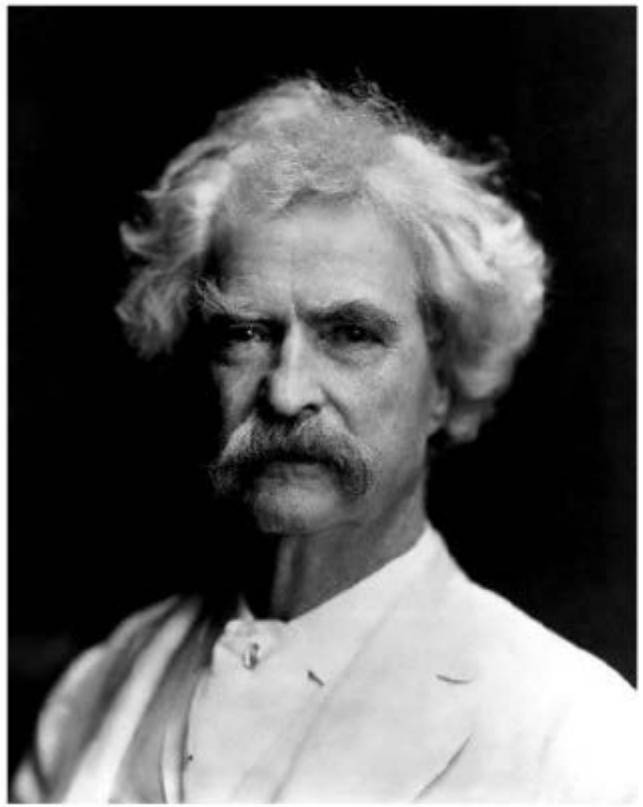
@peterjmclaren

NEXT GEN EDUCATION, LLC

NEXT GEN EDUCATION, LLC

Need for Change

NEXT GEN EDUCATION, LLC

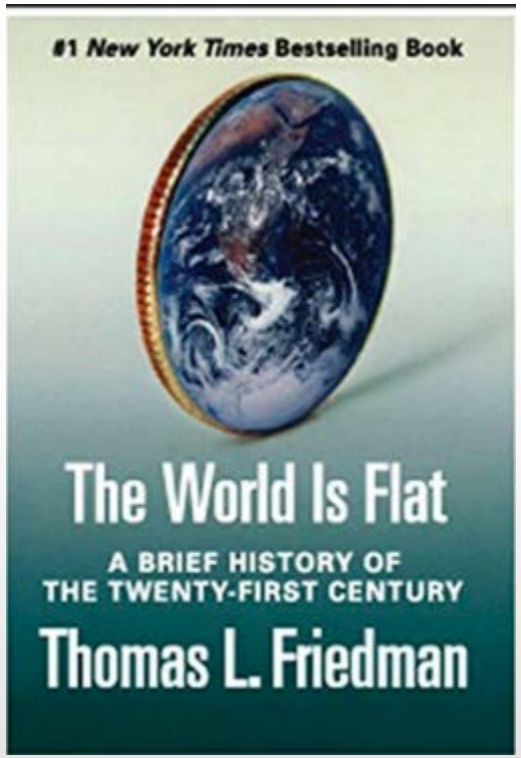


"The only person who likes change is a baby with a wet diaper." - Mark Twain

NEXT GEN EDUCATION, LLC

Ten Forces That Changed the World

- **Collapse of Berlin Wall**-- (11/09/1989)
- **Netscape --** (8/9/1995)
- **Work Flow Software:** The ability of machines to talk to other machines with no humans involved.
- **Uploading:** Communities uploading and collaborating on online projects. Examples include open source software, blogs, and Wikipedia
- **Outsourcing:** outsourcing has allowed companies to split service and manufacturing activities into components, with each component performed in most efficient, cost-effective way.
- **Offshoring:** Manufacturing's version of outsourcing.
- **Supply-Chaining:** modern retail supply chain is like a river, Wal-Mart as an example of a company using technology to streamline item sales, distribution, and shipping.
- **Insourcing:** UPS as a prime example for insourcing, in which the company's employees perform services--beyond shipping--for another company. For example, UPS itself repairs Toshiba computers on behalf of Toshiba. The work is done at the UPS hub, by UPS employees.
- **In-forming:** "Never before in the history of the planet have so many people-on their own-had the ability to find so much information about so many things and about so many other people"
- **"The Steroids":** Personal digital devices like mobile phones, iPods, personal digital assistants, instant messaging, and voice over Internet Protocol (VoIP).

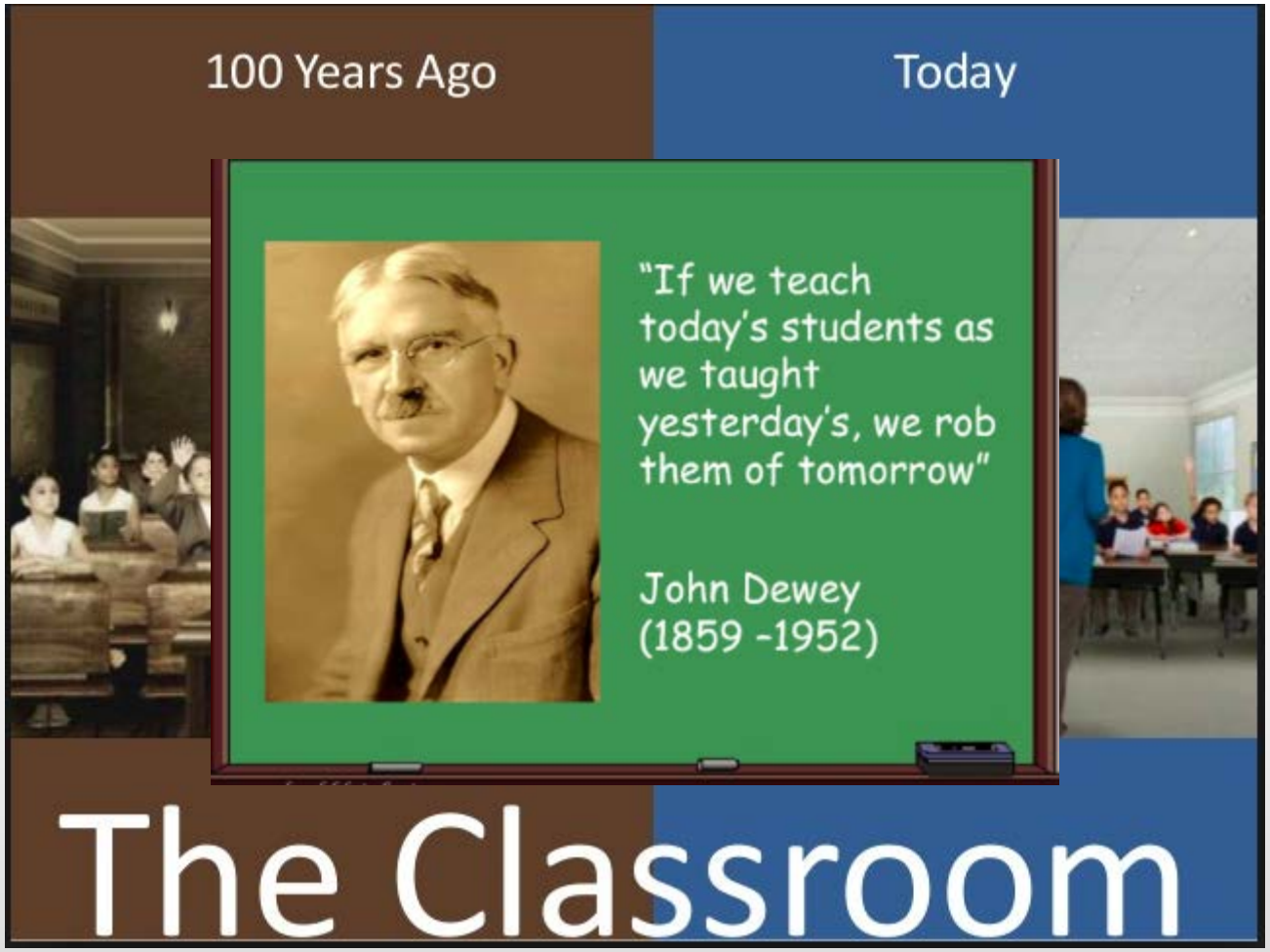


NEXT GEN EDUCATION, LLC

What Do Kids Need?

