THE COLLABORATIVE ART OF TEACHING SCIENCE THROUGH DRAWING

Merrie Koester, Ph.D.  USC Center for Science Education
Seymour Simmons, Ed.D.  Winthrop University Art Education

NAEA, Chicago, Saturday, 9:00 am, McCormick Place, North Building, N134
CREATIVE LEADERSHIP (the theme of this conference!)

• Challenges us to ADAPT, CONNECT, RELATE, JOIN FORCES, and POOL OUR RESOURCES. (Rolling, 2016).

• “Makes us agents of change rather than agents of the status quo”. (Kantawala and Rolling, 2014).
The “status quo” in a traditional lecture-based science class.
Making the Art and Science CONNECTION

I dedicate this sketchbook to my own amazing self in celebration of the artist and scientist I am!
To draw something is to know it.

Leonardo da Vinci
The artist who draws something without understanding the science of how it works is as uninformed as the scientist who relies only on theories and books. Each is like a sailor who tries to steer a boat that lacks a rudder or compass. Each needs to experience Nature directly through the senses.  Leonardo da Vinci
A ship without a rudder will hit stuff.
Art and science inquiry practices are very similar.
Art Studio Habits of Mind

• OBSERVING
• ENVISIONING
• INNOVATING THROUGH EXPLORATION AND DESIGN
• REFLECTIVE SELF-EVALUATION
• ENGAGING AND PERSISTING THROUGH MISTAKES
• CRITIQUING

Source: Hetland, Winner, Veenema, and Sheridan, Studio Thinking 2: The Real Benefits
Science and engineering practices (NGSS Standards)

• Ask questions and define problems.
• Develop and use models.
• Design solutions.
• Obtain, evaluate, and communicate information.
What do YOU think?

Making the Art and Science Connection

There are 7 “Cross-Cutting Concepts” in the Science Standards:

1. Patterns
2. Cause and effect
3. Energy and matter
4. Scale, proportion, and quantity
5. Structure and function
6. Stability and change
7. Systems and systems models

HOW MIGHT THE ARTS EDUCATOR TEACH THESE SAME SUBJECTS?

WILL YOU DESCRIBE A HIGHLY EFFECTIVE PROFESSIONAL DEVELOPMENT WORKSHOP WHERE SCIENCE AND ART TEACHERS WORK TOGETHER TO DESIGN CURRICULUM?
Famous Artist/Scientists who drew

- Leonardo da Vinci
- Galileo Galilei
- Sir Isaac Newton
- Samuel F. B. Morse
- J. J. Audubon
- Charles Darwin
- Thomas Alva Edison
- F. A. Kekulé
- Nicola Tesla
- C. S. Peirce
- William James
- J. Watson and F. Crick
- Einstein

Galileo, 1609

S. F. B. Morse: Drawings for the original telegraph

F. Crick, 1953

T. Edison: Drawing for a quaduplex telegraph
Science fields that involve drawing

- Biological Sciences
- Medicine
- Physics
- Chemistry
- Engineering
- Invention
- Astronomy
- Geology
- Geography
- Psychology
- (Add to the list)

Leonardo da Vinci: Anatomical Drawings

Charles Darwin: Drawings of heads and beaks of Galapagos finches
Science still needs drawing: Medical Illustration

Predictive facial ideal for reconstructive surgery of hypertelorism

Medical Illustration Assignment

David Brown: Illustrator
Science still needs drawing: The design of engineering solutions.
Illustration FOR Mechanical SCIENCE: College Level

Mechanical Toy: Observational Drawing to Cross-Section Schematic
Drawing is essential in the design of engineering solutions.
Invention: College Level

Time Machine: Concept Sketches to Cross-Section Schematics
The Problem of Language and Communication
Most science teachers have had little to no training in drawing or the art of visually organizing information.
Virtually all teachers have students who are…

• are reading below grade level.

• are English Language Learners

• have special needs.
“One in five children in the U.S. struggles with issues related to reading, writing, math, focus, and organization. These kids are as smart as their peers. But they are not getting the support they need to succeed…Only 68% of students identified as having specific learning disabilities like dyslexia graduate from high school. 19 percent of students with learning disabilities drop out.”

www.understood.org
Some descriptive statistics

NAEP 2011 Science and Reading Assessment Summaries
For 8th grade students

<table>
<thead>
<tr>
<th>Student category</th>
<th>% scoring below basic in READING</th>
<th>% scoring below basic in SCIENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Students</td>
<td>25</td>
<td>36</td>
</tr>
<tr>
<td>Low Income Families</td>
<td>37</td>
<td>52</td>
</tr>
<tr>
<td>English Language Learners</td>
<td>71</td>
<td>83</td>
</tr>
</tbody>
</table>
When achieving science literacy depends primarily on reading and listening fluency, there can be profound problems.
What is must feel like to be a struggling reader in a lecture-based science class.

But as he looked down over the other side he slipped—

And there wasn’t any other side of the mountain. He was falling, in thin air.
For the purpose of science – whenever the student cannot be expected to discern the real thing by him/herself, the educator needs to [be able to] provide a sufficiently simple version of the final image.

- Rudolf Arnheim, *Visual Thinking*
How STEAM is conceptualized in the Project Draw for Science Action Research.

http://merriekeoester.wix.com/project-dfs

- The belief that the arts connect, communicate, and break down barriers, opening windows to the world.

- The inclusion of arts practices in the teaching, learning, and application of the Next Generation Science Standards (NGSS).

