Mathematics in Literature

Sally I. Lipsey and Bernard S. Pasternack

Understanding of major mathematical concepts may be motivated, explored, and enhanced through literary art. Literature stirs our imaginations and emotions, making ideas more enjoyable and memorable. It enlivens what many people see as the isolating abstractness of mathematics (cf. Midgley, 1-39). Literature also elicits expressions of feeling, increasing our insight about joys and frustrations in studying math. In an enrichment course that we gave in the spring, 2002, we used short stories, poems, and excerpts from novels as a springboard for discussion and study of mathematical concepts. The literature and discussions interested both those who already enjoyed mathematics and those who never had previously. Frucht describes how mathematics may be conveyed to the reader via literature: Reading Lewis Carroll as a child, "I had no idea that I was having my first encounter with a rigorously logical mind. Still, something of the obsessive mathematical edge to Carroll's thinking must have sunk in." (Frucht, xi.) Frucht believes that " ... using mathematics to tell stories and using stories to explain mathematics are two sides of the same coin. They join what should never have been separated: the scientist's and the artist's ways of uncovering truths about the world." (Frucht, xii)

Authors use math in stories, plays or poems in a variety of different ways. In producing their art, writers may (1) call on math to illuminate a theory (e.g., Dostoyevsky, and Tolstoy, and Austen); (2) be inspired by mathematical themes to create a work of art based on the themes (e.g., Doxiadis, Growney, Lem, Reese, and Upson); (3) poke fun at typical experiences in learning math or at mathematicians (e.g., Dodgson, Leacock and Russell); (4) want to produce an educational work(e.g., Enzensberger); or (5) want to write the imagined life of an intriguing mathematician (e.g., Petsinis). In our course, topics such as logic, geometry, measurement, number theory, statistic s, topology, set theory, and calculus arose naturally from the readings. In addition to discussing the general ideas of each assigned reading and the characters portrayed, we analyzed and developed the meaning of the mathematics that appeared, using mathematical materials correlated with the literature. There are many choices of literary art that serve the goals of integration well. Some examples follow.

The Symbolic Logic of Murder by John Reese "... adjusts Boolean algebra , of an admittedly elementary order, to the requirements of popular fiction." (Fadiman, *Fantasia ...,* 223.) The solution to the murder depends on facility with negations, unions and intersections! More subtly and with humor, Lewis Carroll (Charles Dodgson) creates many logical puzzles for us to savor; these are illuminated in detail in Martin Gardner's *Annotated Alice.*

In a moving story of a mathematical child-genius, *Young Archimedes*, Aldous Huxley=s young hero combines a loving proficiency in music with an extraordinary ability in math. As the story unfolds, we encounter both geometric and algebraic proofs of the Pythagorean theorem! No diagrams accompany these proofs - we make the drawings ourselves from the words of the story, check the steps of the proofs, and compare the two different techniques.

A female mathematical genius is portrayed in Mark Clifton's story, *Star, Bright*, which has two aspects, the problem of rearing a genius, and mathematical activities. Star, a three-year old child, invents a Moebius strip and also figures out a way to teleport herself into 4-dimensional space and to travel backwards and forwards in time. Other female geniuses have been subjects of two plays, *Arcadia* by Tom Stoppard, and *Proof* by David Auburn. Although the 19th century heroine (aged 13) of *Arcadia* fails to solve Fermat's Last Theorem, she does anticipate the 20th century topics of chaos and iteration. *Proof*, a play about genius and love, considers the probability that a young woman could have authored a path-breaking proof.

The Moebius strip is a popular focus of a number of stories. For instance, in the humorous story, *Paul Bunyan Versus the Conveyor Belt* (Upson, 33-35), uranium mine workers Paul Bunyan and Ford Fordsen use a 1 mile wide, 4 feet long, conveyor belt to transport the ore. The belt is a Moebius strip with one twist. Needing to lengthen the belt, they argue with Loud Mouth Johnson about the result of cutting it lengthwise down the middle. A need to lengthen the belt again later leads to a new argument.

