



Addressing the Standards...What Does It Look Like in Practice?

MD Partnership for Children in Nature

January 30, 2014

Is This What It Feels Like???



MSDE's Definition of STEM Education

STEM education is an **approach** to teaching and learning that **integrates the content and skills** of science, technology, engineering, mathematics, and other subjects, as appropriate

The goal of STEM education is to **prepare students for post-secondary study and the 21st century workforce.**

STEM Standards of Practice guide STEM instruction by defining the combination of **behaviors**, integrated with STEM content, which is expected of a proficient STEM student.

These behaviors include

- engagement in inquiry,
- logical reasoning,
- collaboration, and
- investigation.

STEM Standards of Practice

1. **Learn and Apply Rigorous Science, Technology, Engineering, and Mathematics Content**
2. **Integrate Science, Technology, Engineering, and Mathematics Content**
3. **Interpret and Communicate STEM Information**
4. **Engage in Inquiry**
5. **Engage in Logical Reasoning**
6. **Collaborate as a STEM Team**
7. **Apply Technology Appropriately**



NGSS and STEM

NGSS Science and Engineering Practices

1. Asking questions (science) and defining problems (engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (sci) and designing solutions (engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

STEM Standards of Practice

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Capacities of Literate Individuals

INDEPENDENCE

**STRONG CONTENT
KNOWLEDGE**

**COMPREHEND
AND CRITIQUE**

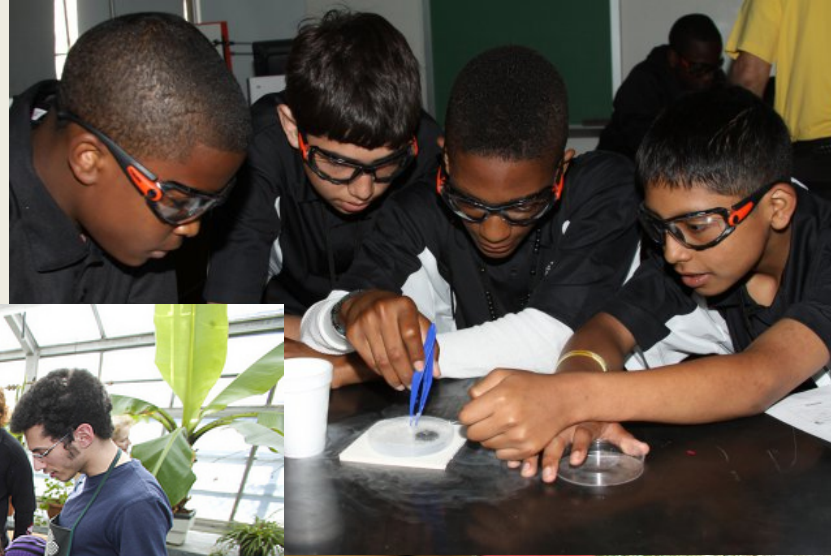
**UNDERSTAND
PERSPECTIVES
AND CULTURES**

**USE
TECHNOLOGY**

**RESPOND TO VARIOUS
DEMANDS**

**VALUE
EVIDENCE**

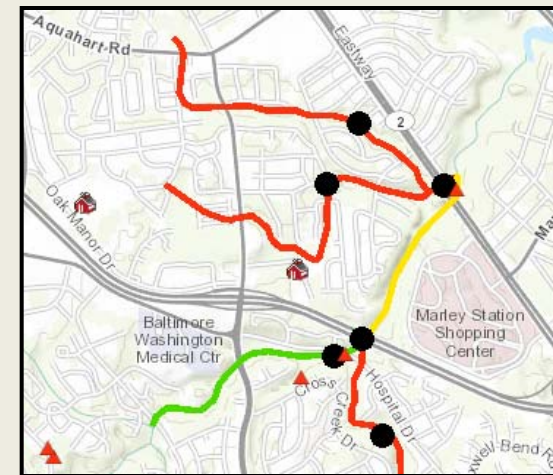
Structure of a “Lesson”





Engage Students in the Context

Engage students with the issue of importance of healthy streams



NEWS

Fly ash dump draws Md. fine

By Justin Fenton and Justin Fenton, SUN REPORTER | August 8, 2007

The state's environmental agency has ordered the operator of a coal ash dump site to pay a "significant" fine and clean contaminated water recently detected in Anne Arundel County. The Maryland Department of the Environment gave BBSS Inc. 60 days to comply or face legal action, agency spokesman Robert Ballinger said yesterday. He did not elaborate on the amount of the fine or specific actions. "Taking this corrective action is how we deem it necessary to take care" of the contamination, Ballinger said.





