

Integrating Mathematics of Worldwide Cultures into K-12 Instruction

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Presentation by Terry Herrera and Judy Spicer

Contact: web@ohiorc.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 the relevance of mathematics by connecting mathematics to aspects of daily life in present and ancient cultures through art, literature, recreation, technology, games, etc.

Every society has the need to

Count

- African Number Words Based upon the Human Body
<http://www.tacomacc.edu/home/jkellermeier/Ethnomath/Africanwords.htm>
- Nepohualtzitzin: A Mesoamerican Abacus http://geocities.ws/a1ma_mia/abacus/index.html
- The Ishango Bone
http://www.naturalsciences.be/expo/old_ishango/en/ishango/introduction.html
- A Brief Introduction to the Abacus <http://www.ee.ryerson.ca:8080/~elf/abacus/intro.html>
- Maya Mathematics <http://www.michiellb.nl/maya/math.html>

Measure

- Aztec Numerical Glyphs
<http://www.math.temple.edu/~zit/Native%20American/9%20Aztecs.pdf> for background about the quahuitl, the Aztec standard unit of linear measure
- Aztec Area Measurement <http://ohiorc.org/r/7TN4T> for an activity related to from the *Geometry Activities from Many Cultures* by Beatrice Lumpkin
- Mozambican Techniques for Laying Out a Rectangle
<http://www.tacomacc.edu/home/jkellermeier/Ethnomath/mozambic.htm>
- Time Story <http://www.ancientegypt.co.uk/time/story/main.html> which is part of the British Museum's Ancient Egypt exhibit <http://www.ancientegypt.co.uk/menu.html>
- The Mayan Calendar <http://www.webexhibits.org/calendars/calendar-mayan.html>
- Egyptian Calendar http://www.ortelius.de/kalender/egypt_en.php
- Inca Khipu <http://www.ee.ryerson.ca:8080/~elf/abacus/inca-khipu.html> and http://www.britishmuseum.org/explore/highlights/highlight_objects/aoa/i/inca_cotton_khipu.a_spx
- The Quipu <http://www.alexwright.org/blog/archives/001088.html>

Design

- Patterns with Beads (South Africa)
<http://www.cyffredin.co.uk/Beads%20on%20the%20web/Counting%20with%20Beads.htm>
- Pre-Columbian Pyramids <http://csdt.rpi.edu/latino/pyramids/index.html>
- The Square and the Roman House: Architecture and Decoration at Pompeii and Herculaneum
<http://www.nexusjournal.com/the-nexus-conferences/nexus-1996/104-n1996-carol-watts.html>
- *vedi*: Vedic Altars <http://ccat.sas.upenn.edu/george/vedi.html>
- Sona Sand Drawings
<http://academic.evergreen.edu/curricular/Patterns/Assignments/SonaSandDrawings2.htm>
- Sand Drawings and Mirror Curves
http://www.sciencenews.org/view/generic/id/2005/title/Math_Trek_Sand_Drawings_and_Mirror_Curves
- Dramis (Bhutan) <http://www.cyffredin.co.uk/Multicultural/Drami/Drami.htm>
- Working with Rangavalli Patterns (India)
<http://www.cyffredin.co.uk/Multicultural/Rangavalli/Working%20with%20Patterns%20Rangavalli.htm>

Locate

- Secrets of Ancient Navigation <http://www.pbs.org/wgbh/nova/longitude/secrets.html>
- Compass (China) <http://kaleidoscope.cultural-china.com/en/136Kaleidoscope2.html>
- What is a Map? <http://www.press.uchicago.edu/books/akerman/>
- Astronomy and Navigation in Polynesia and Micronesia
<http://www.ethnomath.org/resources/akerblom1968.pdf>
- Marshall Islands Stick Chart <http://www.ethnomath.org/resources/bryan1938.pdf>
- Marshall Islands Stick Chart
http://www.museumstuff.com/learn/topics/Marshall_Islands_stick_chart
- Micronesian Stick Charts http://www.janesoceania.com/micronesian_stick_chart/
- Lost Knowledge: Stick Chart Navigation
<http://blog.makezine.com/archive/2009/07/lost-knowledge-stick-chart-navigati.html#>
- Navigational Chart (*Rebbilib*) <http://www.metmuseum.org/toah/works-of-art/1978.412.826>
Rebbilib is a name for a type of stick navigational chart.

Play

- Math Games: Butterfly (Nigeria), Dara (Nigeria), Igba-Ita (Nigeria) and Tsoro Yematatu (Zimbabwe) <http://www.behindtheglass.org/africaresources/mathgames.asp>
- Konane (Hawaii) <http://www.k12.hi.us/~gkaapuni/konane.htm>
- Mancala (Africa and Asia) <http://www.coolmath-games.com/0-mancala/index.html>
- Pachisi (India) <http://www.tradgames.org.uk/games/Pachisi.htm>
- Shax (Somalia) <http://www.dm.unipi.it/~jama/ethno/shax.html>

Resources for Integrating Mathematics of Worldwide Cultures into K-12 Instruction