The Law, by Robert Coates, focuses on insights into human behavior, and the important role of

statistics. It motivates discussion of the meaning of the familiarly cited "law of averages," the various types of averages, the normal curve, how these can be used properly, and what care must be taken in their interpretation. The story involves an unusual traffic jam, and assorted other events in which the law of averages no longer appears to operate. Congress has to take action, including a constitutional amendment. The congressional reform is effective, but a new problem arises: the law of diminishing returns needs refurbishing also.

During the 19th century, there was a period when Anon-Euclidean geometry was the talk of café society throughout Europe@ (Hoffman, 113), and an excerpt from *The Brothers Karamazov* shows Dostoyevsky=s use of the new mathematical ideas to illuminate his philosophy. In the excerpt, Ivan explains to his younger brother, Alyosha, that while he believes in God, he has difficulty believing in the world God created: Aan offensive comedy of human conflict@, and uses the following analogy: AEven if the parallel lines converge and I actually witness it, I shall witness it and say they have converged, but all the same I shall not accept it.@ (Dostoyevsky, 270-271.)

In *War and Peace,* another Russian novel of the same era, Tolstoy uses math to bolster his theory of history (see pp. 568-1145). Tolstoy's theory is that history needs to be analyzed mathematically and statistically: not as discrete incidents, but (in a reference to calculus) as a continual process, where causes are shown in a regressive process back infinitely far, a kind of infinite sum of infinitesimal quantities. He also uses *Achilles and the Tortoise* to show that history cannot be analyzed as a series of discrete vignettes. In addition, Tolstoy provides an example of the use of ratio and linear equations to clarify how the disadvantaged (such as the Russians) can win battles against more advantaged (such as the French) if they have enough spirit and energy. Ratio and proportion can be used to relate the power of an army to its spirit! Jane Austen is another author who uses ratio, but more subtly, and as an in-joke. The title of the novel, *Emma,* alludes to the ratio M/A, based on the 18th century philosophy of Francis Hutcheson, who believed that the ratio measured "virtue, " where A is perfect virtue and M is attained virtue. The heroine, Emma, clearly must improve, for her M < A. Perfection would be reached when M = A (Honan, 356).

"*A sense of wonder, even of awe,"* according to Huntley (87, his italics), "in the presence of the infinite, is one of the basic human emotions." Thus we can expect that many young and older adults will enjoy and learn from Stanislaw Lem's *The Extraordinary Hotel, or the Thousand and First Journey of Ion the Quiet*, in which an infinite number of rooms are rented. A single newcomer can be accommodated, as we all know, by placing this person in Room #1, and moving each present occupant of Room #N to Room # (N+1). But the story goes on to many other possible scenarios, illuminating beautifully many properties of infinite sets. For instance, to accommodate an infinite set of newcomers, a 1-1 correspondence is made between the set of positive integers and the set of all their doubles.

Many poems and limericks express appreciation, understanding, love, or fear of mathematics from a variety of different perspectives. Poems and limericks are often humorous. The content of a poem may relate to the subject matter, or the associated pedagogy; it may be about a mathematician, or a mathematician's life. For instance, JoAnne Growney's poem, "A Mathematician's Nightmare" (*My Dance* ..., 15), seems on the surface to be about decision-making in pricing and shopping, but it is an excellent depiction for a student or lay reader of the Collatz Conjecture, a famous unsolved problem. In a poem about Emmy Noether, called "My Dance is Mathematics," Growney asks "If a woman's dance / is mathematics, / must she dance alone?" (*My Dance* ..., 27.)

The relationship to mathematics is usually seen in the content of the poem, but may also be a matter of structure. Here is the beginning of Growney's poem "December and June" (*My Dance* ..., 13), which is mainly based on prime factorization (1, 2, 3, 2x2, ...):

cold
winds howl
geese go south
nights long tea steeps
...