Engaging in the context

- activates student thinking and assesses prior knowledge
- encourages students to ask questions
- uncovers student misconceptions



Establish the Essential Question



How can we reduce the impact of human activities on the water quality of streams in Maryland?

The Essential Question

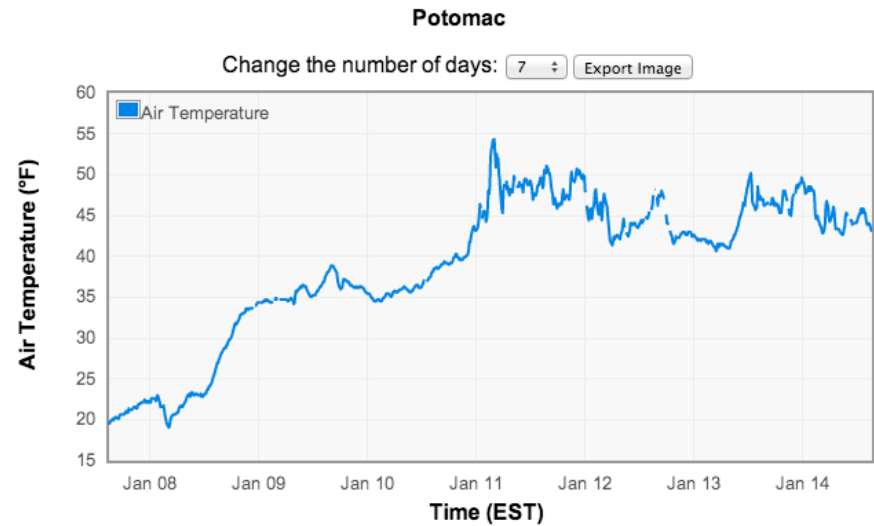
- How can we reduce the impact of human activities on the water quality of streams in Maryland?
 - Establishes the purpose for learning
 - Guides the inquiry
 - Is aligned with appropriate standards
 - Provides opportunities for student investigation
 - Makes connections between past and present learning experiences



