Integrating Mathematics of Worldwide Cultures into K-12 Instruction

NCSM Conference, Philadelphia, April 21, 2004

Terry Herrera
therrera@enc.org

Judy Spicer
jspicer@enc.org

A multicultural approach can benefit students by facilitating students'

- engagement in mathematics when they understand their mathematical roots
- respect for the cultures of others by understanding the development of mathematics and contributions from various peoples
- perception of relevance of mathematics by connecting mathematics to art, literature, technology, games, etc.

Every society has the need to

- **Count**

  African Number Words
  http://faculty.plattsburgh.edu/john.kellermeier/Ethnomath/Awords.htm
  A Mesoamerican Abacus
  http://www.geocities.com/a1ma_mia/abacus/
  Ishango Bone
  www.simonsingh.net\The_Ishango_Bone.html
  Introduction to the Abacus
  http://www.ee.ryerson.ca:8080/~elf/abacus/intro.html

- **Measure**

  Aztec Quahuitl
  http://www.mts.net/~lsisco/PAGE4.HTM
  Mozambican Techniques
  http://faculty.plattsburgh.edu/john.kellermeier/Ethnomath/mozambic.htm
  Time
  www.ancientegypt.co.uk/time/story/page4.html
  Part of the British Museum's Ancient Civilizations site
  www.thebritishmuseum.ac.uk\education\ancientcivilizations\index.html
  Egyptian Calendar System
  www.mnsu.edu\emuseum\prehistory\egypt\dailylife\calendar.html
  Sona Drawings
  www.everyschool.org\u\logan\culturalmath\networking.htm
  Inca Khipu
  http://www.ee.ryerson.ca:8080/~elf/abacus/inca-khipu.html

- **Design**

  Patterns with Beads
  www.cyffredin.co.uk\Beads on the web\Counting with Beads.htm
  Pre-Columbian pyramids
  www.ccd.rpi.edu\Eglash\csdt\latino\temple\noelle\specificexamples3d.htm
  The Square and the Roman House: Architecture and Decoration at Pompeii and Herculaneum
  www.leonet.it\culture\nexus\96\cwatts.html
  Geometry of Vedic Altars
  www.leonet.it\culture\nexus\96\joseph.html

- **Locate**
  Shipbuilding and Navigation http://india.coolatlanta.com/GreatPages/sudheer/ship.html
  Traditional Marshallese Stickchart Navigation www.marshall.csu.edu.au\html\essays\es-tmc-2.html

- **Play**
  Mancala
  http://www.germantownacademy.org/academics/us/math/geometry/stwk98/jenlr2/mancala.htm
  To-pe-di
  www.germantownacademy.org\academics\us\math\geometry\stwk98\JENLR2\topedi.htm
  Konane http://www.k12.hi.us/~gkaapuni/konane.htm

  Shax http://www.dm.unipi.it/~jama/ethno/shax.html

Selected Resources for Bringing in Math from Around the World

More information on these materials, selected from ENC's Collection, is available by going to this search page: http://www.enc.org/resources/search/advanced/?ls=ho and type in the entire ENC number given [for example: ENC-002345] in the first space; from the adjoining small menu, select ENC number. This is all! Submit the search and up will come a record for the resource, complete with a full description, price, contact information for the publisher, etc. ENC receives NO commission on any sales.

Math Lessons, Games, and Activities

The multicultural math classroom: bringing in the world ENC-008965 Grades 1-8. The multicultural lessons that comprise the main body of this text provide background information with references, suggestions for cooperative learning activities that encourage creativity and critical thinking, and advice on opportunities for open-ended, long range projects

Mathematics from Many Cultures. Level F ENC-011258 Grade 5. The brightly colored Big Book and teacher's guide reinforce mathematics concepts and help children see how these areas connect with a diversity of cultural backgrounds and experiences. In six investigations, students explore the works of art from India, Persia, China and Holland for symmetry, tessellations and transformations, examine number triangles, and investigate the development and use of measuring systems from cubit to meter. They also examine the never ending networks drawn by the Bushoong and Tamil people, investigate number systems with bases other than ten, and explore the game Alquerque from Spain. [Also available for Grades K-4]

More Math Games and Activities From Around the World ENC-027713 Grades 4-10. More than 60 games are drawn from many different cultures across the world, and each is described in the context of the culture where it was developed. The games involve math concepts such as geometry, arithmetic, and spatial relationships. Extensions ask students to think critically about the game and how it is played or about specific strategies that could be used. Also **Math Games and Activities From Around the World** ENC-015196 for grades 2-7.

Math Around the World: Teacher's Guide ENC-006462 Grades 4-8. Developed by the Lawrence Hall of Science, this guide provides instructions, designs, activities, background

information, built-in assessment strategies, and literature connections for nine mathematically educational games played throughout history across many continents. Activities that build on students' game playing experiences help students develop and analyze mathematical concepts related to game theory**,** logic, probability, mental math, network and graph theory, and pattern recognition among others.

Math and science across cultures: activities and investigations from the Exploratorium This book for grades 4-12 contains lesson plans for 14 different activities which investigate math and science principles as they are used in cultures all over the world. Each multi day activity features a hands-on component that allows students to investigate or apply concepts they are learning.