A similar type of enrichment can be based on the visual arts. Math/art materials have been developed

under the auspices of the NSF (National Science Foundation) project, MTC (Mathematics Throughout the Curriculum). Participants in this project prepared materials to enliven more traditional class presentations, and some created full semester courses in Mathematics and Art (*Math and Art ...*, 5). More traditional sources include *Aesthetic Infinity* (Maor, Part III), which has an excellent section on the mathematical art of Maurits C. Escher); and Edward Rothstein=s *Emblems of the Mind: the Inner Life of Music and Mathematics.*

Ubiratan D'Ambrosio recommends and carries out activities involving literature, art, movies, and sports in courses for the preparation of math teachers at all levels.(D'Ambrosio, p. 46). Students of all ages can be motivated to write poems or short stories using a mathematical theme as a basis. Our course, Math in Literature, was given for members of the Institute for Retired Professionals at New School University. Literature with mathematical imagery exists for every level and age of student, and provides a way of adding new "excitement, adventure, erudition" to standard classroom procedures (White, vii).

BIBLIOGRAPHY

Auburn, David. *Proof: A Play.* London: Faber and Faber, 2001.
About love, genius, insanity, and whether an important proof could have been authored by a young woman.

Clifton, Mark. *Star, Bright*. In *Mathematical Magpie*. Compiled and edited by Clifton Fadiman. New York: Copernicus, 1997, p. 70-96.
About a three-year old, female, mathematical genius.

Coates, Robert M. *The Law.* In *Mathematical Magpie*. Compiled and edited by Clifton Fadiman. New York: Copernicus, 1997, p.15-19.
Fantasy about a seeming failure of the law of averages.

D'Ambrosio, Ubiratan. *Mathematics and Literature.* In *Essays in Humanistic Mathematics.* Edited by Alvin White. Washington, D.C.: Mathematical Association of America, 1993.
Essay on the value of connecting different types of subject matter.

Dodgson, Charles L. *The Annotated Alice*. Martin Gardner, ed. New York: Bramhall, 1960.
Mathematical allusions analyzed; explanations usefully placed in the margins.

Dostoyevsky, Fyodor. *The Brothers Karamazov.* Translated by David McDuff. Reprint. NY: Penguin Books, 1993.
Originally published in Russia in 1880.

Doxiadis, Apostolos. *Uncle Petros and Goldbach's Conjecture.* New York: Bloomsbury, 2000.
Novel about a search for a proof.

Enzenberger, Hans M., et al. *The Number Devil: A Mathematical Adventure.* NY: Metropolitan, 1998.
A novel woven about mathematical matters such as number theory, Fibonacci numbers and other enrichment topics. Suitable for all ages, 10 and above.

Fadiman, Clifton, ed. *Fantasia Mathematica.* New York: Copernicus, 1997. Originally published by Simon and Schuster, 1958.

----------. *Mathematical Magpie* . New York: Copernicus, 1997. Originally published by Simon and Schuster, 1962.
Two sets of stories and poems with mathematical content or imagery.

Frantz, Marc, ed. *Mathematics Throughout the Curriculum: Project Newsletter*. Bloomington, IN: Department of Mathematics, Indiana University, Spring, 2001. See also php.indiana.edu/~mathart/viewpoints, math.iupui.edu/mtc and MTC@indiana.edu.
Descriptions of experiments on integrating different types of subject matter.

Frucht, William, ed. *Imaginary Numbers: An Anthology of Marvelous Mathematical Stories, Diversions, Poems, and Musings.* New York: Wiley, 1999.

Growney, JoAnne. *My Dance is Mathematics.* Bloomsburg, PA: the author, 2001.

Growney, JoAnne, ed. "Numbers and Faces." *Humanistic Mathematics Network Journal*. Issue #24, June, 2001.
Poems with mathematical imagery.

Hoffman, Paul. *The Man who Loved only Numbers*. NY: Hyperion, 1998.
Biography of Erdos.

Honan, Park. *Jane Austen, Her Life.* New York: St. Martin's Press, 1987.

Huntley, H.E. *The Divine Proportion: A Study in Mathematical Beauty.* New York: Dover, 1970.

Huxley, Aldous. *Young Archimedes.* In *The World of Mathematics.* Edited by James R. Newman. Vol.IV, Part XXIII. New York: Simon and Schuster, 1956, pp. 2221 - 2249.
About the exploitation of a young mathematical and musical genius.