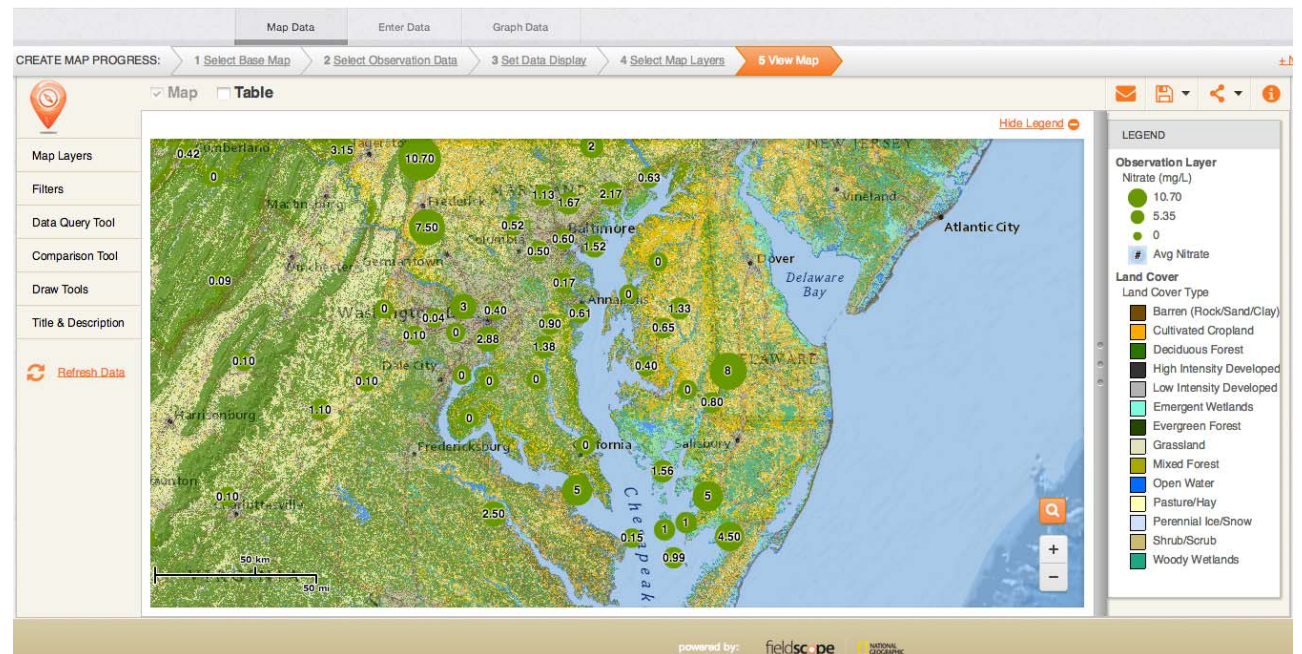
Student Exploration



STUDENT EXPLORATION



From: 2014-01-07 15:10:00 To: 2014-01-14 15:10:00



What students do in the classroom before the field experience

- Participate in guided inquiry activities to build background knowledge
- Identify resources appropriate to the essential question
 - Protocols
 - Equipment
 - Methods to collect data
 - Dichotomous keys
 - Field guides

Student Preparation

- Review literature for relevant background information

STREAM HEALTH RANKINGS PREDICTED BY SATELLITE DERIVED LAND COVER METRICS¹

Marcia N. Snyder, Scott J. Goetz, and Robb K. Wright²

ABSTRACT: Land cover and land use change have long been known to influence the chemical, physical, and biological characteristics of streams. This study makes use of land cover maps derived from fine resolution satellite imagery and an extensive stream quality dataset to determine the relationship between small watershed health rankings and land cover composition and configuration. Landscape metrics were derived from digital impervious surface area (ISA), tree cover (percent), and agricultural crop maps within Montgomery County, Maryland. Watershed rankings were developed by state and county collaborators (MD-INR and MCDP) using extensive biological and chemical measurements. In stepwise logistic regression models the factors accounting for the most variation in stream health ranking were the percent ISA, followed by the percent of tree cover. Riparian buffer zone tree cover was also a significant predictor. Of the metrics that considered the spatial configuration of the landscape, a contagion index and the percent of ISA in the flow path from the ISA to the stream were also found to be significant predictors of stream health. Despite limited ability to characterize landscape configuration or narrow riparian buffer zone vegetation with coarser resolution imagery (from Landsat), model results were not significantly different from those based on the use of fine-resolution ISA information, suggesting that broader area applications of the approach are possible. The results indicate that management practices designed to improve stream water quality should focus on the amount of ISA and tree cover in both the watershed and within the buffer zone.

KEY TERMS: land use planning; remote sensing; restoration; riparian buffers; stream health; urbanization; water quality; watershed management.

Snyder, Marcia N., Scott J. Goetz, and Robb K. Wright. 2005. Stream Health Rankings Predicted by Satellite Derived Land Cover Metrics. *Journal of the American Water Resources Association* (JAWRA) 41(3):659-677.

INTRODUCTION

The National Academy of Sciences has identified land cover and land use change as one of the primary drivers affecting ecological systems (NRC, 2001; U.S. Global Change Research Program, 2003). Freshwater systems are especially vulnerable to land use change, particularly the increased urbanization occurring across much of the nation, which has contributed to changes in aquatic community structure and degradation of stream biota (e.g., Wang *et al.*, 2001; Nilsson *et al.*, 2003). Currently more than 70 percent of freshwater mussels, 55 percent of crayfish, 42 percent of amphibians, and 40 percent of freshwater fishes are either vulnerable, imperiled, or critically imperiled in the United States (USEPA, 2002). In the Chesapeake Bay watershed, numerous studies have demonstrated the association between land use changes and the degradation of the biological, chemical, and physical quality of streams (Liu *et al.*, 2000; Jones *et al.*, 2001; Palmer *et al.*, 2002; Paul *et al.*, 2002). In the State of Maryland 46 percent of all streams are in poor condition, based on a combined macroinvertebrate and fish Index of Biological Integrity (IBI), and the proportion of urban land cover is expected to increase to between 16 and 21 percent of total land area within the next 25 years (Howard *et al.*, 1999). In the greater Baltimore-Washington, D.C., region, urban and residential lands surrounding the Chesapeake Bay have increased by 63 percent in the 15 years from 1986 through 2001, and a predictive model calibrated with these results estimates an additional 80 percent

¹Paper No. 659-677 of the *Journal of the American Water Resources Association* (JAWRA) (Copyright © 2005). Discussions are open until December 1, 2005.

