

Essentials For STEM Instruction

November 17, 2014

S.T. r. E. a. M

- **What** is it?
- **Where** we are with it?
- **How** do we implement at Middle School Level and Expand at the Elementary Level?
- **Why** should we implement?

WHAT?

WHAT?

- Integrated teaching and learning. No silos! (Dewey)
- Inquiry / discovery with meaningful results from high quality work. Teacher provides resources/materials, and is the facilitator.
- Project- based learning stimulates **creativity** and **critical thinking**.
- **Projects that ask students to design solutions for real-world problems!**

- **QUAD D**



Chinese Proverb

*“I hear and I forget,
I see and I remember,
I DO and I UNDERSTAND!!!”*

The Letter E!

- Can unify all four subjects!
- **Science-** Move away from facts to the Pursuit of the best solution **to Apply** knowledge and **Explore!**
- **Technology-** Move away from a plugged in device to Driving innovation of technology to **create** advancements.
- **Math-** Move away from “How many Apples Does Sally Have?” to **Authentic Problem Solving** situations.

**Engineering

- What is it?
- What do Engineers do?



Engineering

- “The application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.”
- “Application of Math and Science”



Engineering!

- “**Solving problems** using science and math, harnessing the forces and materials in nature. Use **creative powers** to come up with **quicker, better,** and **less expensive** ways to do the things that need to be done. Finding ways to **make dreams a reality!**”

-American Society of Engineers



Key Words???

- **PROBLEM SOLVING!! CREATIVITY! QUICKER!
BETTER! LESS EXPENSIVE! DREAMS COME TRUE!**

- Be careful not to translate and simplify into-

“To solve problems in Math or Science Class is to do engineering.”

Critical thinking skills are no longer word problems or story problems! (One dimensional- irrelevant!)



Engineering

- “Why do we have to learn this?”
- “When am I going to use this?”
- Good teachers explain and design lesson to show how classroom content connects to outside world.
- Engineering provides pathways for engaging creativity.
- Service Learning- authentic causes



Engineer ?



- Solves problems
- Builds, designs, explores
- Tackles problems derived from real world!
- Makes use of Math, Science and Technology

(In educational setting- problems sometimes need to be “made up” rather than actual- but they should **never be simplistic or irrelevant!**)

Tools/Elements needed For Engineering?

Tools for Engineering

1. **Curiosity**-Inherent! Keep the flame burning!
2. **Creativity**- Divergent thinker/ “Think out of the box”
3. **Organization and Logic**- for problem solving
4. **Clear and Concise Problem Formulation**- to Specific Instructions
5. **Critical Thinking Skills**- Analyze, compare, contrast, conclude
6. **Practical Knowledge** of Math, Science and Technology.
7. **Ability to Work in Teams**- Consider opinions
8. **Communication Skills**- seek/ meet needs



Engineering Design Process (EDP)

- Important as the Scientific Method
- Different versions
- Engineering is Elementary (EiE) (Museum of Science in Boston)
- “To take advantage of the natural **Curiosity** of **Children** to **Cultivate** their **understanding** and **Problem-Solving** in engineering and technology.”
- Easy 5 step process:

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

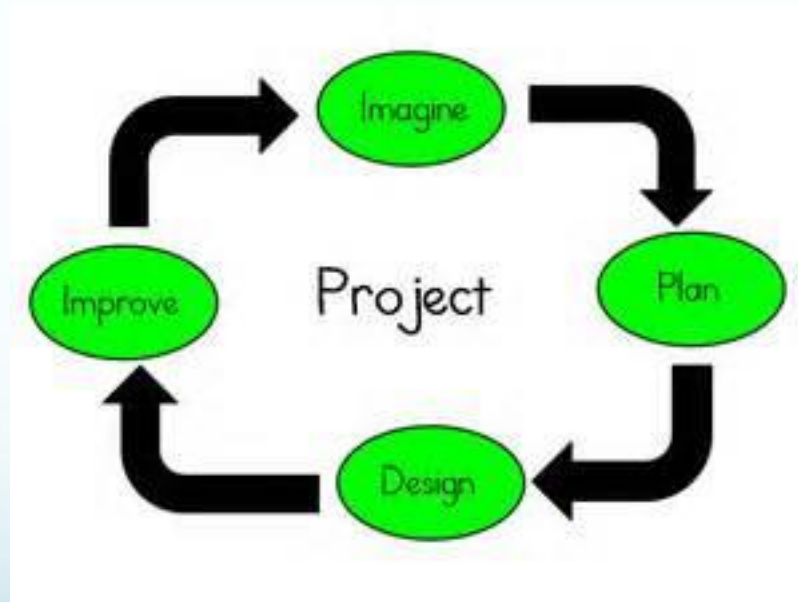
- Follow the plan
- Test it out

5. Improve

- Discuss what can work better
- Repeat steps 1-5 to make changes

12 step EDP

- Define the Problem
- Brainstorm
- Research and Generate Ideas
- Identify Criteria and Constraints
- Explore Possibilities
- Select an Approach
- Develop a Design Proposal
- Model or prototype
- Test and Evaluate
- Refine
- Create or Make
- Communicate Results



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Where?

District Goal

To build capacity of all teachers to increase student engagement and learning through continued expansion and implementation of Science, Technology, Engineering, and Mathematics (STEM) across grades K-12.

Where is EHT?

- K-5
- PK
- 6= pilot
- Middle School STEM Special
- Middle Schools
- High School MSA course and more
- Full Integration?
- <http://www.eht.k12.nj.us/~huntk/STEM%20-%20District/stem.htm>



HOW?

How to Get There?

- Think out of the box
- Collaboration on program and lesson building
- Research and Experimentation

******Mind shift**



MINDSHIFT

S.T.E.M.

**Integration; Creativity; Critical Thinking;
Inquiry; Design; Exploration; Project
Based; Student Centered; Authentic;
Open Ended Problem Solving**

Questions

How can we use STEM as the foundation of how and what we teach?

Questions

- Can we begin lessons with stating a problem for students to solve?
- Are we able to facilitate lessons where students are collaborating to research with technology, create relevant projects, analyze, evaluate, and redesign?

Questions

- Is it OK for a class of 20 students to produce 20 different work products?
- Are we ready to guide students to be independent-dependable 21st century learners?

Why STEM? and Why Now?



National Demands

- Nation must educate engineers and scientists who are efficient users and innovative producers of the emerging cyber-infrastructure.
- Nation must create STEM professionals who are creative, fluent in software use, comfortable with foreign languages and working on culturally diverse teams, and are able to manage global projects with geographically dispersed teams.

What Employers Want

- Willingness and ability to share information and ideas.
Ability to work in teams.
- Better knowledge of Math and Science
- Decision Makers
- Sense of ownership with work and ideas
- Willingness to take calculated risks, without fear of consequences.
- Communication (Multi-cultural)
- Problem Solvers

PARCC

Current Reality

- 5% of US High School graduates major in anything related to STEM.
- 60% of the 5% switch major or drop out.
- 2% earn STEM degrees

Prepare Students

- <http://www.futuristspeaker.com/2011/11/55-jobs-of-the-future/>

- **Majors:**

- *Interactive Telecommunications

- * Data Sciences

- *Biometrics

- * Cybersecurity

- *Bioinformatics

- *Petroleum Engineering

- *Biomedical Engineering

- *Robotics

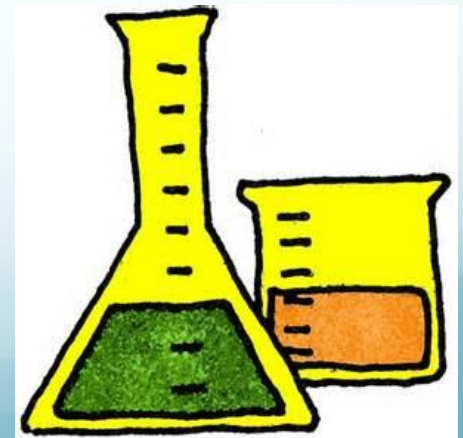
- *Nanotechnology

- *Sustainability

NGSS (7-9-2014)