- Today's kids need new skills to be successful (e.g., creativity, critical thinking, teamwork, communication).
- Our world is complex and interconnected (especially compared to the really old days)

Teaching and Learning



NEXT GEN EDUCATION, LLC

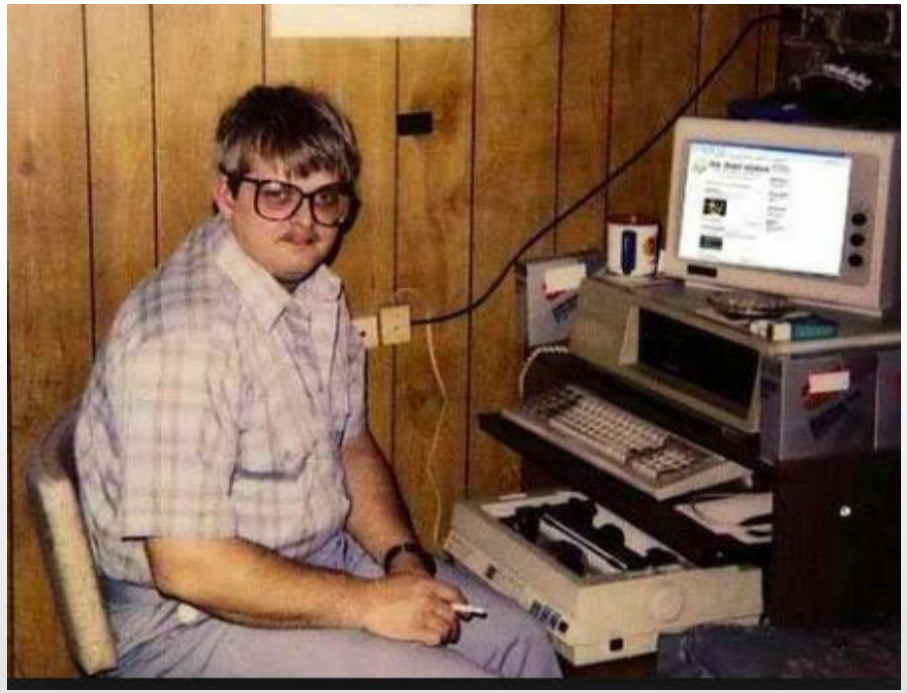
The Goal

“moving STEM from a conundrum and a loose affiliation of disciplines to a powerful domain for structuring K-16 learning based upon a coherent set of shared practices and cross cutting concepts appears to be within our collective reach,”

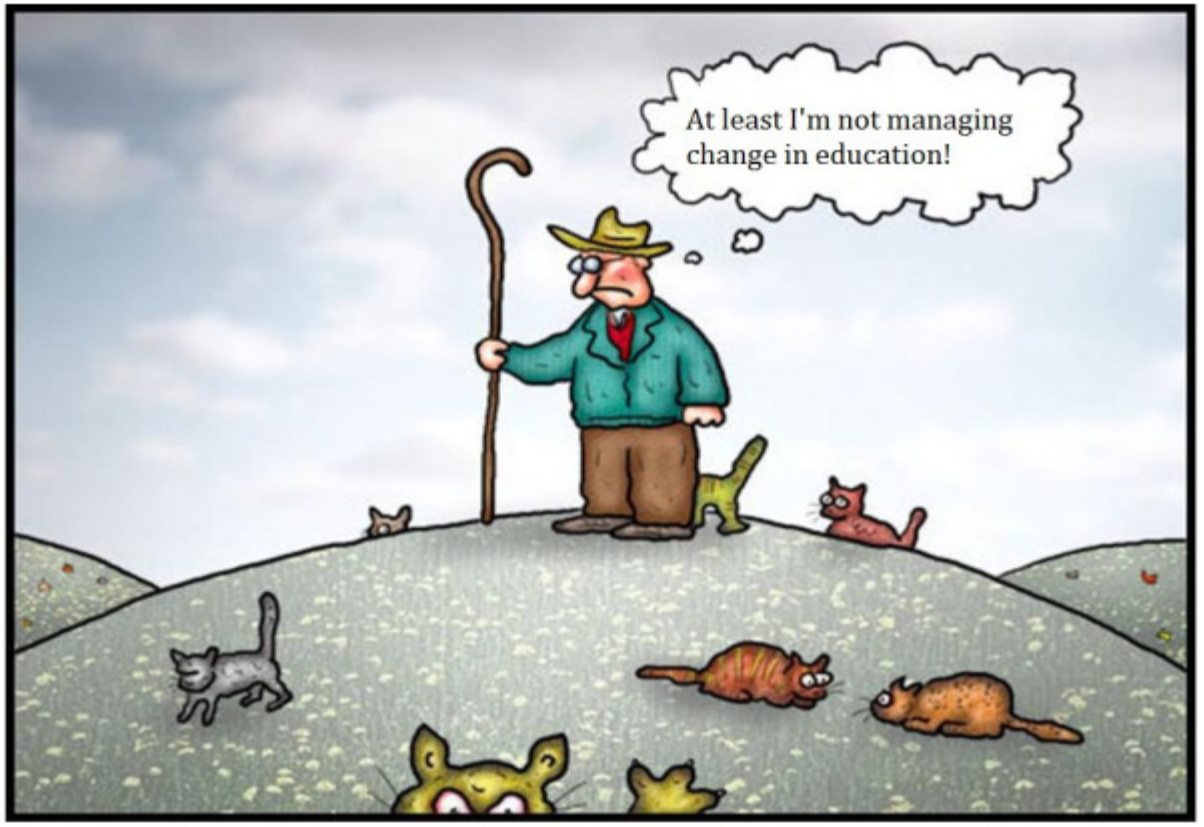
Moon & Singer, January 2012

21st Century Competencies

AKA - How Do You Keep Your Kids Out of the Basement When They are 40



NEXT GEN EDUCATION, LLC



NEXT GEN EDUCATION, LLC

The History and Evolution of Classroom Science

NEXT GEN EDUCATION, LLC

The History and Evolution of Classroom Science

Direct instruction

Hands-On

Inquiry

3 Dimensional (3D) Science instruction

NEXT GEN EDUCATION, LLC

Direct Instruction

NEXT GEN EDUCATION, LLC

Direct Instruction

Pros:

It's easy

We teachers feel smart and in control

It works for some students

NEXT GEN EDUCATION, LLC

Direct Instruction

Pros:

It's easy

We teachers feel smart and in control

It works for some students

Cons:

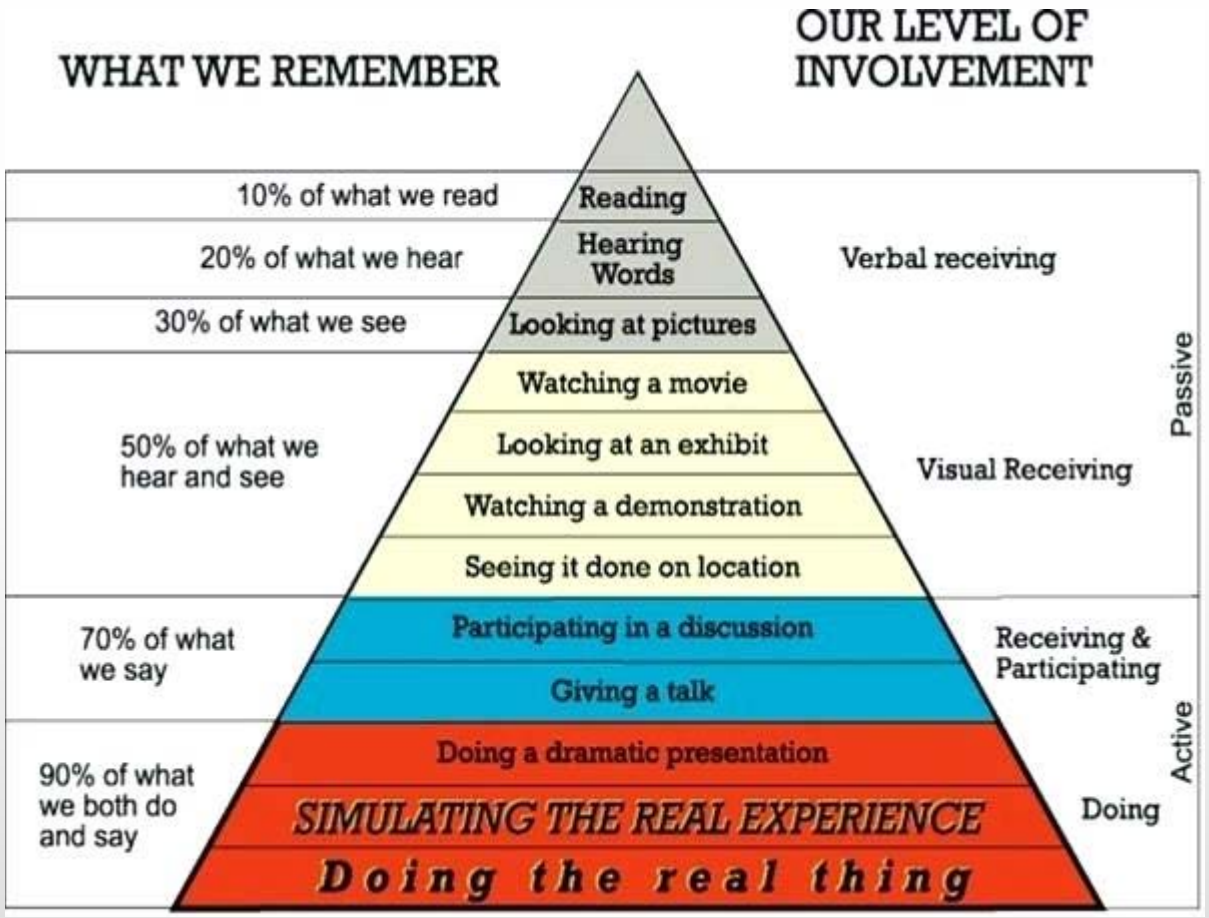
It doesn't work for everyone:

"students in classes with traditional stand-and-deliver lectures are 1.5 times more likely to fail than students in classes that use more stimulating, so-called active learning methods."
(Freeman, et al. 2014)

NEXT GEN EDUCATION, LLC

Telling is Not Teaching – Listening is Not Learning

Vygotsky - 1934
Conceptual understanding is more than memorization

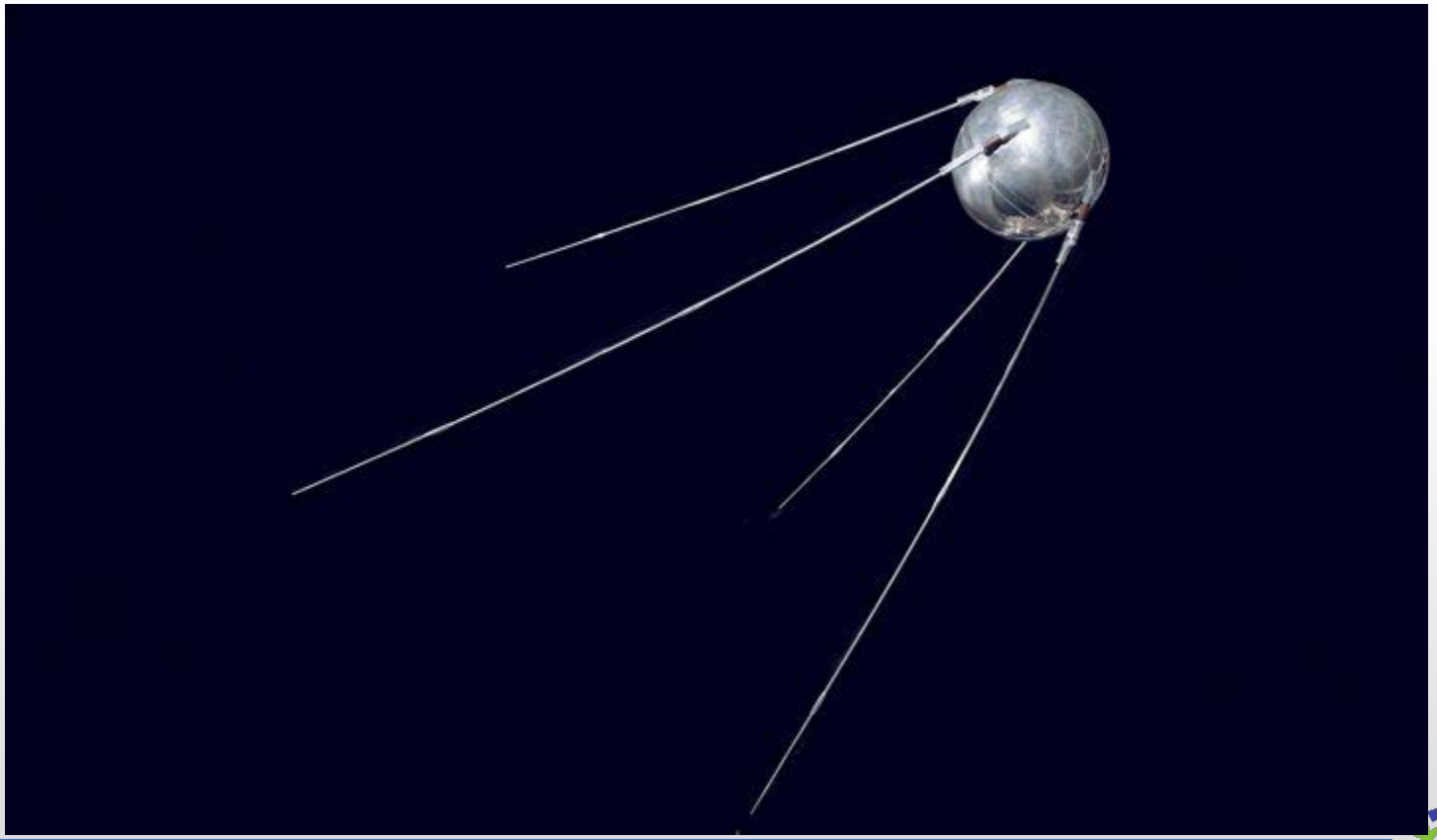


Piaget - 1936
Cognitive development and students' mental models

NEXT GEN EDUCATION, LLC

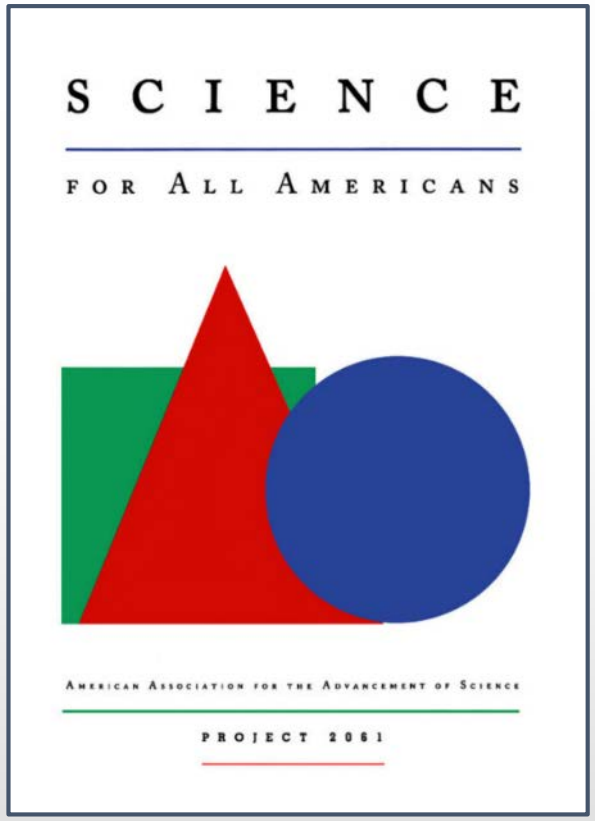
But, that’s not enough to change science education...