²Respectively, Organization for Tropical Studies, La Selva Biological Station, San Pedro, Costa Rica; The Woods Hole Research Center, P.O. Box 296, Woods Hole, Massachusetts 02543-0296; and NOAA Special Projects Office, 1305 East-West Highway, Silver Spring, Maryland 20910 (E-Mail:Goetz@spota@whrc.org).



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INTERACTIVE MAP

About the Maryland Biological Stream Survey

Current Stream Health Overview

Maryland's Stronghold Watersheds

Forested Stream Buffers

How Impervious Surface Impacts Stream Health

How Impervious Surface Impacts Stream Health

"Impervious surface" refers to all hard surfaces like paved roads, parking lots, roofs, and even highly compacted soils like sports fields. The problem with impervious surfaces is that they prevent the natural soaking of rainwater into the ground and slowly seeping into streams. Instead, the rain water accumulates and flows rapidly into storm drains. This results in severe harm to streams in three important ways:

- Water Quantity:** storm drains deliver large volumes of water to streams much faster than would occur naturally, resulting in flooding and bank erosion. Stream inhabitants are stressed, displaced, or killed by the fast moving water and the debris and sediment it brings with it.
- Water Quality:** pollutants (gasoline, oil, fertilizers, etc) accumulate on impervious surfaces and are washed into the streams.
- Water Temperature:** during warm weather, rain that falls on impervious surfaces becomes superheated and can stress or kill stream inhabitants.

All stream inhabitants are harmed by impervious surfaces, but some are more sensitive than others. Brook trout, for example, are not found in watersheds with more than 4% impervious surface. Some salamanders disappear from watersheds with as little as 0.3% impervious surface!

Less Impervious Surfaces, Healthier Streams



Governor Martin O'Malley
Lt. Governor Anthony G. Brown

In the News

Board of Public Works Approves \$28 Million in Grants for Clean Water and the Chesapeake Bay MDE 12/15/10

Instructional Video for DNR Stream Walkers Program DNR 11/10/10

Message From the Governor

The health of the Bay is ultimately determined by what we do on the land -- in our cities and towns, on our farms and forests, in our schools and backyards. The 10,000 miles of streams that run through our communities can deliver either clean water or pollutants to the Bay. It's our Bay and it's our choice.

Thank you for choosing to get involved in improving the health of your stream and our Bay.

Student Preparation

- Identify resources appropriate to the essential question
 - Protocols
 - Equipment
 - Methods to collect data

Freshwater Macroinvertebrates Protocol



Welcome Introduction Pre

Purpose

To sample, identify and count macroinvertebrates at your Hydrology Site

Overview

Students will collect, sort, identify, and count macroinvertebrates from habitats at their site.

Student Outcomes

- Students will learn to,
- identify taxa of macroinvertebrates at their site;
 - understand the importance of representative sampling;
 - use biodiversity and other metrics in macroinvertebrate research (advanced);
 - examine reasons for changes in the macroinvertebrate community at their Hydrology Site (advanced);
 - communicate project results with other GLOBE schools;
 - collaborate with other GLOBE schools (within your country or other countries); and
 - share observations by submitting data to the GLOBE archive.

Science Concepts

Earth and Space Sciences

Soils have properties of color, texture and composition; they support the growth of many kinds of plants. Soils consist of weathered rocks and decomposed organic matter.

Life Sciences

Organisms have basic needs. Organisms can only survive in environments where their needs are met. Earth has many different kinds of environments that support different combinations of organisms.

Organisms functions relate to their environment.

Organisms change the environment in which they live.

Humans can change natural environments.

Ecosystems demonstrate the complementary nature of structure and function.

All organisms must be able to obtain and use resources while living in a constantly changing environment.

All populations living together and the physical factors with which they interact constitute an ecosystem.

Populations of organisms can be categorized by the function they serve in the ecosystem.

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Stream Observation Data Sheet			
School		Date	
Stream Study Site			
Teacher		Group Members:	
Latitude _____ degrees NORTH		Longitude _____ degrees WEST	
Weather			
Yesterday		Today	
Air Temperature _____ ° C or ° F		Air Temperature _____ ° C or ° F	
Cloud Cover clear _____ partly cloudy _____ cloudy _____		Cloud Cover clear _____ partly cloudy _____ cloudy _____	
Precipitation _____		Precipitation _____	
How could yesterday's weather affect today's field study?			

