Teaching and Learning in a STEM Focused World

Materials and Manufacturing Teacher Institute 2019

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Peter McLaren - Executive Director
Next Gen Education, LLC
@peterjmclaren
Need for Change
“The only person who likes change is a baby with a wet diaper.”

- Mark Twain
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).
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)

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Teaching and Learning

100 Years Ago

Today

“If we teach today’s students as we taught yesterday’s, we rob them of tomorrow”

John Dewey
(1859 -1952)

The Classroom
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
At least I’m not managing change in education!
The History and Evolution of Classroom Science
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- Direct instruction
- Hands-On
- Inquiry
- 3 Dimensional (3D) Science instruction
Direct Instruction
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Pros:

It’s easy

We teachers feel smart and in control

It works for some students
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)
Telling is Not Teaching – Listening is Not Learning

Vygotsky - 1934
Conceptual understanding is more than memorization

Piaget - 1936
Cognitive development and students’ mental models
But, that’s not enough to change science education...

Something happened on Oct. 4, 1957
Hands-On (1970-80s)
Pros:

Fun and engaging for students
Pros:
- Fun and engaging for students

Cons:
- Students can participate without learning
- Scary for teachers
Inquiry (1990s) - Teaching Focused
Inquiry (1990s) - TeachingFocused

Pros:
Engages students in authentic scientific practices.
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
Pros:

Again, engages students in authentic scientific practices.
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
3 Dimensional Teaching and Learning (2012)
Persistence
Critical Thinking
Collaboration
Problem Solving
Systems Thinking
Empathy
Creativity
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
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)
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).

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
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”

\[ P(\text{tad}t) = \frac{1}{n(\text{s}w\text{d}t)} \]

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!
Questions?
Contact Information

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

Twitter
@peterjmclaren