the STEM SCHOOLS PROJECT

Science · Technology · Engineering · Math

Strategies to Develop a School-wide STEM Culture

By Hans Meeder

Two Questions

The STEM Schools Project asks two important questions:

- ***What factors contribute to a strong implementation of a STEM program like Project Lead The Way***, AND,
- ***How can a school move beyond having good STEM programs to becoming a school that embeds STEM teaching and learning across the school – in short, becoming a STEM-focused school?***

Site Visits, Fall 2011
Case studies now available

Edison Middle School, Janesville, Wisconsin
Clearbrook-Gonvick High School ,Clearbrook, Minnesota
Greenfield Central High School, Greenfield, Indiana
Humboldt High School, Humboldt, Iowa
Lenawee County Intermediate School District, Addison, Michigan
Pine River Backus High School, Pine River, Minnesota
Thomas Worthington High School, Worthington, Ohio
St. Thomas More High School Milwaukee, Wisconsin
Wheeling High School, Wheeling, Illinois

3 strategies we identified Along the "STEM Continuum"

1. Create an exceptional PLTW implementation
2. develop a school-wide STEM culture
3. implement related school improvement strategies

1. Create an exceptional PLTW implementation

1.1 Building Readiness and Support for PLTW Implementation

1.2 Select and Support a Strong PLTW Instructional Team

1.3 Set Goals for Program Enrollment

1.4 Reach Out to Prospective PLTW Students

1.5 Reach Out to Local Businesses to Gain and Sustain Support

2. Develop a school-wide STEM culture

2.1 Establish Shared Guiding Principles for STEM Learning
- 2.1.1 Define STEM Education
- 2.1.2 Define STEM Literacy
- 2.1.3 Develop District-wide Vision for STEM Learning

2. DEVELOP A SCHOOL-WIDE STEM CULTURE

2.2 Implement Innovative STEM Curriculum and Instruction
- 2.2.1 Integrate STEM-rich Instruction across Math, Science, and Other Applied STEM Programs
- 2.2.2 Implement Inquiry-based and Project-based Learning Strategies

2.3 Engage Math, Science, and PLTW Teachers in Collaborative Planning and Instruction

2.4 Related STEM Enhancements and Reforms

3. IMPLEMENT RELATED SCHOOL IMPROVEMENT STRATEGIES

3.1 Provide Academic Support and Intervention to Enhance Student Learning

3.2 Prepare Students for Postsecondary and Career Success
- 3.2.1 Offer Career Development and College Planning
- 3.2.2 Offer Opportunity to Earn College Credit

3.3 Focus on Professional Development, Growth, and Collaboration

3.4 Use Data to Make Instructional Decisions

2. DEVELOP A SCHOOL-WIDE STEM CULTURE

2.1.1 DEFINE STEM EDUCATION

EXAMPLE:

WHEELING HS: school-wide goal of "preparing students to think critically and solve complex problems, adapt to new technologies, and communicate effectively to a variety of audiences – all skills required to succeed in a global 21st century economy."

Every student is expected to develop the following STEM skills:

- ***Problem Solving,***
- ***Teamwork,***
- ***Technology, and***
- ***Communication.***

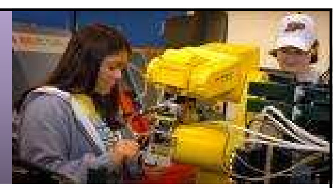
2.1.1 DEFINE STEM EDUCATION

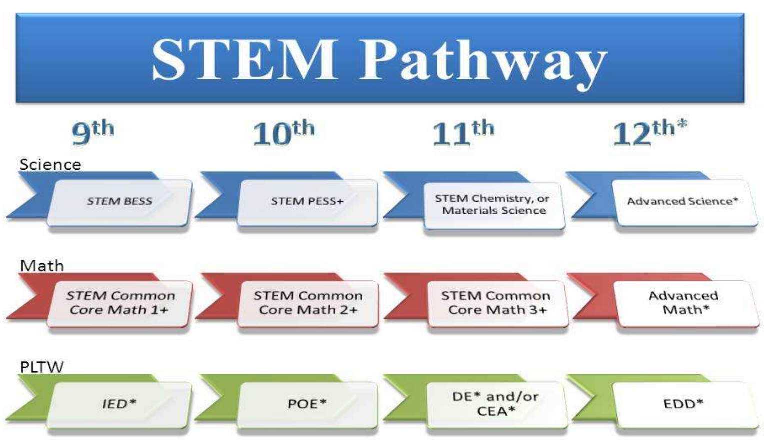
EXAMPLE:

"A metadiscipline created through the collaboration of a science teacher, technology/engineering teacher and math teacher. These teachers contribute to the creation of a 'new' discipline based on the successful bridging among these discrete disciplines."

