


**FROM STEM
TO STEAM**

**Integrating
the Arts
into STEM
Learning**

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STEM is...




• **2006: US National Academy of Sciences** Concerned about the declining state of education in USA in **science, technology, engineering, and mathematics (STEM)**.

STEM is...



▣ **2007: Congress passed the America COMPETES Act, authorizing funding for STEM initiatives from kindergarten through graduate school.**

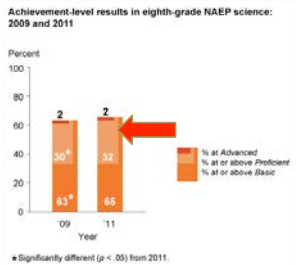


Is STEM Working?

- 4th-, 8th-, and 12th-graders performed **poorly** on **higher-level problem-solving** and **critical-thinking skills**, in both real and simulated laboratory settings.

Is STEM Working?

2011, less than one-third of 8th-graders performed at NAEP “**proficient**” levels of achievement in science.

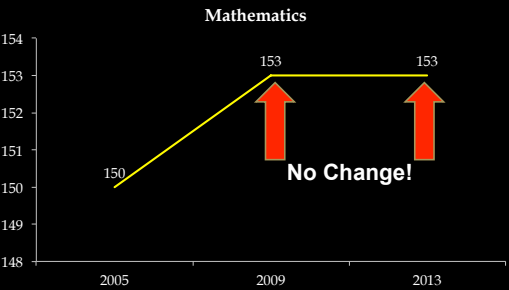


Achievement level results in eighth-grade NAEP science: 2009 and 2011

Year	% at or above Basic	% at or above Proficient	% at Advanced
'09	63*	30*	2
'11	66	32	2

* Significantly different ($p < .05$) from 2011.

12th Grade - 2013 NAEP Mathematics



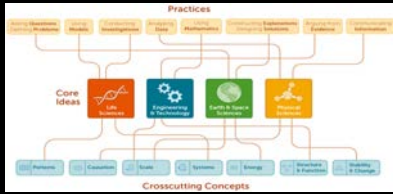
Mathematics

Year	Score
2005	150
2009	153
2013	153

No Change!

Source: National Center for Education Statistics

What's Next? Next Generation Science Standards



NGSS will do little to improve student learning unless:

- ✓ curriculum becomes more meaningful...and

✓ science and mathematics instruction concentrate on creative and real-world problem solving—i.e., what working scientists and mathematicians *really* do.



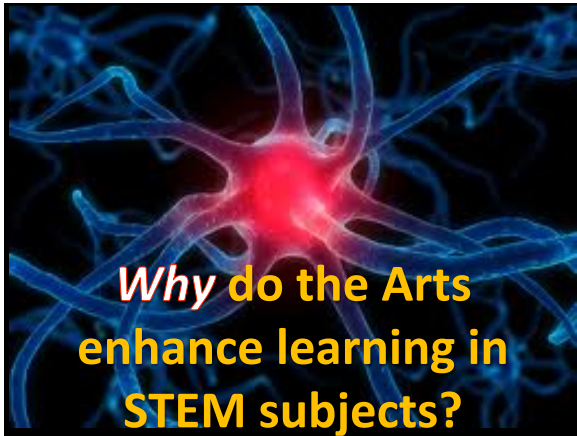
Enter the ARTS!

What activities increase student engagement, raise motivation, focus on relevant issues, and, most importantly, develop *creativity*?

Integrating arts-related skills into STEM courses is an effective way to enhance student interest and achievement.