Multicultural Mathematics Materials ENC-020913 Grades 1–8. This book of activities and games from different parts of the world is designed to bring ethnic and culturally diverse approaches into the mathematics curriculum. Lesson plans, background information, and blackline masters are provided. The materials are classified by geographic region. Of note is a special section devoted to the Hopi Indians of northeastern Arizona.

Native American Geometry http://www.earthmeasure.com/ ENC-013761. Intricate and colorful designs from various Native American nations are used to describe this physical, proportional geometry that originates form the simple circle. The fundamentals of compass and straightedge constructions are included, along with instructions and templates for the creation of geometric designs.

William's Home Page http://www.cyffredin.co.uk/ ENC-29244 Grades 3-10. This Internet site contains instructions for a variety of hands-on geometry activities that use simple materials and are designed to enrich the mathematical learning of patterns and shapes. Many of the activities are multicultural and based on mathematics obtained from such places as India, Sierra Leone, and Sri Lanka.

Teaching mathematics in the multicultural classroom: a resource for teachers and teacher educators ENC-005893 Grades 1-8. This collection of resource materials is meant to assist teachers, teacher educators, and leaders of inservice education courses to take into account cultural and linguistic factors in the learning and teaching of mathematics.

Multiculturalism in mathematics, science, and technology: readings and activities ENC-001354 Grades 8-11. These mathematics and science materials aim to help fulfill the vision of a global, multicultural education; to increase the mutual respect, pride, and understanding that come from the knowledge that all cultures have contributed to mathematics and science; and to provide materials that help teachers integrate mathematics and science.

Symmetry and Pattern: The Art of Oriental Rugs http://mathforum.org/geometry/rugs/ This overview of the patterns and symmetries found in Oriental design carpets includes a gallery of carpet designs and classroom activities on analyzing the types of symmetry.

Culturally Situated Design Tools http://www.rpi.edu/~eglash/csdt.html This site features culturally related tools that are based on mathematical principles. The software can help students apply standards-based mathematics as they simulate the original artifacts, and develop their own creations.

Historical Mathematical Contributions of Various Cultures

Math through the Ages: A Gentle History for Teachers and Others ENC-029507. The first part of this book offers a general overview of math history, including the early roots of mathematics in India, Egypt, and Greece and the development of Western mathematics in medieval and modern times. Later chapters describe how specific topics of mathematics evolved over time and around the world. These chapters include question and projects for students

The history of counting ENC-019678 Grades 5-10. This book gives a detailed history of counting with respect to time and culture. It makes the point that counting had to be invented and developed from one-to-one relationships to concrete counting and, finally, to abstract numbers.

Egyptian Numerals http://www.saxakali.com/COLOR_ASP/historymaf5.htm Illustrations plus simple operations using these numerals.

The Quipucamayu: the Keeper of the Quipus
http://www.spanish.sbc.edu/MMLatAm/Quipus.html Some history of the use and making of the Incas' recordkeeping system.

Mayan Numerals http://www.saxakali.com/historymam2.htm This site illustrates and explains the base-20 system of the Mayans.

The librarian who measured the Earth ENC-015932 Grades K-6. This picture book portrays the life of Eratosthenes, a man who found a way to calculate the circumference of the earth. Living in ancient Greece over 2000 years ago, he sought that measurement to include in GEOGRAPHICA, the first geography book of the world.

- **The Noon-Day Project**: **Measuring the Circumference of the Earth**
  http://www.k12science.org/noonday/ ENC-018207. This site presents all the necessary mathematics and science information to enable teachers of grades 5-12 to recreate the measurement of the circumference of the earth as done by Eratosthenes. Shadow measurements taken at high noon local time on a designated day in March are posted online and used to make the calculation.

Hypathia's Heritage: A History of Women in Science from Antiquity through the Nineteenth Century ENC-029356 Grades 9-post-secondary. Organized chronologically, the book portrays the accomplishments of women scientists in the fields of science and mathematics from prehistory through the nineteenth century.

The making of mathematics: a friendly history Grades 9-12 ENC-004118. This book is meant to show the fascinating account of how mathematics came to be. It focuses on people and personalities, discoveries and struggles, and the development of ideas.

Mathematics! Early History ENC-018315. This videotape, part of the PROJECT MATHEMATICS! series, presents an overview of the history of mathematics from 5000 B.C., when calendar makers calculated the onset of the seasons, up the development of calculus in the seventeenth century. Topics include how number systems developed in different cultures, what led the Pythagoreans to number theory studies, and how astronomy gave birth to trigonometry. The videotape series uses computer animation featuring color, motion, and three-dimensional images to demonstrate mathematics concepts.

Multicultural classroom posters ENC-005752. These posters offer a brief illustrated history of the development mathematics. Descriptions of how mathematics concepts were initiated and

integrated into daily life is conveyed through pictures and short articles. Examples include Navajo Native Americans integrating math into rug patterns; Europeans displaying math in Gothic cathedrals with mathematical inscriptions on stained class windows and applying math concepts to building; Japanese demonstrating arithmetic speed calculations; Africans describing the use of weights to measure gold; Chinese illustrating the decimal system; mathematicians from India discussing number theory; and Arabians using decimal fractions.