T. Worthington HS, Ohio

2.1.1 DEFINE STEM EDUCATION

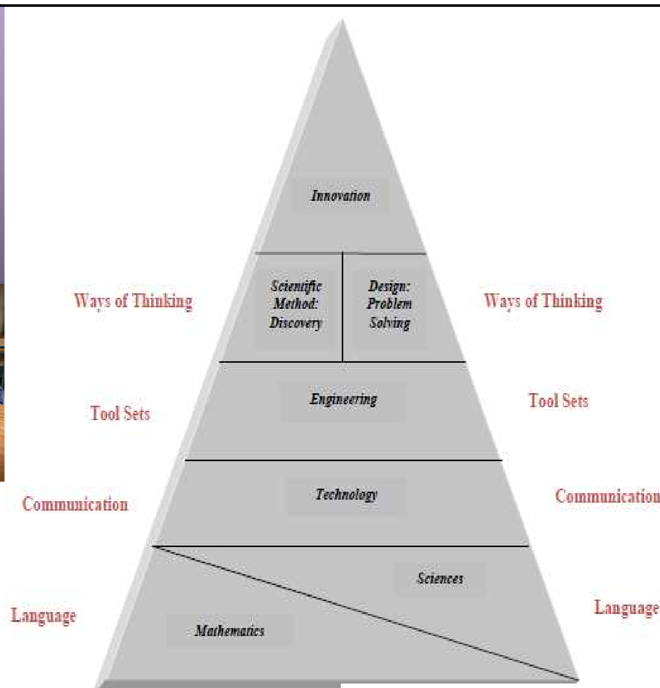




* Opportunities for dual enrollment to earn college credit while in high school.

T. Worthington HS Case Study, 2012

2.1.2 Define STEM literacy



T. Worthington HS Case Study, 2012

2.1.2 Define STEM literacy

EXAMPLE:

"STEM literacy means that a student possesses the ability to apply understanding of how the world works within and across the areas of science, technology, engineering, and math. STEM literacy is an interdisciplinary area of study that bridges the four areas. A STEM-literate student is also experienced in problem-solving, analytical, communication, and technology skills."

Lenawee ISD Case Study, 2012

2.1.2 Define STEM literacy

STEM Processes (T. Worthington HS)		
Engineering Design Process	Scientific Method Process	Mathematical Problem-Solving Process
• Identify the problem • Plan project • Problem specifications • Conceptual design • Final design	• Ask and define the question • Gather information and resources through observation • Form a hypothesis • Perform one or more experiments and collect and sort data • Analyze the data • Interpret the data and make conclusions that point to a hypothesis • Formulate a "final" or "finished" hypothesis	• Read the problem • Identify and organize important information • Choose an appropriate strategy and/or formula • Solve the problem • Check your work

T. Worthington HS Case Study, 2012

2.2.1 Integrate STEM-rich Instruction across Math, Science, and Other Applied STEM Programs

Curriculum mapping across disciplines.

Example, the physics instructor teaches kinematics/motion in the beginning of the curriculum, but the Principles of Engineering instructor teaches this concept at the end of the course.

Examples of classes they have connected include:

- Introduction to Engineering Design with Geometry, Algebra II, and Physical Earth Science Systems (PESS),
- Principles of Engineering with Physics, Algebra II/Functions Statistics Trigonometry (FST), and Pre-Calculus Discrete Math (PDM), and
- Digital Electronics with Functions Statistics Trigonometry (FST).

T. Worthington HS Case Study, 2012

2.2.2 Implement Inquiry-based and Project-based Learning Strategies

EXAMPLE:

Wheeling High School's school-wide inquiry model (QUEST) designed to drive instruction and teach students how to approach a problem:

***Q**uestion – Identify the purpose of the audience;*

***U**nderstand – Use available resources to plan an appropriate course of action;*

***E**vidence – Collect and organize data from credible sources or experiments;*

***S**ynthesize – Analyze results to draw conclusions and assess validity; and*

***T**ell – Develop product to effectively communicate research and results to the identified audience.*

Wheeling HS Case Study, 2012

2.3 Engage Math, Science, and PLTW Teachers in Collaborative Planning and Instruction

- Four 7th grade Math/science teachers at Edison Middle School work to integrate PLTW content into both their math and science curriculum.
- Delivery of PLTW content is "invisible" to the students.
- Teachers are required to use common planning time to meet with their teams at least once weekly.
- Team norms and defined purpose guide collaboration meetings. New teachers receive ongoing support from the team members.

Implications For STEM education

- Consider that a STEM school is one in which the STEM skill set is explicitly identified and intentionally developed in every child.
- Consider that a STEM school is one that helps students understand the relevance of STEM literacy to all career fields while also offering "STEM-intensive" pathway options.
- Leaders should to distinguish expectations for STEM "literacy" and STEM "mastery." What do ALL students need and what should SOME students get?
- Leaders should consider a definition of STEM "literacy" that includes both practices that transcend individual disciplines, but also include core STEM content.
- Research needs to determine the cost-benefit comparison between improving individual STEM subjects vs. strengthening the connection among the four – iSTEM ("integrated STEM")

Implications For STEM education

- Many (most?) teachers do not seem to change their curriculum or teaching methodology without clear expectations, professional development, and dedicated time for collaboration with other STEM teachers.
- Developing a school-wide STEM culture does not appear to happen without school-based and district-supported instructional leadership.
- Engineering and Technology are the real-world applications of math and science content – but very FEW students experience a strong dose of engineering and technology. These are essential components of restoring a U.S. manufacturing sector.
- Leaders need to think about scalable options for more students to gain familiarity with engineering and technology.
- Education leaders would benefit from a "play book" for building a STEM culture in a typical public school.

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www.meederconsulting.com/stemschools.html

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