Macroinvertebrate Survey

Collection method used: Kick-Seine or D-Net (circle). If using a kick-seine, collect samples 3 times. If using a D-net, collect 20 scoops and record the number of scoops taken from each of the habitat areas in the table →	<table border="1"> <thead> <tr> <th colspan="2">Benthic Habitat Sampled</th> </tr> <tr> <th>Habitat</th> <th># scoops</th> </tr> </thead> <tbody> <tr> <td>Riffle</td> <td></td> </tr> <tr> <td>Rootwads/ woody debris/ leaf pack</td> <td></td> </tr> <tr> <td>Submerged Vegetation</td> <td></td> </tr> <tr> <td>Undercut Banks</td> <td></td> </tr> <tr> <td>Other (specify):</td> <td></td> </tr> <tr> <td>TOTAL</td> <td>20</td> </tr> </tbody> </table>	Benthic Habitat Sampled		Habitat	# scoops	Riffle		Rootwads/ woody debris/ leaf pack		Submerged Vegetation		Undercut Banks		Other (specify):		TOTAL	20
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Other (specify):																	
TOTAL	20																

Check all of the macroinvertebrates that you find in your stream and calculate the stream's water quality rating (you may also record the number of each captured, but to calculate the rating at the bottom, only count each kind of animal once, regardless of the quantity found).

SENSITIVE to pollution		LESS SENSITIVE		TOLERANT of pollution	
<input type="checkbox"/>	Caddisflies (except net spinners)	<input type="checkbox"/>	Caddisflies, common net spinning	<input type="checkbox"/>	Aquatic worms
<input type="checkbox"/>	Mayflies	<input type="checkbox"/>	Dobsonflies	<input type="checkbox"/>	Black flies
<input type="checkbox"/>	Stoneflies	<input type="checkbox"/>	Fishflies	<input type="checkbox"/>	Midge flies
<input type="checkbox"/>	Watersnipe flies	<input type="checkbox"/>	Crane flies	<input type="checkbox"/>	Leeches
<input type="checkbox"/>	Riffle beetles	<input type="checkbox"/>	Damselflies	<input type="checkbox"/>	Lunged snails
<input type="checkbox"/>	Water pennies	<input type="checkbox"/>	Dragonflies	<input type="checkbox"/>	

What students do during the field experience



- Design and/or participate in investigations to collect data in the field and/or classroom
- Review data and compare to expected results
- Repeat protocol or modify as needed

What students do after the field experience



- Discuss to evaluate validity of investigative results.
 - Compare data collected by classmates
 - Compare data collected by community groups
- Collect additional data as needed
- Analyze data to identify trends

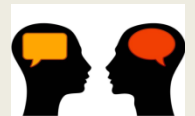
Explaining Results

- Making connections between stream health and human activities



Explaining Results

- Analyze data to make inferences related to the essential question
 - Student data (own and others)
 - Agency data
- Share the data
 - Student-student discourse/Student-teacher discourse
 - Upload to FieldScope
 - Write an essay to explain the results



Making Connections

- Make inferences on the health of the stream
- Conduct additional research as needed
- Construct an argument about the best way to reduce the impact on the stream (“claim – evidence – reasoning”)

