

High School Materials Science: It really works!

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Materials Science & Technology (MST)

- History of MST Curriculum Development
 - Overview of MST Modules
 - MST Teacher Training
 - Impact of MST on Students
 - Future of MST
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MST Curriculum Development

- Un. of Washington, Materials and Technology Curriculum Project (1973)
- Ball State University, CITE – Center for Implementing Technology Education, Soc. of Manufacturing Engineers (1986-1991)
- Battelle Pacific Northwest National Laboratories (PNNL), MST Teachers Handbook – Dept. of Energy (1992)
- Northwestern University, Materials World Modules – NSF (1993)

MST Curriculum Development

- Un. of Illinois at Urbana-Champaign, Materials Science and Technology (MAST) modules – NSF (1993)
- Energy Concepts Inc, MST curriculum modules and lab equipment (1997)
- American Chemical Society, Science in a Technical World (2000)
- Un. of Wisconsin-Madison, Institute for Chemical Education (ICE) - NSF

MST Curriculum Development

- Un. of Wisconsin-Madison, Materials Research Science and Engineering Center (MRSEC) – NSF
- Un. of Washington, The Materials and Manufacturing Technology Institute Program (MTI) – NSF (1997 – 2001)
- Edmonds Community College, Materials for Manufacturing program (EMTECH) – NSF (2001 – 2003)
- ASM Educational Foundation, Materials Camps for students and teachers (2000 -)

What is MST?

- The science of “stuff”
 - Multidisciplinary approach
 - Chemistry, physics, engineering
 - Designed for “team approach”
 - Science and technology teacher
 - Hands-on, minds-on
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Prevailing Concepts

- Use journal
- Apply concepts throughout all units
- Look at “stuff” from micro to macro
- Learn why and how “stuff” does what it does...by understanding the properties of the “stuff”

How is it Offered?

- Dedicated “stand-alone” class
- Incorporate into traditional science or technology class
- Modules



MST Modules

- Introduction: general properties of materials
- Metals
- Ceramics and glass
- Polymers
- Composites



Solids

- Importance of materials science and technology.
- Solids are typically separated into four categories.
- Simple chemistry including chemical bonding, the periodic table, and oxidation-reduction.
- Crystal structures, physical properties.
- How metals are claimed from their ores.
- Importance of maintaining a student journal and keeping good records is stressed.

Solids Activities

- Material safety data sheets
- Identification of materials
- Formation of crystals
- Destructive testing
- Reactivity series of metals
- Oxidation/reduction of copper

FORMS OF MATTER

LIQUID

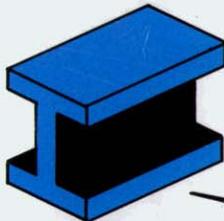
SOLID

GAS

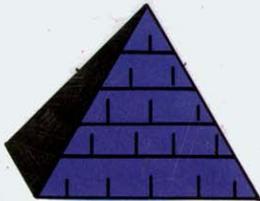
INDUSTRIAL MATERIALS

METALLIC

- FERROUS
- NONFERROUS



I-BEAM



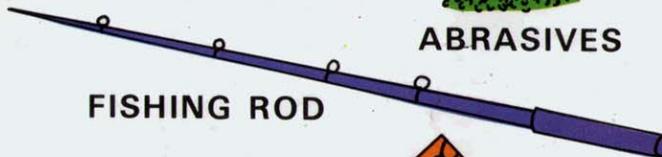
PYRAMID

POLYMER

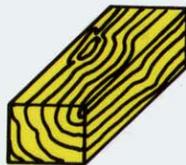
- NATURAL (WOOD)
- SYNTHETIC (PLASTIC)



COMB



FISHING ROD



2x4



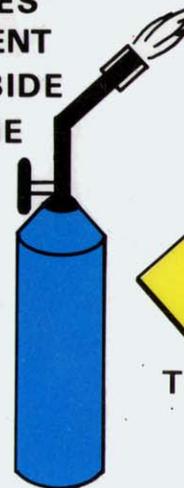
WAFER BOARD



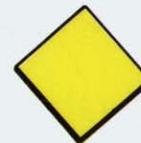
ABRASIVES

CERAMIC

- CLAY
- GLASS
- OXIDES
- CEMENT
- CARBIDE
- STONE



PROPANE TORCH



TILE



WATER



EYE GLASSES

COMPOSITE

- FIBER
- PARTICLE
- LAMINATE
- FLAKE
- FILLER

Metals

- Introduce the properties and historical developments of metals.
- Investigate mechanical properties of metals along with the effects of heat-treating.
- Study alloys and alloying techniques along with phase diagrams.
- Study testing of metals and manufacturing processes.
- A major project is the making of sterling silver jewelry using the process of lost wax casting.