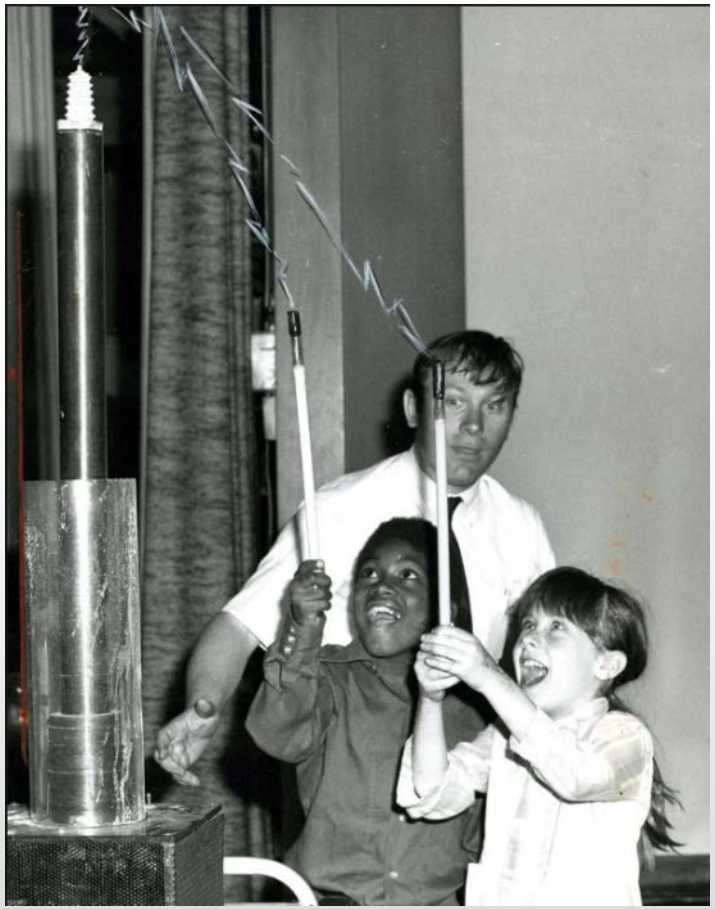
Something happened on Oct. 4, 1957



NEXT GEN EDUCATION, LLC

Hands-On (1970-80s)



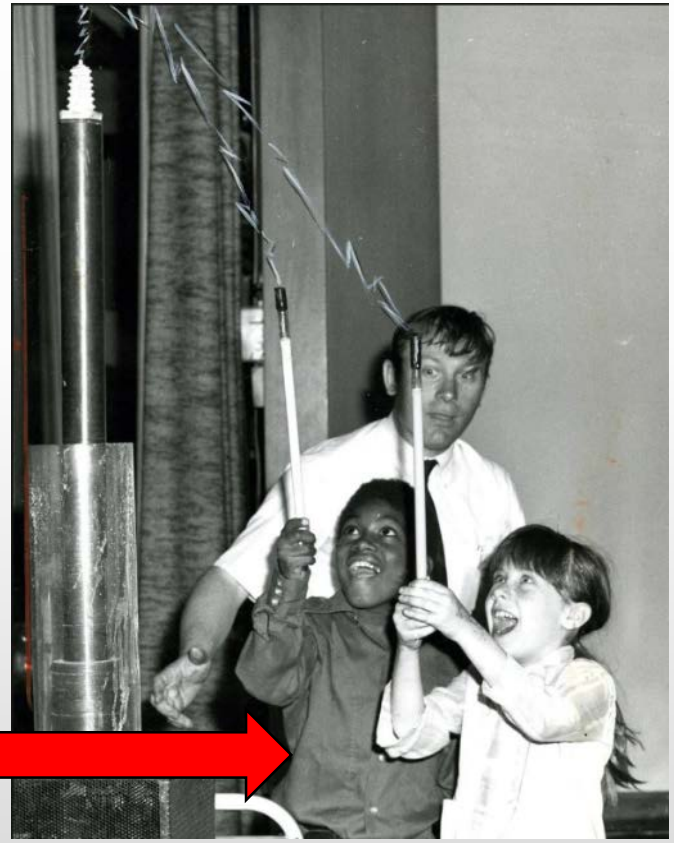


NEXT GEN EDUCATION, LLC

Hands-On (1970-80s)

Pros:

Fun and engaging for students

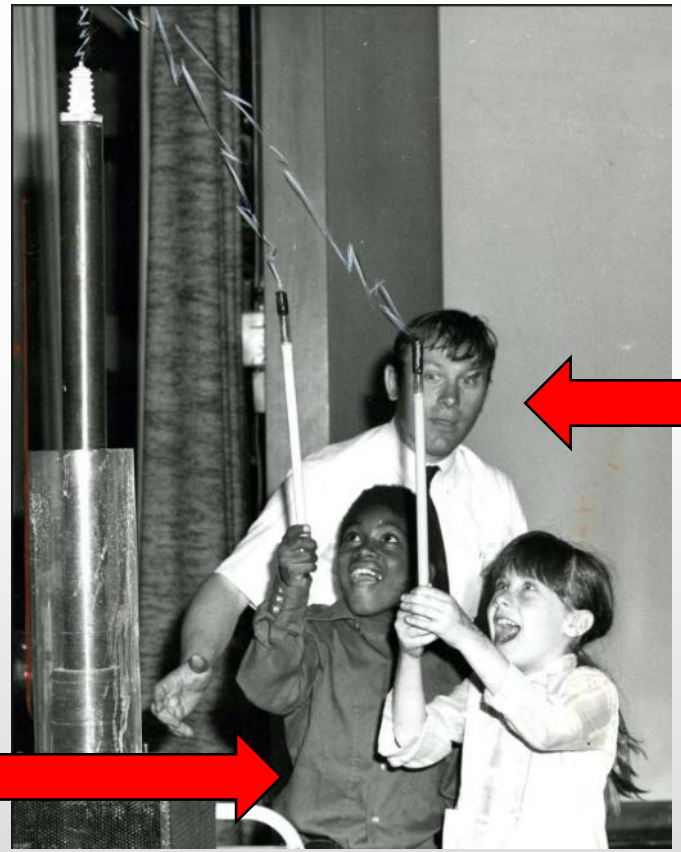


NEXT GEN EDUCATION, LLC

Hands-On (1970-80s)

Cons:

