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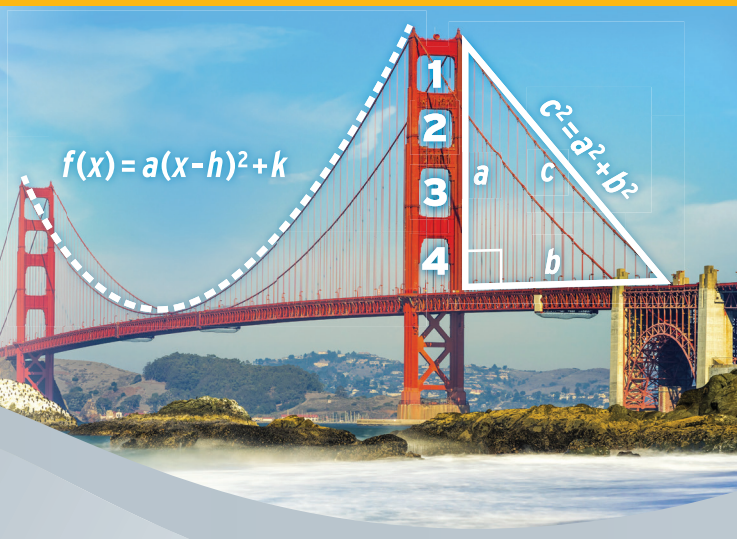

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Artist? Mathematician? Developing both enhances learning!*

SARAH B. BUSH, KAREN S. KARP, AND JENNIFER NADLER

Although many people consider mathematics important, some Americans often publicly dismiss the subject as something they cannot do, or they commonly ask, "When will I ever use this?" On the other hand, in a 2005 Harris Poll on Americans' attitudes, 93 percent of the respondents stated that the arts are critical for developing a well-rounded education, as noted by the American Alliance for Theatre and Education (n.d.). Students who learn about art in school are four times more likely to be honored for their academic achievement and three times more likely to be honored for attendance (National Endowment for the Arts 2014). Data from the Programme for International Student Assessment (PISA) (Organisation for Economic Cooperation and Development [OECD] 2011) also reveal that arts education programs are mandatory in countries that rank consistently among the highest for mathematics and science test scores, such as Japan, Hungary, and the Netherlands.

In another study of approximately 160 fourth and fifth graders, students were taught how to look closely at artwork and use reasoning to think about what they observed. The findings revealed that the students' ability to generate conclusions and inferences about the art transferred to their reasoning about images in other disciplines (Tishman, MacGillivray, and Palmer 2002).

Paul Cézanne (French, 1839–1906). *The Card Players* (*Les Joueurs de Cartes*), 1890–1892. Oil on canvas, 53 1/4 × 71 5/8 in. (135.3 × 181.9 cm). BF564. Photo © 2015 The Barnes Foundation

Just as in art, reasoning skills are crucial to success in mathematics, as described in both the Common Core's (CCSSI 2010) Standards for Mathematical Practice (SMP) 2: *Reason abstractly and quantitatively* and NCTM's *Principles to Actions* (2014) Mathematics Teaching Practice 2: *Implement tasks that promote reasoning and problem solving*. Additionally, art has been noted as an entry to mathematics and other STEM subjects for students who have not previously enjoyed or experienced success in the sciences (Bequette and Bequette 2012; Wynn and Harris 2012). Linking art with mathematics and other STEM subjects provides "creativity across disciplines [that] can be used as a way to engage students of all aptitudes and educators from problem-solving fields in the quest for innovation" (Wynn and Harris 2012, p. 47).

Artists have employed mathematics in composition. Even such painters as Paul Cézanne manipulated geometric shapes to create an illusion of three-dimensional space. Cézanne painted many versions of men playing cards, and his arrangement of the men around the table is geometric even if we do not see the lines of the triangle painted on the canvas. When geometric shapes are used

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How many people high are the trees in this painting?

Henri Rousseau (French, 1844–1910). *View of Montsouris Park, the Kiosk (Vue du Parc Montsouris, Le Kiosque)*, probably 1908–1910. Oil on canvas, 25 7/8 × 31 3/8 in. (65.7 × 79.7 cm). BF570. Photo © 2015 The Barnes Foundation

in paintings, they are often transformed: The back of the rectangular table is dilated to make the table appear as if it goes back into the space of the painting. Without the ability to transform geometric shapes, Cézanne's *The Card Players* might not look realistic. Composing a painting is just one example of how art provides real-world mathematical opportunities.

Classroom teachers can link art to the mathematics concept of sorting and classifying, a skill that will serve students well throughout their K–grade 12 mathematics career. Using a Venn diagram, K–grade 2 students can identify two basic attributes of a specific shape (e.g., four sides); then, given a variety of different shape cutouts, determine if each shape cutout meets one or both of those attributes and place the cutout in the appropriate place on the Venn diagram. An explicit connection to art can be made when students extend to categorizing different paintings in a gallery or collection of artwork into landscapes, portraits, and still lifes. In this case, a Venn diagram with three intersecting circles can be used so that students can place paintings with attributes of landscapes, portraits, or still lifes or a combination of these categories into the appropriate place on the Venn diagram. See the Barnes Foundation's collection at www.barnesfoundation.org/collections.