Metals Activities

- Rolling a coin
- Drawing a wire
- Alloying copper and zinc
- Cost of a penny
- Making a light bulb
- Making lead-tin solder
- Annealing copper
- Powder metallurgy
- Lost wax casting

Sterling Silver Rings



Ceramics & Glass

- Learn that most ceramics are crystalline solids.
- Study properties related to the ionic or covalent bonds that hold them together.
- Learn that glass has different properties than most ceramics due to the amorphous structure of glass.
- Study processes used to manufacture ceramics including a stained glass and a Raku pottery project.

Ceramics & Glass Activities

- Forming, firing, and glazing clay
 - Thermal shock
 - Glass bending and blowing
 - Glass batching and melting
 - Dragon dribble & dragon tears
 - Coloring glass
 - Stained glass project
 - Making Raku
 - Ceramic slip casting
- 

Colored Glass



Fused Glass



Raku Test Samples



Polymers

- Study synthetic polymers and their chemistry.
 - Include the classification of polymers along with how they are altered chemically or with additives.
 - Emphasize concerns with recycling.
 - Review the chemical changes brought about by cross-linking.
 - Include historical developments and manufacturing processes.
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Polymer Activities

- Cross-linking a polymer (slime)
- Polymer identification
- Making nylon 6-10
- Latex rubber ball
- Memory in polymers
- Epoxy resin cast
- Polymer foam creations