Students can participate without learning



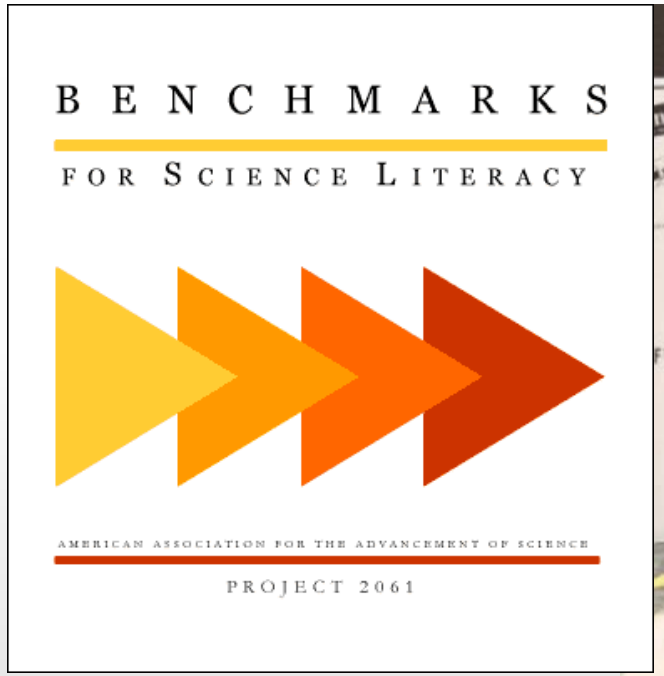
Scary for teachers

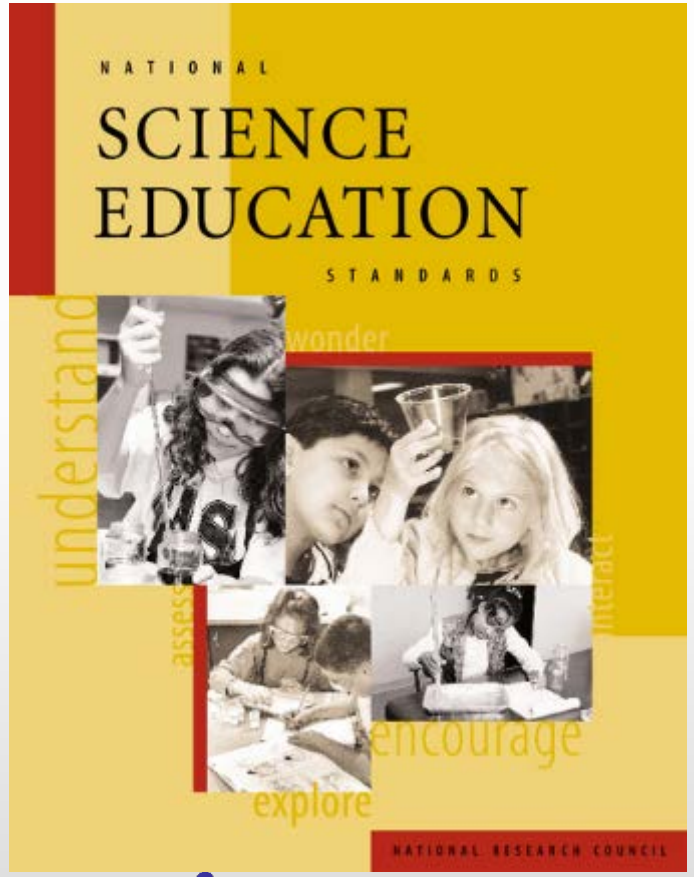
Pros:

Fun and engaging for students

NEXT GEN EDUCATION, LLC

Inquiry (1990s) - Teaching Focused





NEXT GEN EDUCATION, LLC

Inquiry (1990s) - Teaching Focused

Pros:

Engages students in authentic scientific practices.

NEXT GEN EDUCATION, LLC

Inquiry (1990s) - Teaching Focused

Pros:

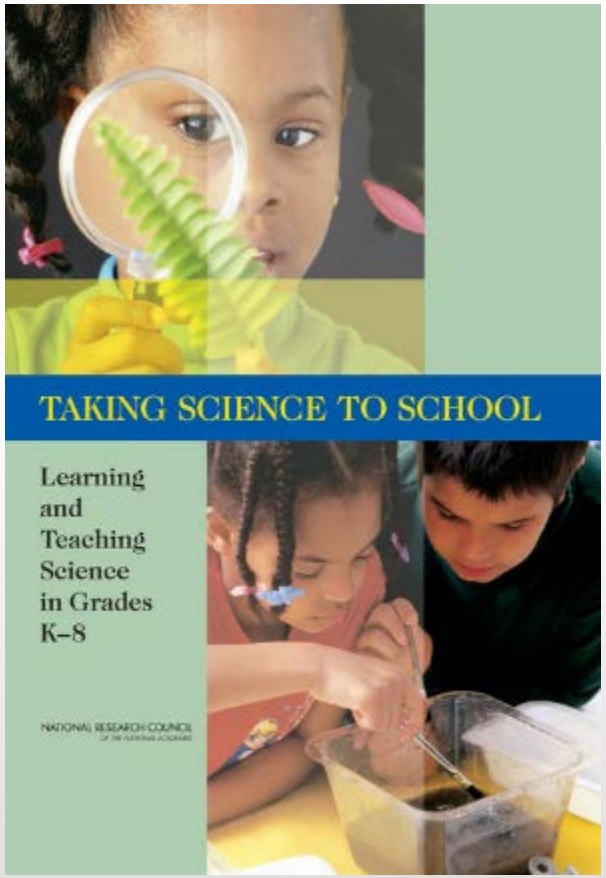
Engages students in authentic scientific practices.

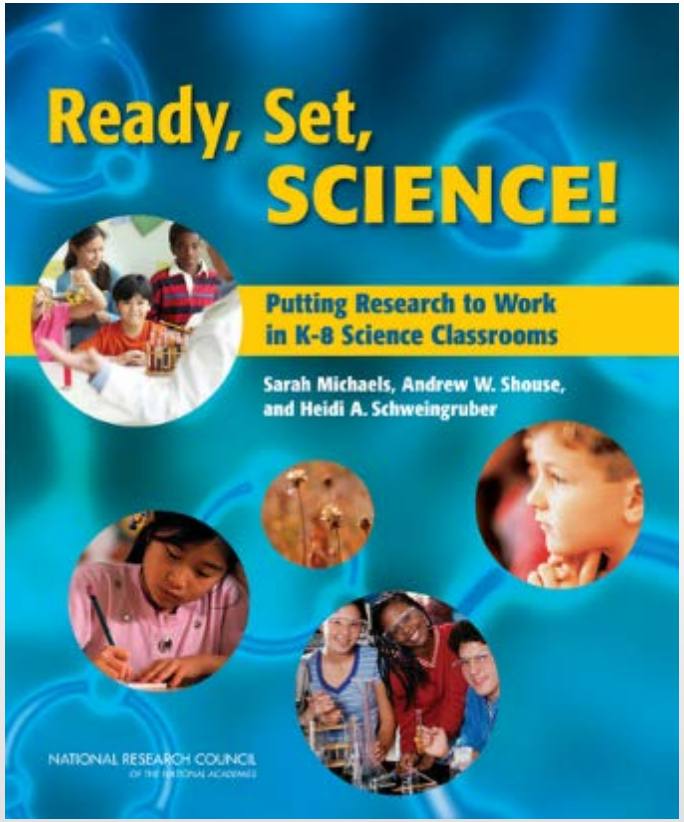
Cons:

Difficult to teach to teachers

When done poorly, increased opportunity gap.

Inquiry (2000s) Learning Focused





NEXT GEN EDUCATION, LLC

Inquiry (2000s) Learning Focused

Pros:

Again, engages students in authentic scientific practices.

NEXT GEN EDUCATION, LLC

Inquiry (2000s) Learning Focused

Pros:

Again, engages students in authentic scientific practices.