Children's Literature

The Token Gift ENC-017323 and **The King's Chessboard** ENC-028558 are two versions of the Indian story of grains of rice on a chessboard, 1 in the first square, 2 in the second, 4 in the fourth, etc.

The librarian who measured the Earth ENC-015932 Grades K-6. This picture book portrays the life of Eratosthenes, a man who found a way to calculate the circumference of the earth. Living in ancient Greece over 2000 years ago, he sought that measurement to include in GEOGRAPHICA, the first geography book of the world.

My Numbers = Mis Numeros ENC-020322 Grades preK-1. This full-color illustrated book is written to introduce children to numbers in English and Spanish. The book consists of ten double-page spreads each illustrating a number between 1 and 10.

Count on your fingers African style ENC-019472 Grades K-3. This illustrated children's book acquaints readers with the different ways that counting, or indicating, small numbers takes place in African countries.

Count on Pablo ENC-019301 Grades K-2. In this illustrated storybook, designed to give students practice in counting, Pablo goes to work at the market with his grandmother. There he counts the produce by twos, fives, and tens.

The history of counting ENC-019678 Grades 5-10. This book gives a detailed history of counting with respect to time and culture. It makes the point that counting had to be invented and developed from one-to-one relationships to concrete counting and, finally, to abstract numbers.

Emeka's gift: an African counting story ENC-019358 Grades pre-K-2. This picture book introduces counting numbers through the story of a child in a Nigerian village.

Fun with 9umbers ENC-006221 Grades 1-4. This book combines descriptive illustrations and facts about the different ways we count, measure, write out numbers, and solve number problems. Historical facts about mathematics and the contributions different groups of people have made to the area of mathematics are used throughout the text.

Senefer: a young genius in old Egypt ENC-019127 Grades 3-6. This illustrated children's story book is intended to increase multicultural awareness of the history of mathematics. It tells the story of Senefer, a nine-year-old boy, who grows up to be a mathematician.

What are you figuring now?: a story about Benjamin Banneker ENC-014464 Grades 3-6. This book is a biography of Benjamin Banneker, an African American farmer and self-taught mathematician and astronomer who lived around the Revolutionary War. Banneker served his country as the surveyor for the new capital city of the United States in 1791 and also calculated a successful almanac that was noted for its precision.

The Tortoise Who Bragged: A Chinese Tale with Tangrams ENC-018529 Grades 2-4. A Chinese folktale about how a tortoise and his egret friends search for a new home during a drought. Students work with triangles to build ideas of symmetry and spatial awareness.

Background Reading

Series from NCTM
Changing the Faces of Mathematics:

Asian Americans and Pacific Islanders ENC-016863
Perspectives on indigenous people of North America ENC-029158
Perspectives on African Americans ENC-017142
Perspectives on Latinos ENC-014850

Ethnomathematics Digital Library http://www.ethnomath.org/ There are over 500 items in this collection, which is regularly adding new materials, particularly those relevant to the Pacific region. Users may browse the items by subject, geographical area, and cultural group.

Africa Counts: Number and Pattern in African Cultures ENC-015135 This classic describes the contribution of African culture to the science of mathematics. Using numbers and patterns as organizing principles, the author describes African numeration systems, use of geometry in art and architecture, and mathematical games, all of which reveal a well-developed understanding of mathematics. Additional topics include time, weights and measures, counting, and cultural beliefs about specific numbers.

Mathematics elsewhere: an exploration of ideas across cultures ENC-028311 Grades 12-Post-Sec. This book, written for a general audience, presents mathematical ideas of people from a variety of small-scale and traditional cultures in an attempt to humanize our view of mathematics and expand traditional conceptions of what is mathematical. The book uses examples of how particular societies structure time, reach decisions about the future, make models and maps, systematize relationships, and create intriguing figures to demonstrate that traditional cultures have mathematical ideas that are far more substantial and sophisticated than is generally acknowledged. The ideas discussed in the book come from geographically varied cultures, including the Borana and Malagasy of Africa, the Tongans and Marshall Islanders of Oceania, the Tamil of South India, the Basques of Western Europe, and the Balinese and Kodi of Indonesia

Math and Science Through the Eyes of Culture ENC-021055 This videotape with instructional guide demonstrates how the roots of mathematics and science can be found in cultures from around the world. It features three university professors who explain how they use the interdisciplinary links between culture and mathematics or science in their research and teaching. The video describes the value of origami to mathematics and art, the traditional and nontraditional uses of rain forest plants for healing, and how a source of fractal patterns can be found in artifacts of African cultures.

International Study Group on Ethnomathematics (ISGEm)
http://www.rpi.edu/~eglash/isgem.htm
ENC-012550 This website provides information about the International Study Group on Ethnomathematics (ISGEm), an affiliate of the National Council of Teachers of Mathematics (NCTM) dedicated to the study of mathematical practices of identifiable cultural groups.

Mathematical practices include the formal symbolic systems, spatial designs, practical construction techniques, ways of reasoning, and other cognitive and material activities.