Resin Cast Clothespin



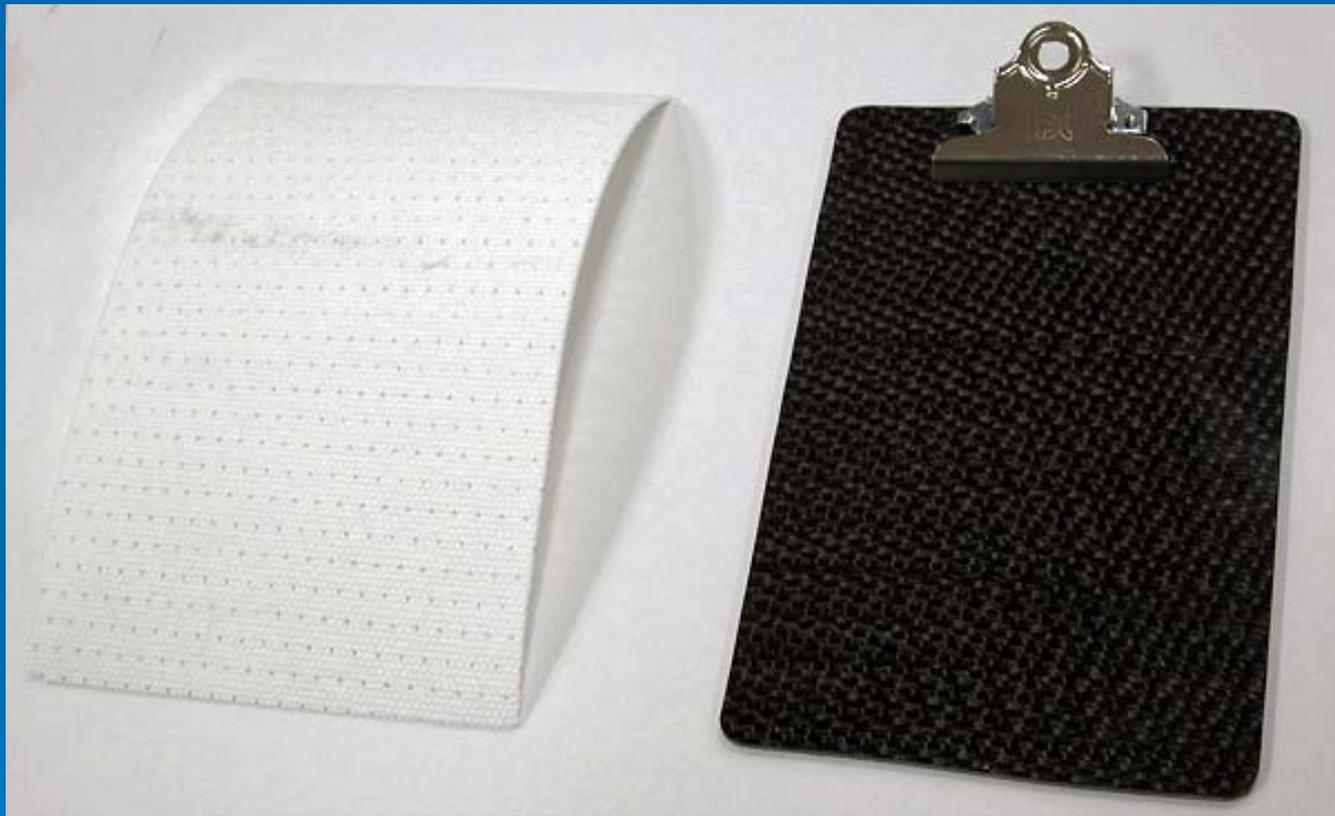
Composites

- Describe and categorize types of composites.
 - Emphasize strength-to-weight ratios including strength measuring, testing, and altering.
 - Use wood and concrete as two traditional composites to introduce many concepts.
 - Discuss fiber reinforced composites including those containing graphite and Kevlar fibers.
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Composite Activities

- Stressed-skin composites
- Plaster of Paris matrix composite
- Compression and tension in a bending beam
- Laminated wood beams
- Using Portland cement to make & test concrete
- Hand lay-up of a glass fiber reinforced polymer

Coremat[®] & Graphite Cloth Clipboard



MST is FUN!!!



MST Teacher Training (Over 1000 trained!)

Organization	Teachers Trained
Battelle PNNL	150
Energy Concepts Inc.	100
Un. of Washington	200
Edmonds Com. College	600
UF-Gainesville	100
ASM Foundation	60

MST Training Resources

- 600 copies of PNNL MST Teachers Handbook distributed throughout U. S.
- 45 MST labs installed by Energy Concepts Inc.
- 500 schools are using Materials World Modules

States that have MST Classes

- California
- Colorado
- Florida
- Illinois
- Iowa
- Kansas
- Massachusetts
- Michigan
- Mississippi
- Missouri
- Ohio
- Oregon
- Pennsylvania
- Tennessee
- Virginia
- Washington
- Wisconsin

Student Comments

- "I love working with materials. I learn so much easier by working with my hands."
- "It was a non stop action class. Almost everyday we are doing something new. I got to make a lot of cool stuff that I can keep forever."
- "My friends used this class as a stepping stone to get into the Manufacturing Boeing Internship in Auburn."