Cons:

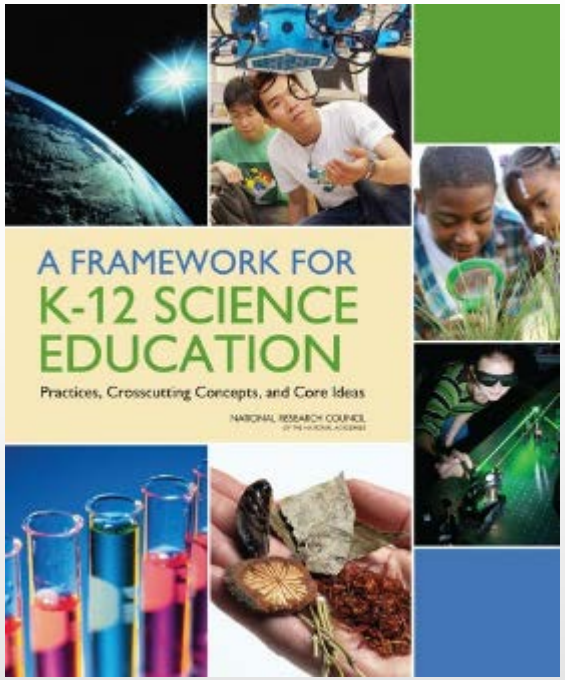
Again, difficult to teach to teachers

Difficult to get teachers to stop focusing mostly on content

Some students thrive and some fall behind

NEXT GEN EDUCATION, LLC

3 Dimensional Teaching and Learning (2012)



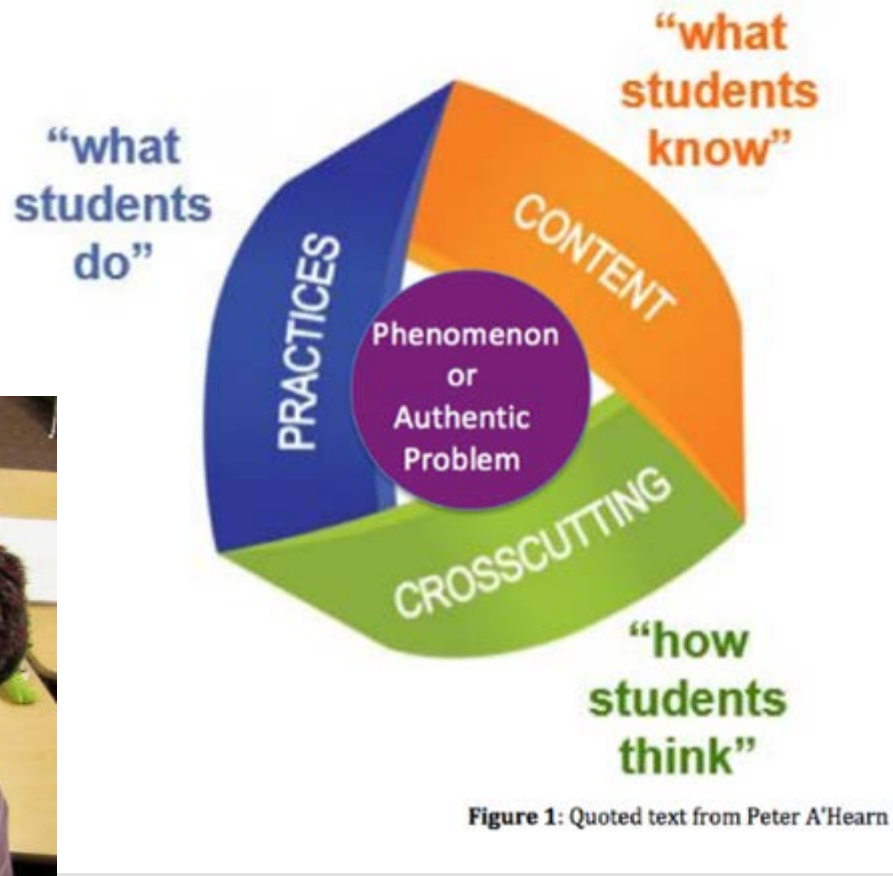
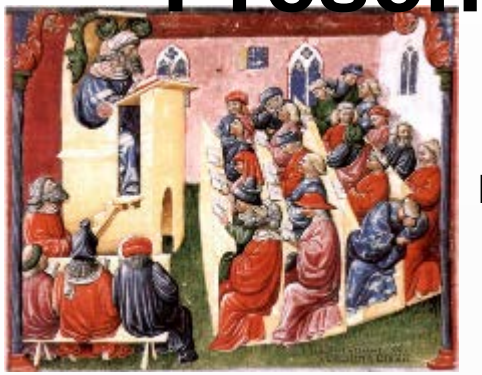
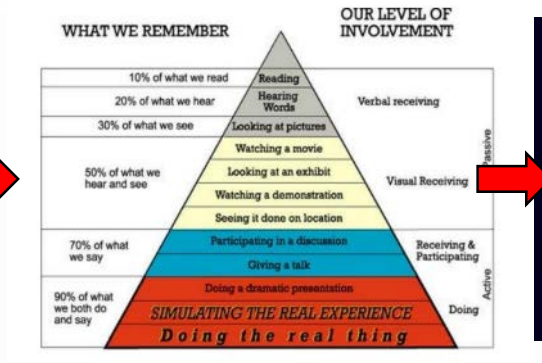


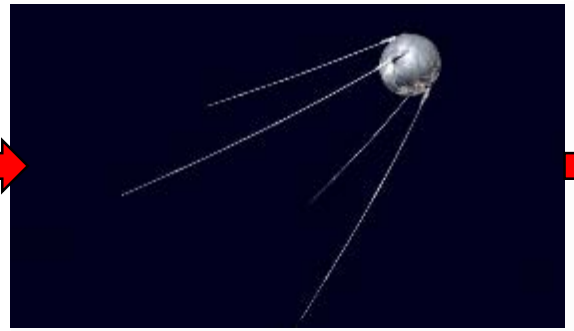
Figure 1: Quoted text from Peter A'Hearn

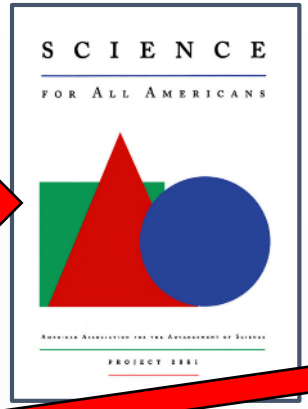
NEXT GEN EDUCATION, LLC

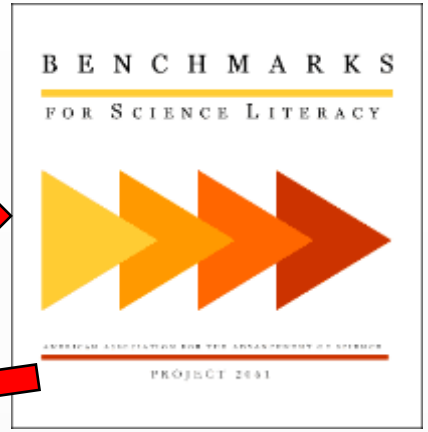
Science Teaching and Learning Past and Present

