The A Is for ART!
STEM to STEAM: How Science Shapes Art

Ms. Tiffany Albers-Lopez, Marian Catholic High School
Mrs. Brenda Rentfro, Alan B. Shepard High School
Dr. Lauren Rentfro, Lewis University

NSTA 2018 -- Atlanta, GA
Personal Experiences:
- Apprenticeship
- Theatre Productions
- Interdisciplinary Teams
- Collegial Evaluation Process

The 5e's
- Engage
- Explore
- Explain
- Elaborate
- Evaluate
Common Skills

• Observation vs. Inference
  – Overcoming the Symbol Set
    • Blind Contour Drawing
    • Grids
  – Perspective (Spatial & Auditory)
  – Dissection

Common Skills

• Problem-solving & Inquiry
  – Communication
    • Reading Art and Artistic Intent
    • Developing an Idea or Experiment
    • Performance
  – Construction/Formulation
    • Building an Object
    • Practicing Reading
Common Skills

- Lab Safety & Manipulating Materials
  - Eyes
    - Heat, Wire, Glass, Sprays, etc.
  - Lungs
    - Dusts, Fumes, etc.

- Academic Language
  - Materials
    - Ceramics, Glass, Metals, etc.
      - Oxidation or Reduction, Colorants, Anodizing, etc.
    - Paints, Pastels, Pencils, etc.
      - Cadmiums, Cobalt, Titanium, etc.
    - Sheet Music
      - Frequency, amplitude, intensity
    - Script
      - Structure, Procedure (stage directions),
**Common Skills**

- **Academic Language**
  - Processes
    - Estimating, measuring, classifying, etc.
    - Reading & Analysis
  - Communication
    - Verbal
    - Beyond Verbal

**Ceramics & Science**

- **Bacteria & Mold**
  - Types
  - Processes & Products
Ceramics & Science

- Diffusion & Osmosis
  - Processes
    - All about control
  - Shrink Rates

Ceramics & Science

- Forces
  - Centrifugal & Centripetal
    - Wheel
    - Warping
    - Stabilizing Triangle
Ceramics & Science

• Chemistry of Glazes
  – Additives
    • Color
    • Texture
    • Firing Temperature
  – Types of Glazes
    • Temperature
    • Processes

Ceramics & Science

• Types and Properties of Clay
  – Earthenware
  – Stoneware
  – Porcelain
  – Geographic Variations
Music

- Measurement
  - Time
    - Notes
    - Rests
    - Intervals
      - Overtone Series
  - Distance
    - Intervals
      - Overtone Series
    - Volume

Music

- Engineering
  - Golden Ratio
  - Building something new
    - Composing
    - Problem Solving
  - Instrument Care and Understanding
Music

- Anatomy
  - Muscles
    - Diaphragm
    - Trapezius
    - Mouth muscles
    - Vocal folds
    - Tongue
  - Other Parts
    - Nasal Passages
    - Rib Cage
    - Pelvis
    - Spine

Photography

- Vision
- Light & Lenses
- Paper & Chemicals
- Digital Devices
Color Theory

- Vision
  - Color/Field Relationships
- Light
- Emotions & Memory
- Elements & Compounds

Model Making

- Sculpture
- Drawing
- Photography
- Collage
Theatre/Acting

- Interpretation/Conceptualization
  - Text
  - Space
  - Abstract Ideas
    - Moles
    - Cells
    - Forces

- Storytelling
  - Progression of events
  - Development
  - Change
  - Publishing/Sharing Ideas
  - Fusion Science Theatre
    - [http://www.fusionsciencelearning.org](http://www.fusionsciencelearning.org)
    - Holly Walter Kerby
Theatre/Design

- Engineering
  - Building
  - Problem Solving
  - Torque
  - Electricity
    - volts
    - amps

STEM to STEAM Lessons:
From the Pilot Year
PRE-INSTRUCTIONAL REFLECTIONS

• “My stain worked really good, I loved the color it came out to be.”
• “I learned how to keep clay from drying and how to make it wet when it is dried out. I also learned the different textures of clay.”
• “I learned how to control the clay while making my bowl.”
• “I took at least 14 prior attempts at making something on the wheel before I had a good piece. I can’t really explain what I did to make this it was just a pinch of luck that this worked out for the better.”

