Back to Basics: Teacher Guide

Subject: Chemistry, Biology
Grade Level: High School

Case Summary

How did this painting end up with such uneven edges and so discolored? Yet, it is still has brilliant colors and the majority of the paper is supple and flexible. It is up to Renee, conservator at the Carlos Museum, to find out and to detect if the painting could be a forgery.

Credits

This case was written by Jennice Ozment (chemistry teacher, Walton High School, Marietta, GA). Author may be contacted at jennice.ozment@cobbk12.org.

Laboratory activities:

Smith, T., Commander, J., Etre, K., & Stein, R. (2013). Pigment Identification lab. Presented at The Science Behind Art Conservation Teacher Workshop, Emory University, July 8-12, 2013

Smith, T., Commander, J., Etre, K., & Stein, R. (2013). pH of paper lab. Presented at The Science Behind Art Conservation Teacher Workshop, Emory University, July 8-12, 2013

Smith, T., Commander, J., Etre, K., & Stein, R. (2013). Textile identification lab. Presented at The Science Behind Art Conservation Teacher Workshop, Emory University, July 8-12, 2013

Learning Objectives

1. Differentiate between plant, animal and man-made fibers using prior knowledge of the differences between plant and animal cells.
2. Utilize a microscope to identify the differences between plant, animal, and man-made fibers.
3. Design and conduct an experiment to test the stability of paper samples
4. Understand the structure/composition of the paper affect its stability
5. Determine the effect of pH on paper quality/deterioration
6. Predict environmental conditions that would ensure the longevity of a valuable document
7. Identify pigments by their physical and chemical characteristics

Additional Materials

Artist's medium (can be purchased at any artist's supply store)

Georgia Performance Standards

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.

a. Follow correct procedures for use of scientific apparatus.
b. Demonstrate appropriate techniques in all laboratory situations.
c. Follow correct protocol for identifying and reporting safety problems and violations.

SCSh3. Students will identify and investigate problems scientifically.

a. Suggest reasonable hypotheses for identified problems.
b. Develop procedures for solving scientific problems.
c. Collect, organize and record appropriate data.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

a. Trace the source on any large disparity between estimated and calculated answers to problems.
b. Consider possible effects of measurement errors on calculations.
c. Recognize the relationship between accuracy and precision.
d. Express appropriate numbers of significant figures for calculated data, using scientific notation where appropriate.
e. Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas as appropriate.

SCSh6. Students will communicate scientific investigations and information clearly.

a. Write clear, coherent laboratory reports related to scientific investigations.
b. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data
c. Use data as evidence to support scientific arguments and claims in written or oral presentations.
d. Participate in group discussions of scientific investigation and current scientific issues.

SC1. Students will analyze the nature of matter and its classifications.

b. Identify substances based on chemical and physical properties.

SC7. Students will characterize the properties that describe solutions and the nature of acids and bases.

b. Compare, contrast, and evaluate the nature of acids and bases:
   - Arrhenius, Bronsted-Lowry Acid/Bases
   - Strong vs. weak acids/bases in terms of percent dissociation
   - Hydronium ion concentration
   - pH

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Assessment

Students will be accessed by:

- The lab sheets for these activities.
- Completion of the Box Chart
- Research into the materials which were used during the Renaissance
- A three page response paper discussing the materials used in the Renaissance, the materials on the student's sample and whether this could be accurate or not, and theories about the stains on the paper

Implementation Strategy

Pre-lab:

- The teacher will hand out small samples of their unknown material painted with a stripe of blue paint.
- If this painting is 'real', the substrate would typically be cotton rag paper, linen, or parchment. Cotton rag paper was chosen in this case.
- Mix a pigment with any medium, which can be purchased at an artist's store.
- Paint stripe on chosen substrate.
- Likely verdigris would have been used during the Renaissance.
- The teacher can chose to paint any of the blue pigments on any of the textiles used the fiber identification activity. The variety can be the forgeries.

Day 1:

- Students will read scene 1 and fill out box chart.
- Students will read scene 2 and fill out box chart.
- The rest of the class time will be spent trying to answer their questions through research. This research will be completed for homework.

Day 2:

- Give a sample of the painted substrate above.
- Students will complete the Fiber Identification Activity.
- The students should answer the following questions:
    a. What is the fiber in my substrate?
    b. Was this material used in the Renaissance?

Note: The lab can be conducted solely with the substrate the students were given or with all of the samples for an unknown and controls.