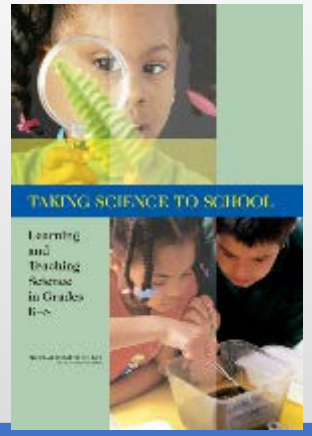


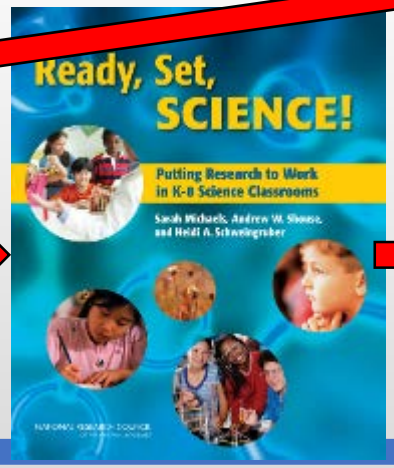


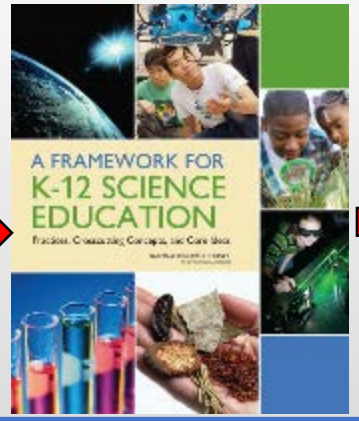


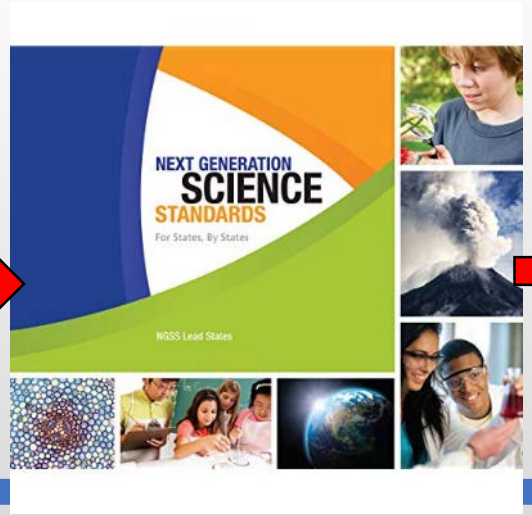












CONNECTICUT NEXT GENERATION SCIENCE STANDARDS (NGSS-CT)

NEXT GEN EDUCATION, LLC

Collaboration

NEXT GEN EDUCATION, LLC

Collaboration

NEXT GEN EDUCATION, LLC

Persistence and Creativity

Failure is information – we label it failure, but it's more like, 'This didn't work, I'm a problem solver, and I'll try something else.'

Carol S. Dweck

Seven Most Important STEM Skills We Should Be Teaching Our Kids

- Statistics
- Problem Solving
- Creativity
- Persistence
- Argumentation
- Intellectual Curiosity
- Data-Driven Decision Making
- Flexibility

Available at: https://www.weareteachers.com/important-stem-skills-teaching-kids/

Influence of Research

It All Starts With A Vision

NEXT GEN
EDUCATION, LLC

Vision of the *Framework*

"The Framework is designed to help realize a vision for education in the sciences and engineering in which (all) students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields."

A Framework for K-12 Science Education (NRC, 2012 pp 8–9)

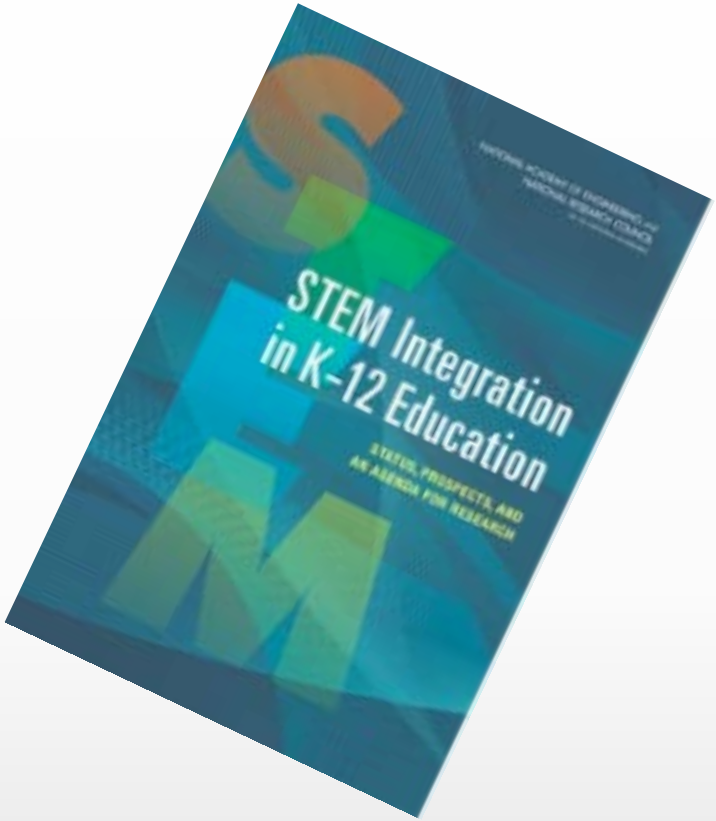
NEXT GEN EDUCATION, LLC

Importance of STEM Integration

- ***Make the integration explicit.***
  - Across a unit of instruction the connections cannot be assumed.
  - Make clear the connections for students and teachers.

- ***Support the content and processes of individual STEM disciplines.***
  - The assumption that students can make connections among the content and processes of four disciplines when they may not understand one or two of the disciplines is, on the face of it, questionable.

- ***Use a measured and strategic approach to the integration of STEM.***
  - Depending on the understanding of STEM disciplines, level of student engagement, and complexity of the context, use caution relative to the degree and depth of integration (i.e., more integration may not be better).