• “When the clay is too thick it can have air bubbles. When it goes in the kiln, the air bubbles pop and the project explodes. Since I made this project, I now know to check the thickness before putting it in the kiln.”
• “…then I made sure it was in the middle and so when I spins I would make sure it would spin with no problem and then I started to make then bowl and it took a couple of try's to do it all and then I got [a] bowl.”

• “…you place it to the center of the wheel and you make a bowl. I would like to become better on the wheel and make better bowls.”
The Process

- Evaluation of Student Responses
- Planning with Pre-Service Teachers
- Lesson Delivery
- Evaluation of Student Responses

MILLION BONES PROJECT
Small gaps and spaces
- Only about 5-30% porous
- Very Strong
- Makes the outer layer
- 80% of bone mass

- Have 3 parts
  - Epiphysis (Round Ends)
  - Diaphysis (Shaft)
- Red Bone Marrow at Ends
- Yellow Marrow In Center
- Arms, Legs, Fingers, Toes
- Mostly Compact Bone
  - Very Strong
CHEMISTRY OF GLAZES
What is in a glaze?

1. **Flux**
   Is any ingredient that is used to help melt the glaze or to lower the temperature that the glaze will melt at.

2. **Stabilizer**
   Is any ingredient that is used to extend the melting range of a glaze and to stiffen the glaze.

3. **Glass former**
   The main ingredient of a glaze and the one that needs additional melting from the fluxes and stiffening from the stabilizers. Silica is the main glass former.

4. **Opacifier**
   Makes the glaze more opaque by obstructing the light as it passes through, often used to make a white glaze.

5. **Colorant**
   These ingredients add color to the base glaze and are used in small amounts, they are usually metals in some form like copper.

---

Glaze Color

3 Main Factors:

- The composition of the glaze. This not only includes the colorants in the glaze, but also other glaze materials that interact and effect that colorant or combination of colorants.

- The temperature to which the glaze is fired. Some colorants are volatile and will dissipate into the kiln atmosphere if fired too high. Others give different colors at different temperatures.

- The kiln’s atmosphere during firing and, in some cases, during cooling.
THE SCIENCE OF RAKU
R \{ lgdw\l r\#lgq\#fhgxf\l rq

- R \{ lgdw\l r\#kh\#lgq\#fhgxf\l rq\# in \{ \text{jhg\#kdh\#fhgxf\l rq\#}
  - rffx\#kh\#khr\#pxq\# in \{ \text{jhg\#fhufh\l nv1\#

- Z kdw\#uh\#zp h\#fhnu\#gd\# \{ lgdw\l r\#(dp sdmb
  - Uwxw\#IH\#kR\#S\# \rightarrow 5IH\#R\#S
  - SxqpdQ\#dp dq\#fhfd\# \#2 khg\#sxcq\#t\#lgq\#dp dgy\#hw\#nu\#dq\#If\#
    - fp sxqgv\#bhfu\# lk\# \{ \text{jhg\#}
  - El\#rac\#k\#dc\#urfu\#vtu\#rr\#hdfw\# lk\# \{ \text{jhg\#r\#inu \#duerq\#
    - gl\# \{ lgh\#kg\# dwhu\#

Uhgxf\l rq\#lgq\# ruh\#hjhg

- Fkhjvh\#hj\#hjhg\#khw\#wru\# \#in\#rwhu\# kr\# dv\# kdy\#k\#wrx\#k\# in \#hj\#xj\#k\# in \#h\#k\#d\#q\#l\#k\#\#hj\#\#k\# in \#hj\#w\#x\# ehg\# lk\# xuq\#hj1
Ungxfwlrq#lqg# ruh#dhjhg