Art naturally links to mathematics in a variety of ways, including identifying patterns, building sense making, grasping a context, solving problems, using prior knowledge to inform how to approach novel problems, using symbols and shapes to communicate ideas, creating visual models and illustrations to support thinking, using tools to think about concepts, and a focus on hands-on learning experiences. Consider such activities as the following:

- Counting the number of flowers, trees, or people in a painting
- Using a still life to explore line symmetry of vases or fruit
- Using a landscape to explore measurement concepts, such as "the trees are as high as six people"
- Calculating the area of a painting or the perimeter needed to frame it

From the evidence above, we conclude that teaching mathematics as a vehicle for learning about art and teaching art as a vehicle for learning about mathematics make good sense. At a time when many districts and states are cutting art programs, classroom teachers can use the connections between art and mathematics to create meaningful mathematics learning experiences for their students through the context of art.

BIBLIOGRAPHY

American Alliance for Theatre and Education (n.d.). *The Effects of Theatre Education*. http://www.aate.com/?page=effects

Bequette James W., and Marjorie Bullitt Bequette. 2012. "A Place for ART and DESIGN Education in the STEM Conversation." *Art Education* 65 (2): 40–47.

Common Core State Standards Initiative (CCSSI). 2010. Common Core State Standards for Mathematics (CCSSM). Washington, DC: National Governors Association Center for Best Practices and the Council of Chief State School Officers. http://www.corestandards.org/wp-content/uploads/Math_Standards.pdf

Organisation for Economic Cooperation and Development (OECD). 2011. "Lessons from PISA for the United States, Strong Performers and Successful Reformers in Education." 2011. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264096660-en

National Council of Teachers of

Mathematics (NCTM). 2014. *Principles to Actions: Ensuring Mathematical Success for All.* Reston, VA: NCTM.

The National Endowment for the Arts, the National Endowment for the Humanities, and the Institute of Museum and Library Services. "Re-Investing in Arts Education: Winning America's Future Through Creative Schools." The President's Committee on the Arts and Humanities. Accessed Feb. 28, 2014. http://www.pcah.gov/publications

Tishman, Shari, Dorothy MacGillivray, and Patricia Palmer. 2002. "Investigating the Educational Impact and Potential of the Museum of Modern Art's Visual Thinking Curriculum: Final Report." In *Critical Links: Learning in the Arts and Student Achievement and Social Development*, edited by R. Deasy, Washington, DC: Arts Education Partnership.

Wynn, Toni, and Juliette Harris. 2012. "Toward a STEM + Arts Curriculum: Creating the Teacher Team." *Art Education* 65 (5): 42–47.

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A closer look at SMP 2: Reason abstractly and quantitatively

BY ROBYN SILBEY, PD AND CAMPUS CONSULTANT

The Common Core's Standards for Mathematical Practice (SMP) 2 states that mathematically proficient students "make sense of quantities and their relationships in problem situations" (CCSSI 2010). The standard invites students to create a coherent representation of the problem at hand, *decontextualize* it while solving, and *contextualize* it both during and after finding the solution.

In the elementary grades, students translate a problem situation into a number sentence, thus *decontextualizing*, or removing the context. After solving, they consider their solution in terms of the context of the problem. Let's look at two examples:

How many 6-pack cupcake boxes are needed to store 20 cupcakes?	Cameron has 20¢. How many 6¢ stickers can he buy?
Students decontextualize, creating the expression 20 ÷ 6 to represent the problem. The quantity of 20 represents the total number of cupcakes, whereas 6 represents the number of cupcakes that can be stored in each box.	Students decontextualize, creating the expression 20 ÷ 6 to represent the problem. The quantity 20 represents the amount of money Cameron has, whereas 6 represents the cost of a single sticker.
Students solve. The quotient is 3 R2.	Students solve. The quotient is 3 R2.
Students consider the solution within the context of the original problem. They are asked to find the number of 6-pack boxes, given 20 cupcakes to store. There will be 3 filled boxes with, 2 cupcakes remaining. A fourth box is required for the last two cupcakes.	Students consider the solution within the context of the original problem. They are asked to find the number of stickers that can be bought with 20¢. A purchase of 6 stickers costs 18¢, with 2¢ remaining. A sticker cannot be bought with 2¢, so only 3 stickers can be purchased.

Standard 2 calls for quantitative reasoning, which stipulates that students create a coherent representation of the problem at hand, consider the units involved, and attend to the meaning and relationship between quantities. This type of reasoning empowers students to look beyond the arithmetic to value the logic and sense making of mathematics.

Questions? Comments? Contact the author at **robyn@robynsilbey.com**.