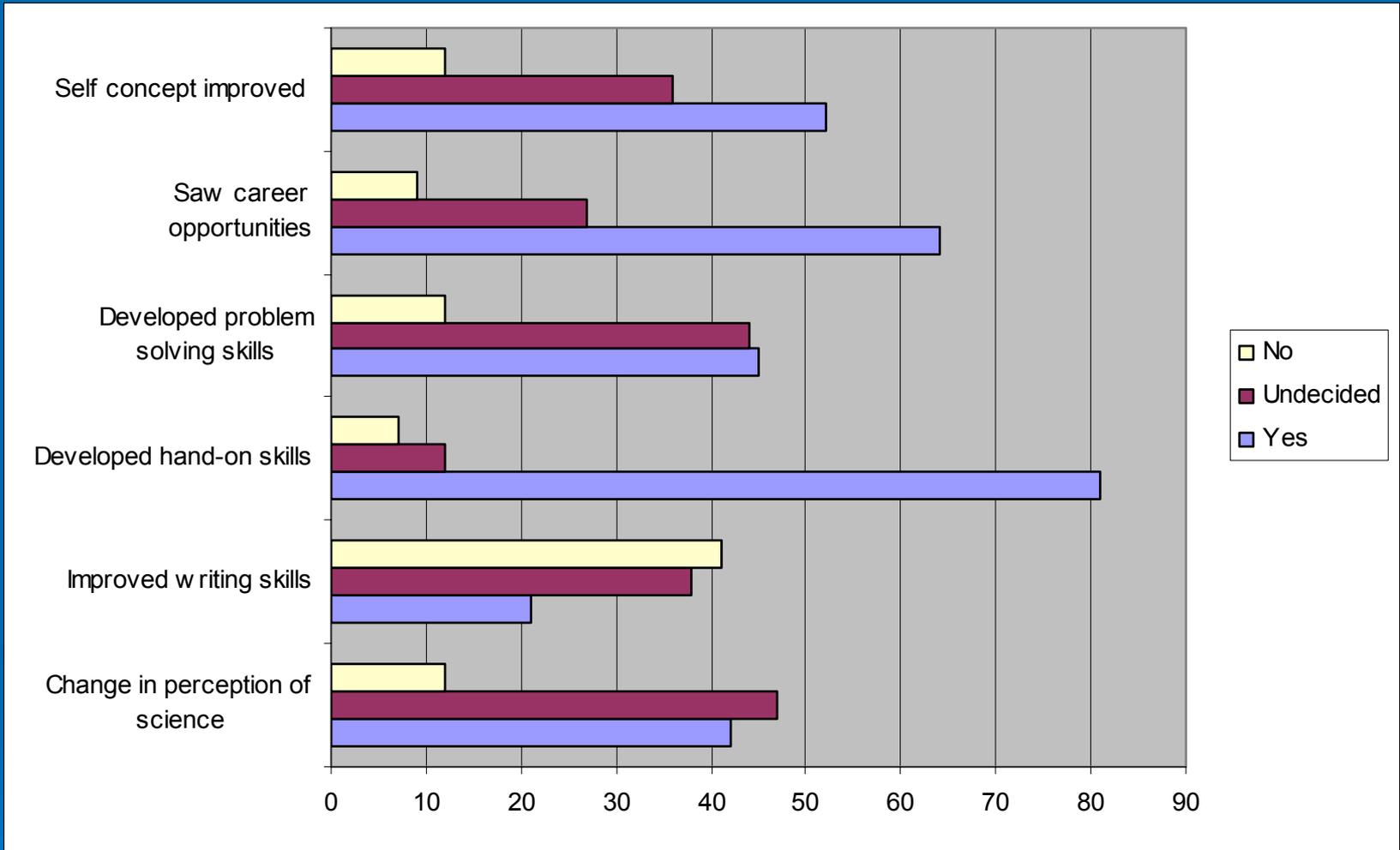
Student Survey (250 Students)

- When asked if they would recommend this class to other students:
 - 76% said yes
 - 19% said probably
 - 5% said no

- When asked to complete the following sentence, " I like materials science because" they finished the sentence with three general themes:
- The most frequently mentioned idea concerned learning about different materials and then using them to make a project
 - The second most common response was the theme of hands-on work.
 - The third most common response was that the lab activities were fun!

Other Findings

- Students become more interested in further science study after taking this course
- Chemistry and physics courses became more popular as a result of the MST course.
- Significant enhancement in the understanding of science and in career opportunities in science and technology
- Provides a means for motivating teachers to engage students more in real science and to motivate students toward more understanding of science and engineering.



“Materials Technology Education Program Impact on Secondary Teachers and Students “ Thomas Stoebe, Guy Whittaker, Karen Hinkley, Journal of Materials Education, 24, 23-30 (2002)

Future of MST

- Teacher training
- Equipment and facilities
- Science/Technology standards
- Test accountability
- School administration approval

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- *Materials Science Technology Curriculum Modules*, Energy Concepts Inc. - Energy Concepts, Inc., 404 Washington Blvd., Mundelein, IL 60060, Phone 847-837-8191, Fax 847-837-8171, eciconcepts@energy-concepts-inc.com, <http://www.energy-concepts-inc.com>
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- Institute for Chemical Education (ICE), Kathleen M. Shanks, Outreach Program Manager, Department of Chemistry, 1101 University Avenue, Madison, WI 53706-1396, 608-262-2940, 800-991-5534 FAX: 608-265-8094, shanks@chem.wisc.edu, <http://ice.chem.wisc.edu>
- University of Wisconsin Materials Research Science and Engineering Center on Nanostructured Materials and Interfaces, <http://mrsec.wisc.edu/edetc/>

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- *Material Science Technology: What It Is and Why It Is Important*, Alan G. Gomez, **techdirections**, March, 2002, <http://www.techdirections.com>
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- ASM Foundation Materials Camp
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