Day 3:

- Students will complete **Part 1** of the pH and Paper Activity.
- Students should answer the following questions:
    a. How would a high acidic content affect paper visually?
    b. Is high quality artist's paper usually acidic?
    c. Would I want to use paper that could become acidic if I wanted to keep the artwork for a very long time?
    d. What else could cause the staining on the painting?

Day 4:

- Students will complete the Pigment Identification Activity.
- Students should answer the following questions:
    a. What is the pigment on my sample?
    b. Was this pigment used in the Renaissance?

Resources

History of Paper/Paper Making
http://www.hqpapermaker.com/paper-history/
http://www.hrc.utexas.edu/educator/modules/gutenberg/invention/papermaking/
http://paper.lib.uiowa.edu/european.php

History of Pigments
www.webexhibits.org/pigments

Renaissance
http://www.ibiblio.org/wm/paint/glo/renaissance/
http://www.history.com/topics/renaissance-art
http://autocww.colorado.edu/~blackmon/E64ContentFiles/PeriodsAndStyles/Renaissance.html

Authentication
http://pubs.acs.org/subscribe/archive/tcaw/11/i03/html/03lesney.html
http://www.livescience.com/13506-paint-material-analysis-ria-110331.html
http://www.camaonline.net/index_files/ArtAuthentication.htm
http://www.conservartassoc.com/spie.html
http://www.biorigami.com/wp-content/uploads/2013/07/BIRO-ARTICLE.pdf
http://content.time.com/time/arts/article/0,8599,1930303,00.html

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Back to Basics: Scene 1

Setting: 13th century Europe, the Renaissance

Joseph unlocked his shop and stepped into the musty, cool room. As his eyes wandered around the room, observing the stacks of handmade paper his contemplation was abruptly broken as someone runs into his shop.

David: "Joseph, I've had an epiphany! I need a sheet of your best artist paper!!"

Joseph: "Calm down David, I'll pick one out right away. What size would you like, full or half?"

David: "Full, please."

Joseph: "That will be one drachma."

David slaps a coin into Joseph's hand, turns around, and runs back out the door. Joseph watches him run out and smiles to himself.

David arrives home, sets up his easel with the artist's paper and begins sketching. The paper is smooth and supple and takes the charcoal smoothly. It is so easy to sketch on this paper, he says to himself. He thinks the paper will be perfect for his pigments. This will be my masterpiece, it will last forever David thinks.

Three months have gone by and David has just finished his masterpiece. He leans back and stretches as he sets down his brush. Examining his painting carefully, David hears a woman scream and a child crying. What is going on thinks David? He runs outside, his village is under attack. The invaders are throwing burning torches onto the thatched roofs of the houses. Quickly he surveys the scene, so much carnage. He turns to run back into his house just as an invader throws a burning torch on his roof. He shouts NO just as he is run through with a spear by the invader.

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Back to Basics Box Chart: Scene 1

What you know:	What you need to know:

Back to Basics: Scene 2

Setting: 8 centuries later, e.g. today, Carlos Museum, Atlanta, GA
Characters: Renee – Conservator of objects at the Carlos Museum, Margaret – Curator at the Carlos Museum

Renee: Margaret, this is beautiful. The paper is still so supple and the images so brilliant. But why are the edges so uneven and brown? The inside edge of this brown discoloration is so straight but the outside edge is so uneven. I've never seen anything like this before.

Margaret: I know, neither have I. It would be a fabulous addition to the collection but its condition is so unusual. Could this be a forgery? The market has been flooded by Renaissance art.

Renee: This will certainly be a challenge. We can, however, check the materials, which were used to make the work of art and make sure these materials are correct for the time period.

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Back to Basics Box Chart

What you know:	What you need to know:

Resources

History of Paper/Paper Making
http://www.hqpapermaker.com/paper-history/
http://www.hrc.utexas.edu/educator/modules/gutenberg/invention/papermaking/
http://paper.lib.uiowa.edu/european.php

History of Pigments
www.webexhibits.org/pigments

Renaissance
http://www.ibiblio.org/wm/paint/glo/renaissance/
http://www.history.com/topics/renaissance-art
http://autocww.colorado.edu/~blackmon/E64ContentFiles/PeriodsAndStyles/Renaissance.html

Authentication
http://pubs.acs.org/subscribe/archive/tcaw/11/i03/html/03lesney.html
http://www.livescience.com/13506-paint-material-analysis-ria-110331.html
http://www.camaonline.net/index_files/ArtAuthentication.htm
http://www.conservartassoc.com/spie.html
http://www.biorigami.com/wp-content/uploads/2013/07/BIRO-ARTICLE.pdf
http://content.time.com/time/arts/article/0,8599,1930303,00.html