Practices not skills- very rich and rigorous

- Call for the basic knowledge of engineering
- 3 Dimensions:
 - 1. Disciplinary Core ideas-** Physical, Life, Earth and Space, Engineering, Technology, and Applications of Science.
 - 2. Science and Engineering Practices**
 - 3. Crosscutting Concepts**



NGSS

- Clarify relevance of STEM
- Emphasizes the engineering makes science real!
- Bridge to engineering
- 21st Century connection- People must be able to **communicate, collaborate, decide, apply and articulate solutions for real-world problems.**



NGSS and EHT

- https://docs.google.com/document/d/1JGL5cjMLVd2_tHgyxztWsio3GFE_pldFQcqdVZmJxWg/edit?pli=1
- <http://www.eht.k12.nj.us/~huntk/STEM%20-%20District/stem.htm>

So Now What?

Creating a STEM Lesson

1. Identify topic
2. Identify learning outcome; standards
3. Identify real world connection to the topic (process or device that links topic to experience)
4. Consider the EDP
5. Map out schedule- How many days? Steps? Materials?
6. Evaluate Learning- rubrics



STEM Lesson

- Design lesson as an engineer
- Design with goal that students will be able to create something that will solve a problem you set, but are no guarantee.
- First iteration may not work
- Redesign- you have a new problem
- Embrace this new approach
- “What could have been done differently?”



Is it a STEM Lesson?

- Does lesson engage students in the engineering design process?
- Do students address a real-world problem?
- Do students work in teams to solve this problem?
- Are there multiple possible solutions?
- Do students get to explore and come up with ideas on their own, without being spoon-fed?

Lessons

- http://www.siemensscienceday.com/activities/build_this_structure.cfm
- <http://www.eht.k12.nj.us/~huntk/STEM%20-%20District/stem.htm>

Advancing Elementary

- <http://www.eht.k12.nj.us/~hartera/activities/STEM%20in%20Preschool.pdf>
- STEM Workshop

Makerspaces

- www.makeymakey.com

Makerspaces

- <https://www.youtube.com/watch?v=zZE8nCABAX4>
- <https://www.youtube.com/watch?v=atitAC2VLCk>
- <https://www.youtube.com/watch?v=hOqTcQedDrw>
- FABLAB <http://fablabatschool.org/>
- 3D Printers- <http://fablabatschool.org/page/tutorials>
- <http://fablabatschool.org/page/useful-links>

Tinkering Resources

- Papertronics; Little Bits
- Arduino Boards- www.arduino.cc/
- www.makershed.com
- <https://tinkercad.com/>

Happenings

- Robotics
- Coding
- Legos= First LEGO league
- 3D printers

How Will STEM Be Taught?

- 1 classroom only?
- One subject only? Such as Math or Science?
- Both Science and Math but in isolation?
- Elective? Special?
- After School Programs?
- Other?

Sample Middle School Model

- <https://njctl.org/programs/#>

- www.middleweb.com/13942/engineer-great-middle-school-stem-curriculum/

RESOURCES

- www.teachengineering.org
- www.tryengineering.org
- http://www.siemensscienceday.com/monthly-theme/?utm_source=MonthlyThemeEmail&utm_medium=100214&utm_campaign=SSD%20Fall%202014
- www.eie.org/eie-curriculum
- www.teachpreschool.org
- www.makeymakey.com
- https://docs.google.com/document/d/1JGL5cjMLVd2_tHgyxztW/sio3GFE_pIdFQcqdvZmJxWg/edit?pli=1
- EHT website- <http://www.eht.k12.nj.us/~huntk/STEM%20-%20District/stem.htm>

More Resources

- <http://www.manassas.k12.va.us/education/components/scrapbook/default.php?sectiondetailid=15845&>
- <http://www.weareteachers.com/hot-topics/special-reports/stem-for-elementary-school>
- futurecity.org/

Let's Do Some Planning

- Elementary?
- Middle?