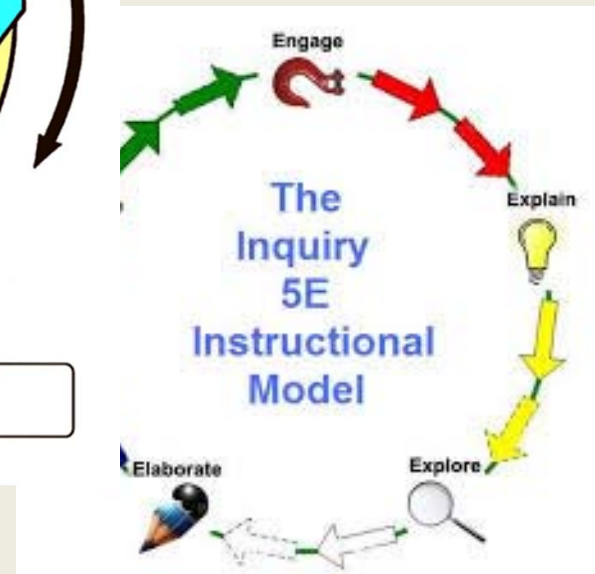
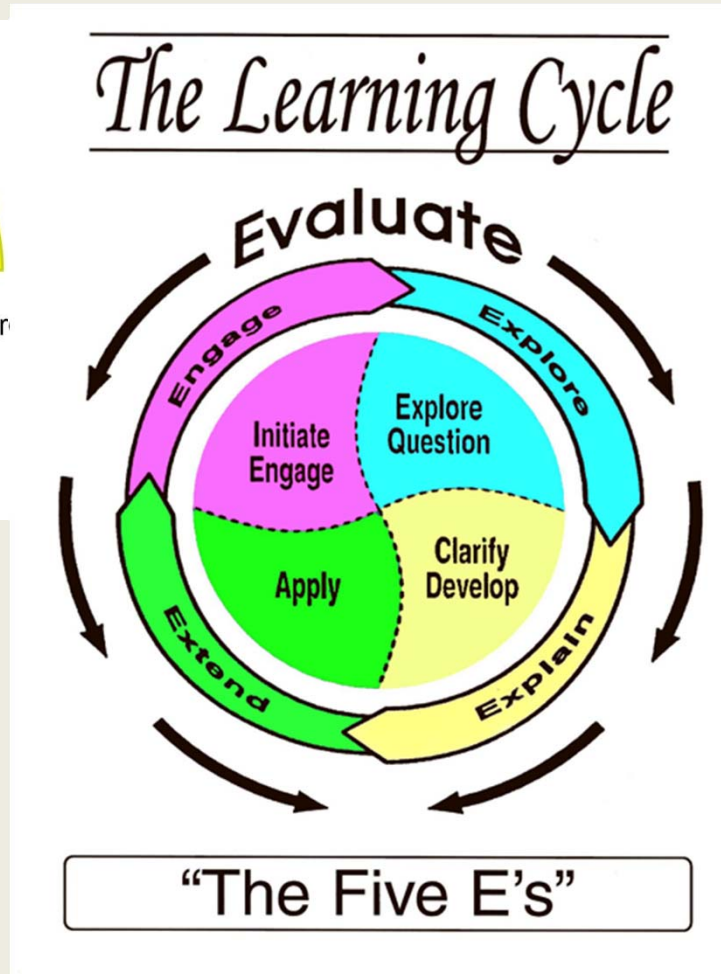
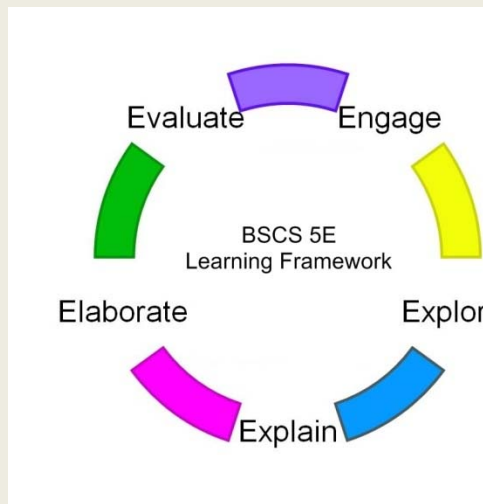
Extending Learning to Civic Action



Engaging in Civic Action

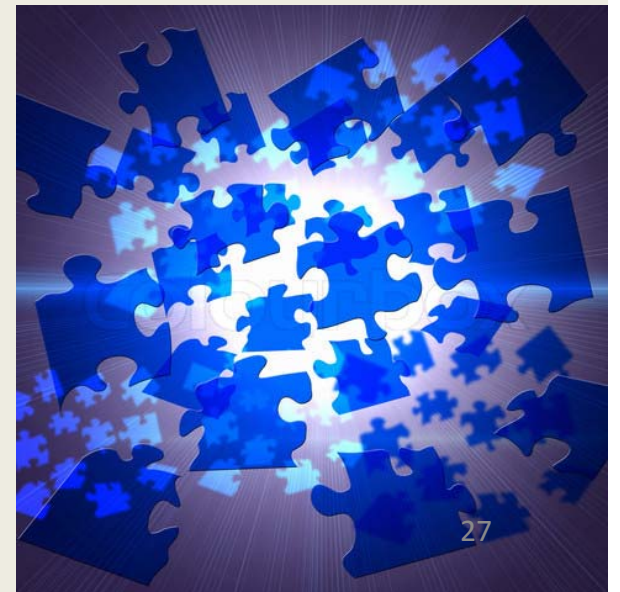
- Student(s) identify appropriate strategy for action
- Work collaboratively to address the issue
 - Identify resources
 - Establish partnerships
 - Anticipate obstacles
- Implement strategy
- Reflect on the effectiveness of the strategy

What Instructional Format was Used?