- Less emphasis on teacher-telling what is "right" or "known" and more time devoted to collaborative, design oriented thinking and performance based assessments.

- The belief that drawing instruction and practice should become an integral part of a school’s STEM education program and curriculum as well as science teacher preparation.
Project Draw for Science

RESEARCH QUESTION

What will happen when science educators acquire the *capacity* to teach through *drawing*, using *pedagogy* which is also *aesthetic*?
THE TRUE STORY OF HOW DOING ART CAN MAKE SCIENCE MATTER TO MORE STUDENTS

Science Teachers Who Draw: The Red Is Always There

Merrie Koester

Deep University Press
Research Finding: Drawing deepens teacher content knowledge.
The Back of the Napkin TEST

Write your *most* favorite area of science to teach.

Write your *least* favorite area of science to teach.
Most middle and elementary science teachers could draw very little on topics related to the physical sciences.
Research Finding

Drawings have a high sticky factor.
Picture Superiority Effect

• New words/concepts are more likely to be remembered when they are presented as pictures rather than with words alone.

Paivio & Csapo, 1971
Picture Superiority Corollary

- *Unlearning* a concept which has been incorrectly presented through drawing is far more difficult than unlearning a concept which has explained through words alone. Also, directional arrows are powerful, symbolic communicators of information and must be used judiciously.
What’s wrong with this picture?

This science teacher inadvertently had an entire class drawing a misconception about the nitrogen cycle.
Teacher often failed to pick up the student misconceptions:
Theory of Aesthetic Masking

• A teacher can be so distracted by the aesthetic appeal of a science drawing that he or she fails to recognize misconceptions which may be represented there.

Koester
Most science is taught through talking and telling…

An *anesthetic* experience.
What if?

• *What If* STEM and Arts educators worked *together* to *cross-train* each other on behalf of their students?

• You get *DEEP STEM[A]M!*
The art educator simultaneously teaches elements of design.
Science teachers and students design “KNOW”tations, using elements of graphic design to communicate their understanding of situated science learning.

The science teacher also learns to use graphic design vocabulary.
What happens in the “Know”tation?

Explanatory IMAGES connect WORDS, SYMBOLS, and ACTIONS of SCIENCE through visual narrative.
Instead of this…
You get meaningful artifacts like this:
“Know”tations…

• Are acts of critical, creative making, the kind Seymour Papert (1991) had in mind when he developed his theory of constructionism. They are “public artifacts,” compositions that inform and transform learning by being made in the first place.
Project Draw for Science

STEAM Professional Development

• Project Draw for Science workshops focus on improving teacher content knowledge across both arts and science standards.

• Science teachers learn the art of creating “Know”tations, while arts teachers guide students and their science/STEM teachers toward improving/revising their visual explanatory models and drawing skills.

• Collaborations can’t be framed only in terms of communicating science/STEM and must also foreground arts studio knowledge and practices.

• Involves arts, science, STEM, and STEAM educators working collaboratively, especially in the writing of grants to fund ongoing action research.

• Values collective over isolated impact.

• © Merrie Koester, Ph.D.
RESEARCH CLAIMS

• **DRAWING**, conceptualized as a meaningful science **LANGUAGE**, should be an integral part of an **INCLUSIVE SCIENCE EDUCATION**.

• The “Know”**tation** is a meaningful, purposefully constructed, **RE-PRESENTATION** of **SCIENCE KNOWING** that can be used as a performance assessment.

• The **best results** can be achieved when **science and arts teachers** work together.
Drawing Across the Curriculum

A National Art Education Foundation Research Project

Andrea Kantrowitz
Teachers College, Columbia University

Seymour Simmons
Winthrop University
BIOLOGY FIELD STUDY 2nd Grade

Studying Snakes

New England Conservatory Lab Charter School, Boston, MA
Jenna Gampel, 2nd Grade Teacher
CELL BIOLOGY: Middle School

Escuela Campo Alegre, Caracas, Venezuela
Michael Anderson, Art Teacher
Adam Fox, Abram Cosby
ASTROPHYSICS: High School

Marlborough High School, Marlborough, MA
Kristi Oliver, Art; Nicole Shanks: Science
How did learning science through drawing make you feel?

How did it affect your academic achievement?
The Feelful Wordle
CLAIM

Aesthetic inquiry can move the student away from ALIENATION and towards AFFILIATION.
Linking drawing to academic achievement
The Action Wordle
Mean Test Scores by Ability Group
Without and With Drawing Project

<table>
<thead>
<tr>
<th>Ability Group</th>
<th>Without</th>
<th>With</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT</td>
<td>88</td>
<td>97.3</td>
</tr>
<tr>
<td>REG</td>
<td>81.3</td>
<td>92.6</td>
</tr>
<tr>
<td>IEP</td>
<td>68.3</td>
<td>88.4</td>
</tr>
</tbody>
</table>

Test scores on a standardized ecology unit test across identified ability groups
Student Quiz 1 Grades Compared to Quiz 2

- Worms/Sponges Quiz
- Echidorms/Mollusk Quiz
Making the Art and Science CONNECTION
How can we put drawing and making in the middle of science and art teaching and learning.

The Art-Bot as Art/Science
What do YOU think?

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However you conceptualize STEAM, we believe drawing needs to be an integral component of the Seeing, Thinking, Knowing, and Doing of the Learning of science/STEM.

Will you help us keep this conversation going by sharing your own Drawing to See, Think, Know, and Do lessons at https://www.facebook.com/scienceteacherswhodraw/?
On your mark, get set...