Leacock, Stephen. *A, B, and C - the Human Element in Mathematics*. In *Mathematical Magpie*. Compiled and edited by Clifton Fadiman. New York: Copernicus, 1997, p. 131-135.
A satire about verbal problems in traditional textbooks.

Lem, Stanislaw. *The Extraordinary Hotel, or the Thousand and First Journey of Ion the Quiet*. In *Imaginary Numbers: An Anthology of Marvelous Mathematical Stories, Diversions, Poems, and Musings*. Edited by William Frucht. New York: Wiley, 1999, p. 185-190.

Maor, Eli. *To Infinity and Beyond: A Cultural History of the Infinite*. Princeton, NJ: Princeton University Press, 1991.

Math and Art Combination is Contagious: Classroom Experiences Shared at Viewpoints 2000'. In *Mathematics Throughout the Curriculum: Project Newsletter*. Vol. 4, no. 2. Edited by Marc Frantz. Bloomington, IN: MTC Project, Department of Mathematics, Indiana University, p. 5.

Math Classroom Libraries. Collected by Attanasio and Associates, Middle Village, NY.
Suitable for grades Pre-K to 8, chosen for math content, cultural diversity, and interdisciplinary connection.

Midgley, Mary. *Science and Poetry*. London: Routledge, 2001.
Philosophy.

Newman, James R., ed. "Mathematics in Literature." In *The World of Mathematics*. Vol. IV, Part XXIII. Reprinted. New York: Dover, 2000, pp. 2214 - 2277. Originally published by Simon and Schuster, 1956.

Petsinis, Tom. *The French Mathematician*. New York: Berkley, 2000. Originally published by Penguin, 1997, and Walker, 1998.
Novel based on the life of Evariste Galois.

Plotz, Helen, compiler. *Imagination's Other Place: Poems of Science and Mathematics*. New York: Crowell, 1955.

Reese, John. *The Symbolic Logic of Murder*. In *Mathematical Magpie*. Compiled and edited by Clifton Fadiman. New York: Copernicus, 1997, p. 223-228.
Using Boolean algebra to solve a murder.

Robson, Ernest, and Jet Wimp, eds. *Against Infinity: An Anthology of Contemporary Mathematical Poetry*. Parker Ford, PA: Primary Press, 1979.

Rothstein, Edward. *Emblems of the Mind: the Inner Life of Music and Mathematics*. New York, Avon Books, 1995.

Rucker, Rudy. *Mathenauts: Tales of Mathematical Wonder*. 1987.

Russell, Bertrand. *The Mathematician=s Nightmare: the Vision of Professor Squarepunt*. In *Mathematical Magpie*. Compiled and edited by Clifton Fadiman. New York: Copernicus, 1997, p. 153-158.
A satire about verbal problems in traditional textbooks.

Schogt, Philbert. *The Wild Numbers*. New York: Four Walls Eight Windows, 2000.

Stoppard, *Arcadia*. London: Faber and Faber, 1996.
A play about a 13-year old female genius of the 19th century who anticipates such 20th century concepts as chaos and iteration. Has references to mathematics, science, history, literature, and love, and moves backward and forward in time.

Thiessen, Diane, Margaret Matthias, and Jacquelin Smith. *The Wonderful World of Mathematics: A Critically Annotated List of Children's Books in Mathematics*. 2nd ed. Reston, VA: National Council of Teachers of Mathematics, 1998.

Tolstoy, Leo. *War and Peace*. Translated by Constance Garnett. Reprint. New York: Modern Library, 1994. Originally published in Russia in 1869.

Upson, William H. *Paul Bunyan versus the Conveyor Belt*. In *Mathematical Magpie*. Compiled and edited by Clifton Fadiman. New York: Copernicus, 1997, p. 33-35.
An amusing story about the use of a moebius strip.

Verse and Universe: Poems about Science and Mathematics. Edited by Kurt Brown. Minneapolis, MN: Milkweed Editions, 1998.

White, Alvin, ed. *Essays in Humanistic Mathematics*. Washington, D.C.: Mathematical Association of America, 1993.

Sally I. Lipsey (sallyirene@worldnet.att.net)
Bernard S. Pasternack (pasternet@aol.com)