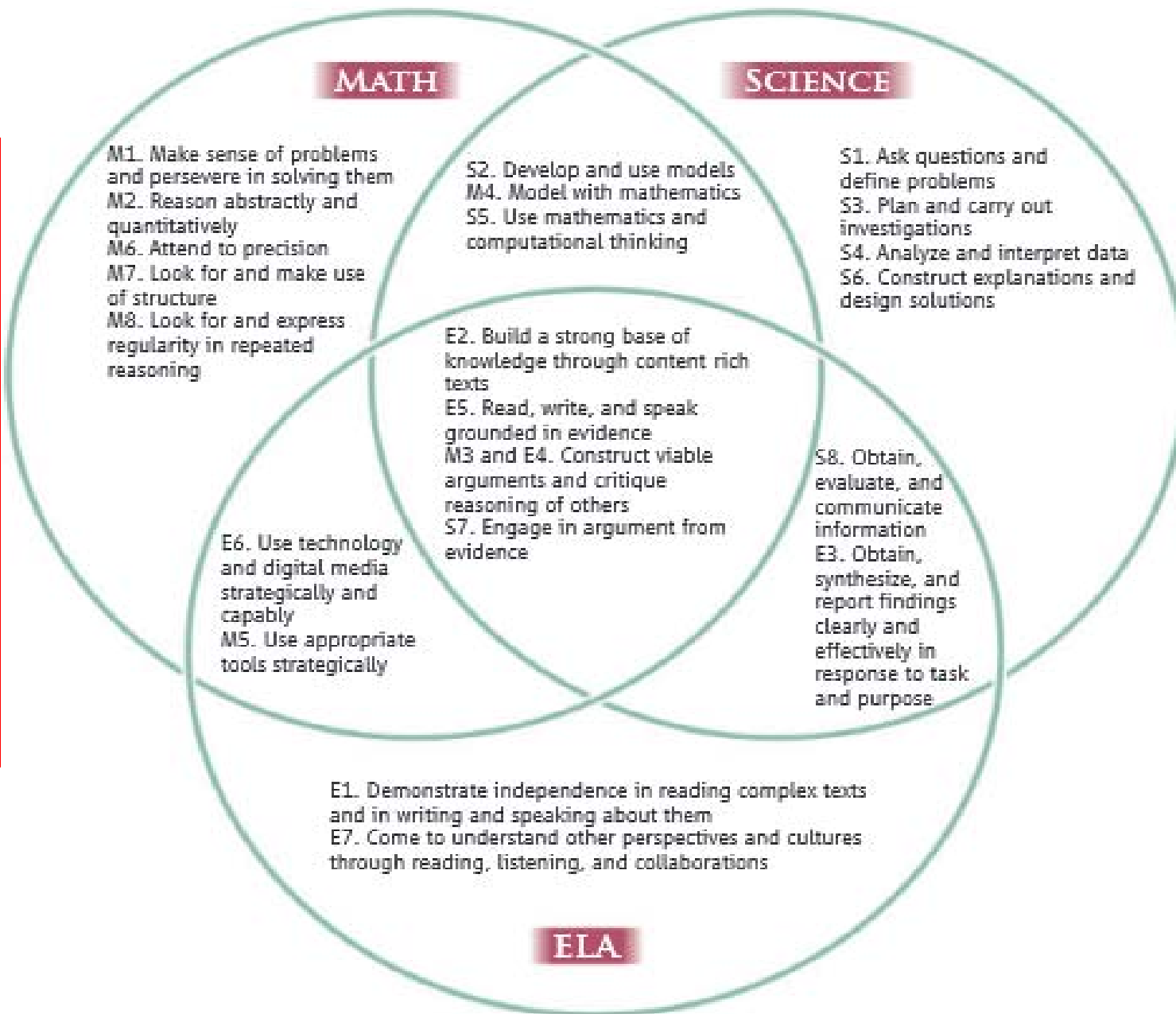


Jigsaw

- Share your individual observations
- Discuss as a group
- Summarize the ahas
- Discuss the implications for your program and/or for instruction
- Report to all



STEM STANDARDS of PRACTICE



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