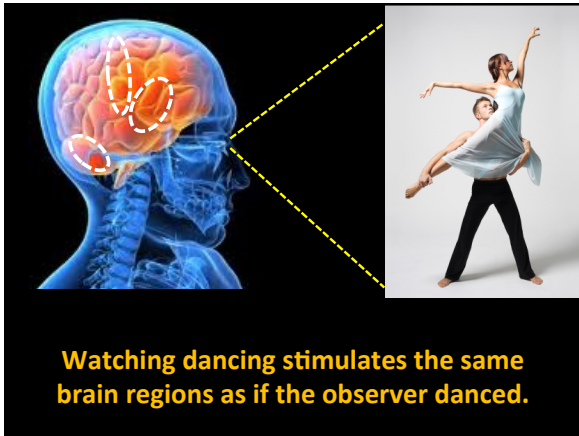
STEAM
↑

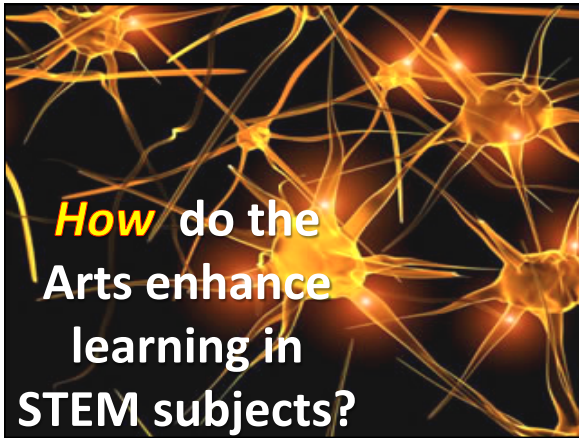


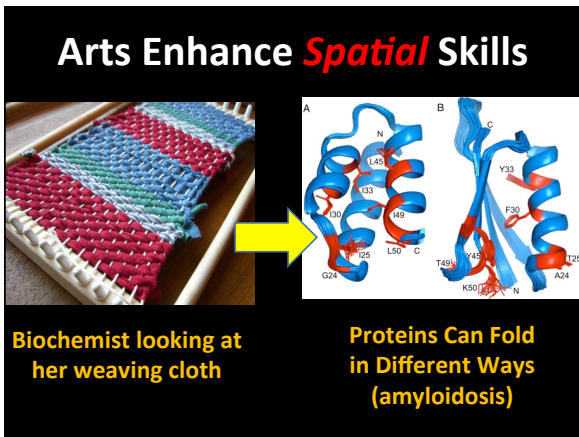
Mirror neurons:

**Neurons that fire when
experiencing a task or emotion
and
when seeing another person
experience that same task or
emotion.**

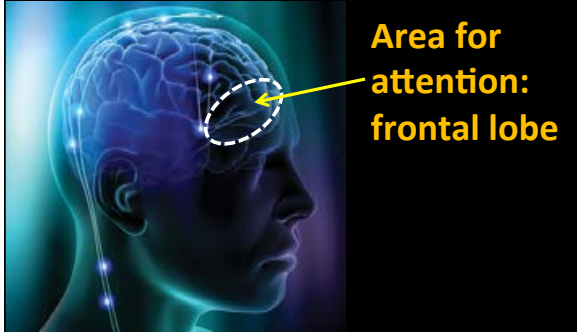








Arts Enhance **Attention** and **Engagement**

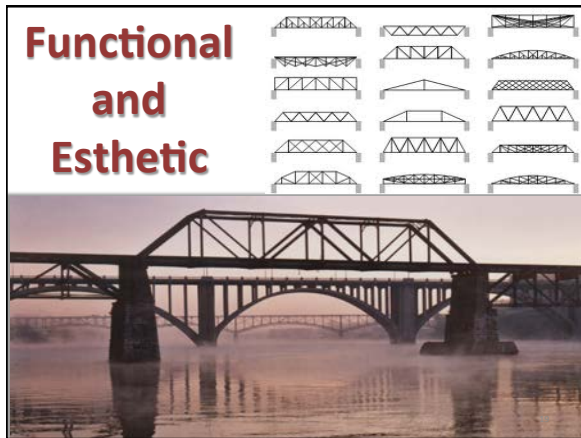


Persistence to work on projects over a sustained period of time

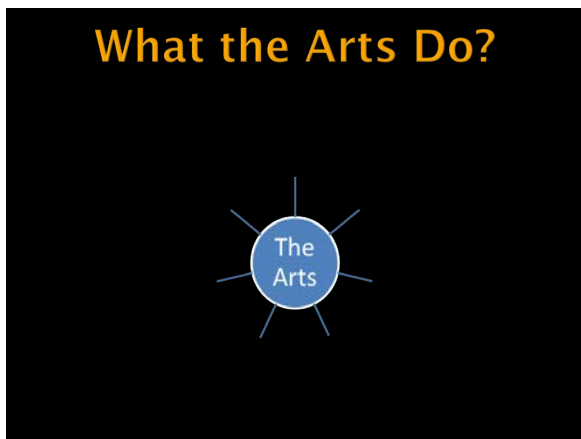


Arts Enhance **Working** and **Long-term Memory Systems**







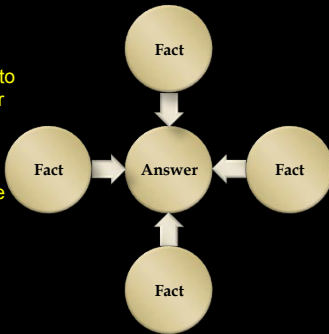


LET'S TALK ABOUT TWO TYPES OF THINKING



Convergent Thinking

- ❖ Collect useful data
- ❖ Piece material together to arrive at a single answer
- ❖ Works best with well-defined problems that have a definite response
- ❖ Usually the only type of thinking used for most tests---single answer easy to correct and machine score



