The Power and Promise of Integrative STEM Education

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Who Will Care for Our Designed World?

- Construction Technologies
- Medical Technologies
- Agricultural & Related Biotechnologies
- Manufacturing Technologies
- Information & Communication Technologies
- Energy & Power Technologies
- Transportation Technologies

People with the Necessary Knowledge and Skills
Technological Literacy

The Ability to Use, Manage, Evaluate/Assess, and Understand Technology

Technology Literacy for All: A Rationale and Study for the Study of Technology (2006)
A Technologically Literate Person Understands:

• What technology is *(much more than a knowledge about computers and digital electronics)*;

• How technology is created;

• How the use of technology shapes society and in turn;

• How society shapes the development of technology; and

• Is comfortable with and objective about the use of technology – neither scared of it nor infatuated with it

The Power and Promise of Integrative STEM Education

• What is the STEM movement?
• T and E: The Overlooked STEM Imperatives
• Increasing relevance in the educational experience
• Potential for ALL students
What is the STEM Movement?

• 1983 - *A Nation at Risk: The Imperative for Educational Reform* (National Commission on Excellence in Education)
• 1990’s - National Science Foundation (NSF) - Science, Technology, Engineering, and Mathematics
• 2005 - *The World is Flat* (Friedman, 2005) - countries surpassing America in the global economy
• More funding began to flow toward STEM
• Today, most everyone seems somewhat familiar with the STEM acronym
S + T + E + M = ?

- Greg Pearson, National Academy of Engineering
S + T + E + M = ?

- Greg Pearson, National Academy of Engineering
An instructional approach that situates **Math** and **Science** learning in the context of **technological** and **engineering design** problems.
T and E: The Overlooked STEM Imperatives

• In the broadest sense, technology extends our abilities to change the world: to cut, shape, or put together materials; to move things from one place to another; to reach farther with our hands, voices, and senses.

  Benchmarks for Science Literacy, AAAS, 1993

• Technology is the process by which humans modify nature to meet their needs and wants.

  Technically Speaking: Why All Americans Need to Know More About Technology, NAE/NRC, 2002
T and E: The Overlooked STEM Imperatives

• The goal of technology is to make modifications in the world to meet human needs. (*National Science Education Standards*, NRC, 1996)

• “technology is human innovation in action”

• “the innovation, change, or modification of the natural environment in order to satisfy perceived human wants and needs”

T and E: The Overlooked STEM Imperatives

• “Engineering is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind”
  
  (ABET - Accreditation Board for Engineering and Technology, 2002)

• “The engineering profession is working with educators of technology to develop alliances for infusing engineering concepts into K–12 education”

  (ASEE – American Society for Engineering Education)
engineering or Engineering?

- engineering with a little “e”
  - Used as a verb
  - Teach students (learners) to think or learn to engineer or use engineering concepts

- Engineering with a Big “E”
  - Used as a noun
  - Prepare students (learners) to be Engineers – career oriented

- The engineering design process
  - Students (learners) learn to use engineering concepts
  - Students (learners) think, create, innovate, and problem solve
Science vs. Technology

- Deals with the natural world
- Is very concerned with what is (exists) in the natural world. (i.e.: Biology, Chemistry, Physics, Astronomy, Geology, etc.)

- Deals with how humans modify, change, alter, or control the natural world
- Is very concerned with what can or should be designed, made, or developed from natural world materials and substances to satisfy human needs and wants
Science vs. Technology

- Is concerned with processes that seek out the meaning of the natural world by “inquiring”, “discovering what is,” “exploring,” and using “the Scientific Method”
- Discovered by people
- Observation and description
- Asks “Why?”

- Is concerned with such processes we use to alter/change the natural world such as practical problem solving, and design
- Created by people
- Invention and innovation
- Asks “How?”

Standards for Technological Literacy, ITEA/ITEEA, 2002

National Science Education Standards, National Research Council, 1996
“The primary aim of education is not to enable students to do well in school, but to help them do well in the lives they lead outside of school.”

Raymond J. McNulty
Integrative STEM Education

An instructional approach that situates Math and Science learning in the context of technological and engineering design problems.
Integrative STEM Education

- Technological and engineering design-based instruction that intentionally integrates the concepts of Science and/or Math with the concepts and practices of Technology and Engineering.

- Integrative STEM education may be further enhanced through integration with other school subjects such as language arts and social studies.

Sanders & Wells, 2006
Increasing Relevance in the Educational Experience

- Children become more excited and confident in math and science when using technology, innovation, design, and engineering to make school subjects personally meaningful.

- The increased relevance of the educational experience with the implementation of integrative STEM can decrease dropout rates.

- Learning becomes fun.
Project Based Learning – Design Challenges
Project Based Learning – Design Challenges

2nd Grade
Sail Boat Challenge
Project Based Learning – Design Challenges

5th Grade
A World In Motion®
JetToy Challenge
Increasing Relevance in the Educational Experience

- Project-based integrative STEM education can inspire learners to obtain a deeper knowledge of the subject.

- Students are motivated to learn and do quality work on projects when they know their work is valued by audiences they have identified.

- STEM education can help students make the links among classroom learning, their everyday lives, and the broader world.
Potential for ALL Students

- Curiosity is at the heart of all young people - by nature they wonder how things work.
- Integrative STEM is not another thing to teach, but an excellent way to teach the current curriculum.
- Integrative STEM education gives shape and meaning to our human-made world and can open doors for all kinds of learners.
- Learners develop confidence and self-direction.
The Engineering Lab

• Engineering labs can enhance student learning and excite interest in learning science, math, and other school subjects through the use of hands-on projects.
• Lab activities can be introduced to all students with very little expense.
• Engineering labs can encourage students to think with flexibility and confidence.
• Engineering Labs connect the disciplines of math, science, and technology while creating pathways to career fields.
• Engineering labs serve as the ‘garage’ of the past and the ‘internship’ of the future to develop the “Scholar-Technician”.
The iterative decision-making process of devising a system or component which meets human needs and wants by applying science, math, and technological knowledge to optimally meet a stated objective.
How We Learn in the STEM Lab

1. **ASK**
   - What are the Problems?
   - What are the Constraints?

2. **IMAGINE**
   - Brainstorm Ideas
   - Choose the Best One

3. **PLAN**
   - Draw a Diagram
   - Gather Needed Materials

4. **CREATE**
   - Follow the Plan
   - Test It Out!

5. **IMPROVE**
   - Discuss What Can Work Better
   - Repeat Steps 1-5 to Make Changes

The Engineering Design Process
Who Will Care for Our Designed World?

Learn & Use Engineering Design & Concepts

Help children learn all they can!

Learn to Think Like an Engineer

Become Flexible & Adaptable Problem Solvers

Our Children!
Engineers
Technicians
Artisans
Teachers
Etc.

Be Healthy!

Become STEM Literate

Be Creative
Be Innovative