- Wkh#fhuhwr$1ungxfwlrq# dv#frxqg$

- Wkh#fhuhwr# dv#yhurdgh# lw# duerq# lqg# kh# uhjhg# r{lqgh# rrs# shu# wrv# wr $1 jhgb# jgh# hfrp hv$1# uhj# lqgh
  - 5F# FxR# 5FxR 5FR

- Dqrp# halfdq# huulrq# $1 udnx# hfrqglw# vhw# vhw# kl# surfhvwl
  - Dqrp# halfdq# huulrq# $1 udnx# hfrqglw# surfhvwl
  - Wkhj# kl# twa#azor# wrv# sro# jhgb# gw# hfrp
  - p dw# twa# azor# gw# hfrp
Why is centering important?

- Clay is **rotating** when properly centered
- Clay is **revolving** when improperly centered
- Objects that are revolving act under different motions, forces, and accelerations than objects that are rotating
Angular Velocity

- The rate at which an object rotates

- Units
  - RPM
  - rad/s
  - °/s

Why your clay collapses

- The axis of rotation for a spinning object runs through its center of mass, where the clay is balanced.
- When the clay is worked too thin, it begins to buckle under stress and becomes unbalanced.
- The object’s center of mass then moves, and inertia attempts to return the object to a state of balance.
- Because it can’t find balance, it continues to wobble due to inertia and eventually collapses due to stress.
POST-INSTRUCTIONAL REFLECTIONS
• “When we learned about the bone and balance of an object it allowed us to break down the structure that is needed to make a well built, balanced, sturdy piece of work.”
• “It allows us to see things from a different point of view, letting us know how to move, balance, and build our work, allowing it to be successful.”

• “In science you learn about different types of chemicals and how they react. In art we work with different types of chemicals in the glazes we use. The heat at which you fire your work at can affect the glaze. Also when you fire the glaze it gives off chemicals in the air so if you fire different types of glazes together it affects their outcomes.”
• “Glaze relates to chemical reactions and elements. The reactions change colors of the glaze and so do … the elements put in the glaze like metals.”
• “I can layer glazes to make more colors.”
• “You need to be aware of what’s toxic and what is made and added when glazing pots.”

• “Science greatly impacts my artistic process in many ways because what science teaches me greatly improves my art pieces. … Through science you can implement physics into [your artwork]. For example, by understanding the physics of the clays as you work with it, and using tools like the wheel requires a basic understanding of science like: motion, rotation, and revolution…”
• “Knowing how much science actually affects my art has completely changed how I feel about my creative process. I understand and feel more confident about creating my art.”
• “I have not made connections like this before.”

The extended study: TOPICS IN PROGRESS
Future Ideas/Labs

• Ruben’s tube
• Flipping of band
• Coloring with bacteria
• Acting out Descent with Modification
• Writing a Script

Future Ideas/Labs

• Golden Ratio Music Study
• Sitting Anatomy Lab
• Stoichiometry of Fireworks
• Chromatography of Pictures
• Living Lab
College Student Themes

- Diversity of Skills, Knowledge, & Experiences
- Connectedness of Subjects
- Differences in Lab Class Management

Plans for the Future...

- Final Exam Reflections & Academic Language
- Creation of Video Clip Lessons
- Additional Science/Art Topics
- Inclusion of Other Art/Science Courses
QUESTIONS AND COMMENTS?

Thanks to...

- Chris Mroczek, Lincoln-Way Central HS
- Karen Linnerud
- Michael Zwartz
- Samuel Boctor
- Laura Diepholz, Mother McAuley HS
- Anthony Romeo, Nequa Valley HS
- Matt Macaluso, Pollman North American, Inc.
- Kelly Rose, Montini High School
Lewis University
College of Education IRB
approval 2013 – Pilot Study