Examples of convergent thinking questions

- ❑ What is the world's largest continent?
- ❑ Who wrote *Moby Dick*?
- ❑ Why do plants grow toward the light?
- ❑ What animal is found on the "buffalo" nickel?



Divergent Thinking

- ❖ Generate several ideas about how to solve a problem
- ❖ Student may use convergent thinking to put parts back together to solve problem in unexpected way
- ❖ Works best loosely-defined problems that have multi-faceted solutions

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graph TD; Problem((Problem)) --> Idea1((Idea)); Problem --> Idea2((Idea)); Problem --> Idea3((Idea)); Problem --> Idea4((Idea));
```

Examples of divergent thinking questions

- ❑ If you saw a creature from Mars, how would you communicate to it that you mean it no harm?
- ❑ How might our country be different today if we never had slavery?
- ❑ Explain whether you believe the death penalty deters crime.

Creativity was driven by nature...genetics!!

Research shows that the proper nurturing environment fosters creative thinking.

Stages of Creative Thinking

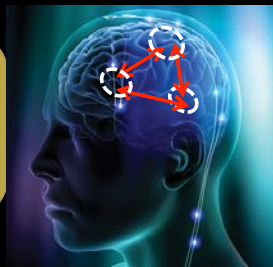
- **PREPARATION**
A period when we focus intently on task



Information from long-term memory floods into working memory

Stages of Creative Thinking

- **INCUBATION**
A period of time away from the task--daydreaming



Distant brain regions -- that usually do not interact -- begin to message each other

Stages of Creative Thinking

- **ILLUMINATION**
The “Aha” moment when the insight becomes clear



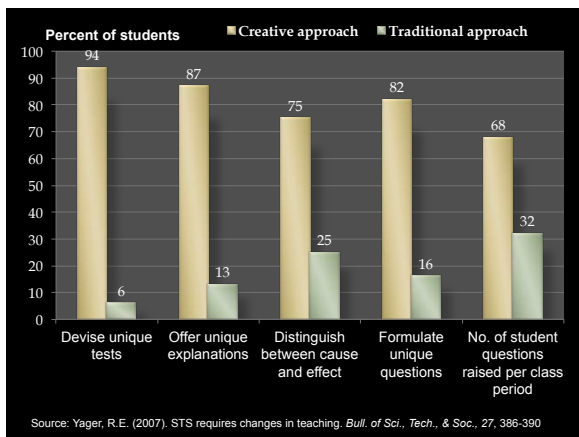
EEGs detect rush of brain waves in right hemisphere up to 8 seconds before insight occurs


Stages of Creative Thinking

- **VERIFICATION**
Testing to see if your solution will actually work



If solution doesn't work, it's back to the incubation stage.






ARTS INTEGRATION:

Learning occurs through any artistic medium that uses **creativity** to help students have a **deeper understanding of both the art form and STEM concepts.**

Grade K - Math

Big Idea: Describe shapes and space

- Florida Benchmarks: MA.K.G.2.1-5
- ▣ Cognitive Complexity: Moderate to High



Traditional Approach

- Work as a class
- Manipulate shapes
- Discuss differences in shapes
- Teacher evaluates

Grade 7 - Science

Big Idea: Energy Transfer and Transformation

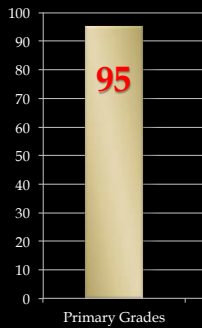
- Florida Benchmarks: SC.7.P.11.1-4
- Cognitive Complexity: Moderate - High



Traditional Approach-STEM


- Lecture and textbook format
- Do on-line research about energy transfer
- Classroom discussion, video presentation
- Write and submit a report
- Take written test

Percent of students who say they are creative



Question:

How would you explain these differences?



The arts develop

- Creativity
- Problem solving
- Critical thinking
- Communications
- Self-direction
- Initiative, and
- Collaboration

...skills those in the STEM subjects will need to succeed.