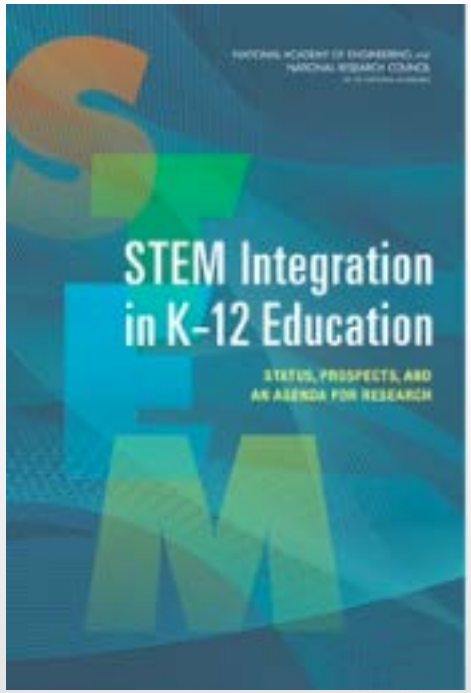
NEXT GEN EDUCATION, LLC

Honey, et al., 2014, p. 7

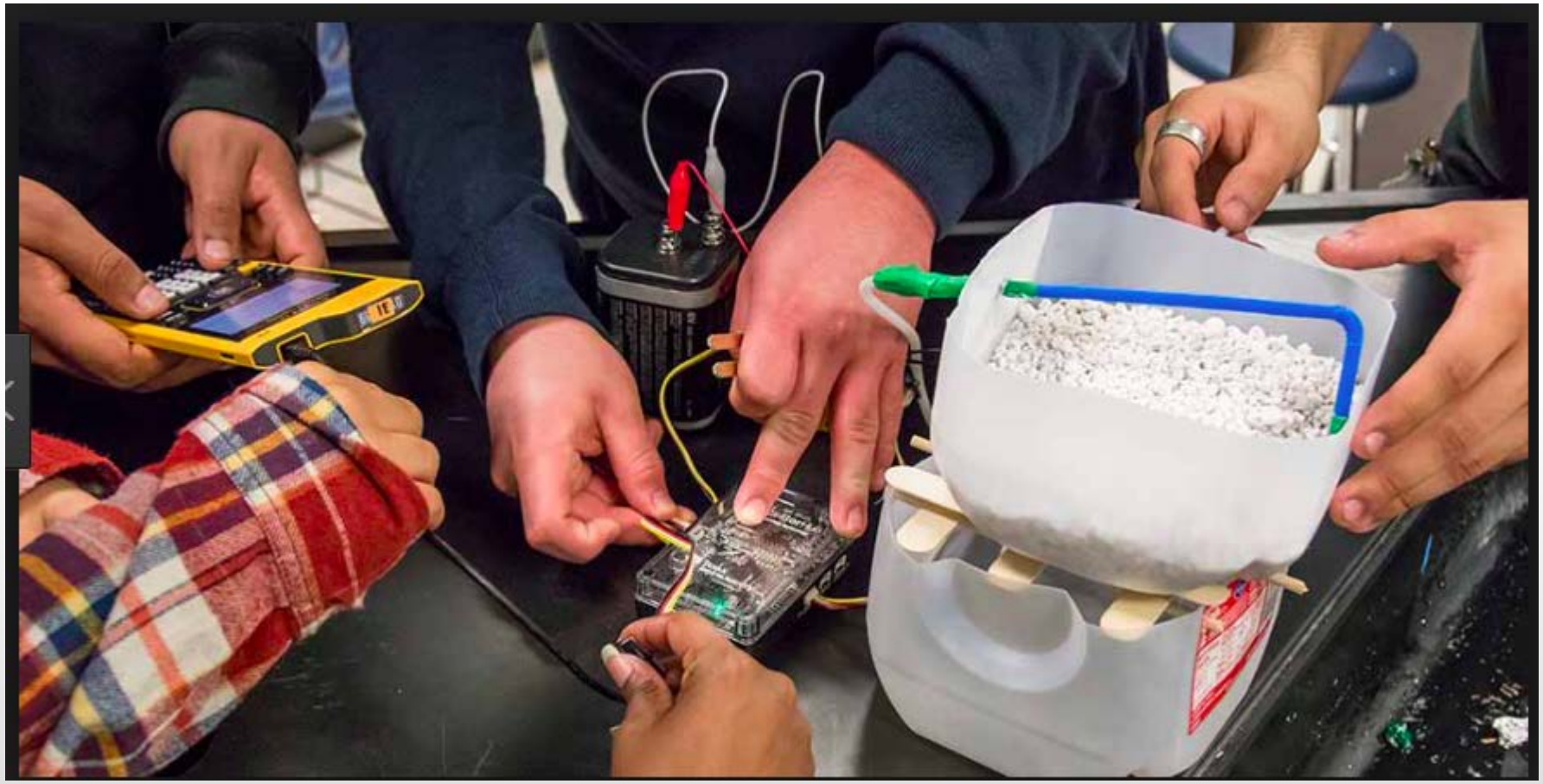
Importance of Professional Learning

"One limiting factor to teacher effectiveness and self-efficacy is teachers' content knowledge in the subjects being taught."

Honey, et al., 2014, p. 7



Students as Innovators



NEXT GEN EDUCATION, LLC

Creating Innovators (Wagner, 2012)

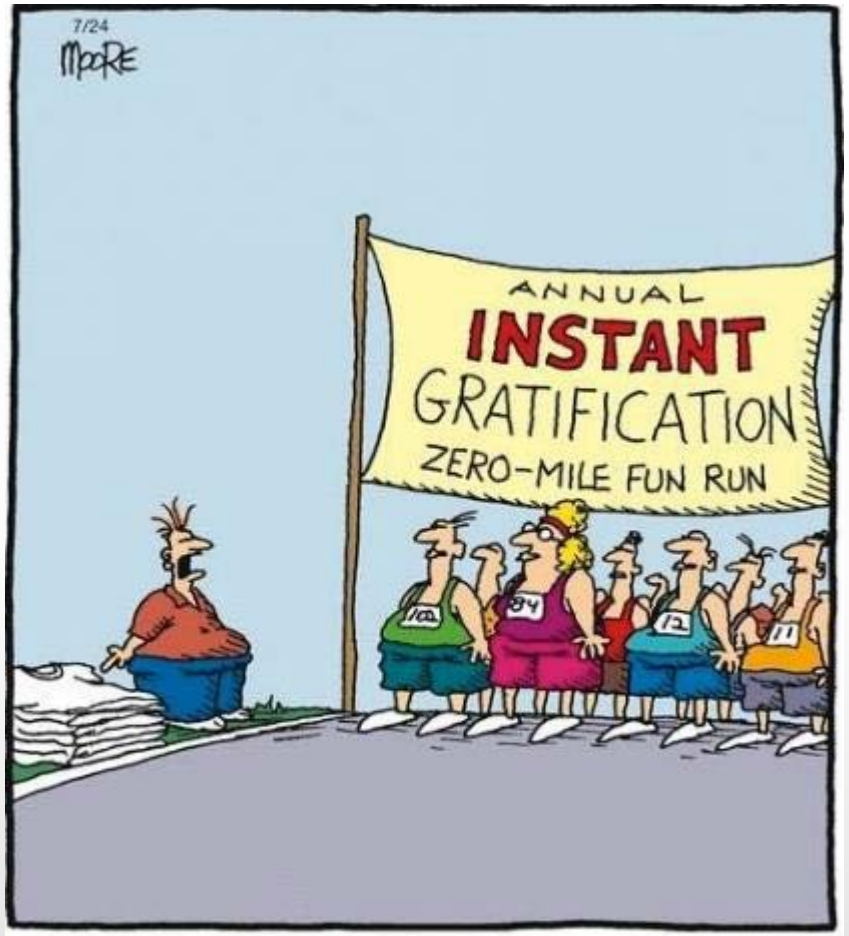
- Collaboration versus individual achievement,
- Multidisciplinary learning versus specialization,
- Trial and error versus risk avoidance,
- Creating versus consuming, and
- Intrinsic versus extrinsic motivation.

The Elkins Principle

"We already do that"

$$P(tadt) = \frac{1}{n(swdt)}$$

The probability of those who say "they already do that" is inversely proportional to the number of people who "say we do that".

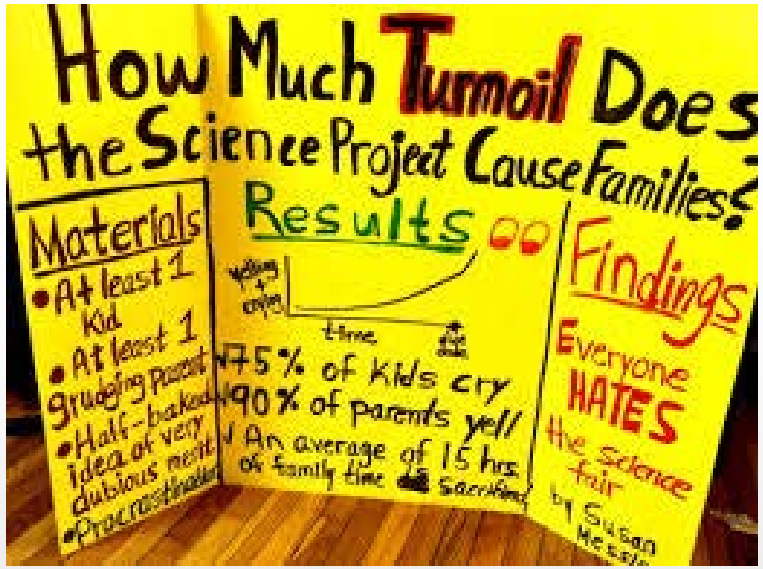


"Runners to your mark. Get set. Go! ... OK, come get your T-shirts."

Have a Joe DiMaggio Day!

NEXT GEN EDUCATION, LLC

Questions?



NEXT GEN EDUCATION, LLC

Contact Information

Peter J. McLaren
Executive Director
Next Gen Education, LLC
mclarenpeterj@gmail.com
401-419-8785

Twitter
@peterjmclaren

NEXT GEN EDUCATION, LLC