Online Math Lessons, Games, and Activities

- Native American Geometry <http://www.earthmeasure.com/native-american-geometry.html>
Intricate and colorful designs from various Native American nations are used to describe this physical, proportional geometry that originates from the simple circle. The fundamentals of compass and straightedge constructions are included, along with instructions and templates for the creation of geometric designs.
- 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/csd.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.
- William's Home Page <http://www.cyffredin.co.uk/> This web 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.
- The Noon-Day Project: Measuring the Circumference of the Earth <http://www.ciese.org/curriculum/noonday/index.html> 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.
- *More Math Games and Activities From Around the World* by Claudia Zaslavsky <http://www.ethnomath.org/resources/zaslavsky2003.pdf> 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.
- Lessons created by Peace Corps Volunteers for students in grades 6-8.
 - Giving Students a Little Latitude <http://www.peacecorps.gov/www/educators/lessonplans/lesson.cfm?lpid=327> Students will use a world outline map to locate places using coordinates of latitude and longitude.
 - Where in the World is...? <http://www.peacecorps.gov/www/educators/lessonplans/lesson.cfm?lpid=324> Students will

- use latitude and longitude and learn the locations of 11 countries where Peace Corps Volunteers are serving.
- Sea Turtle Math
<http://www.peacecorps.gov/www/educators/lessonplans/lesson.cfm?lpid=2301&rid=asiapi>
Students are introduced to real-world conservation of sea turtles in Asia and the Pacific Islands.

In-Print Math Lessons, Games, and Activities

- *The Multicultural Math Classroom: Bringing in the World* by Claudia Zaslavsky
This book features multicultural lessons for grades 1-8 along with background information, references, and suggestions for cooperative learning activities that encourage creativity and critical thinking, and advice on opportunities for open-ended, long range projects.
- *Multicultural Mathematics Materials* by Marina C. Krause
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.
- *Multiculturalism in Mathematics, Science, and Technology: Readings and Activities* by Thom Alcoze and Miriam Barrios-Chacon
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.

Children's Literature

- *The Token Gift* by Hugh William McKibbin and *The King's Chessboard* by David Birch 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* by Kathryn Lasky
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.
- *Count on Your Fingers African Style* by Claudia Zaslavsky
This illustrated children's book acquaints readers with the different ways that counting, or indicating, small numbers takes place in African countries.
- *The History of Counting* by Denise Schmandt-Besserat
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* by Ifeoma Onyefulu
This picture book introduces counting numbers through the story of a child in a Nigerian village.
- *Senefer: A Young Genius in Old Egypt* by Beatrice Lumpkin
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* by Jeri Ferris
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 Trigrams* by Betsy Franco
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 Information for Teachers

- Ethnomathematics Digital Library (EDL) <http://www.ethnomath.org/>
This site features a collection of over 700 items. Users may browse the items by subject, geographical area, and cultural group.
- In 1993, NCTM created a six-volume series titled *Changing the Faces of Mathematics*. Volumes include *Perspective on African Americans*, *Perspectives on Asian Americans and Pacific Islanders*, *Perspectives on Indigenous People of North America*, and *Perspectives on Latinos*.
- *World Cultures in the Mathematics Class* by Claudia Zaslavsky
<http://www.jstor.org/stable/40248015>
- NASGEm North American Study Group on Ethnomathematics <http://nasgem.rpi.edu/> contains a broad description of ethnomathematics as the study of mathematical practices of identifiable cultural groups. These mathematical practices include the formal symbolic systems, spatial designs, practical construction techniques, ways of reasoning, and other cognitive and material activities which can be translated to formal mathematical representation. The page provides links to ethnomathematics-related web sites and to the *Journal of Mathematics and Culture*.
- *Math and Science Through the Eyes of Culture*
This videotape, available through the Great Plains National Instructional Library <http://gpn.unl.edu/>, illustrates 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.

- *The History of Counting* by Denise Schmandt-Besserat
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.
- *Math through the Ages: A Gentle History for Teachers and Others* by William P. Berlinghoff and Fernando Q. Gouvea
The first part of this book offers a general overview of mathematical 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 questions and projects for students.
- Mathematics! Early History <http://www.projectmathematics.com/index.html>
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.
- *Episodes from the Early History of Mathematics, Volume 13* by Asger Aaboe
<http://books.google.com/books?hl=en&lr=&id=5wGzF0wPFYgC&oi=fnd&pg=PA1&dq=Mathematics!+Early+History&ots=WM8iM7XaA6&sig=2o3n0aEytfol6WLdri3l3a0qvf4#v=onepage&q&f=false>
- African Fractals: Modern Computing and Indigenous Design
<http://www.math.buffalo.edu/mad/special/eglash.african.fractals.html>
- On the History of Mathematics in Africa South of the Sahara AMUCHMA-NEWSLETTER-9
http://www.math.buffalo.edu/mad/AMU/amu_chma_09.html#2 by Paulus Gerdes
- Quipu: a Modern Mystery <http://www.sfu.ca/archaeology/museum/laarch/inca/quipue.html>
This site provides images of the few remaining historical quipu and offers insight into their creation and function.
- *Hypathia's Heritage: A History of Women in Science from Antiquity through the Nineteenth Century* by Margaret Alic
Organized chronologically, the book portrays the accomplishments of women scientists in the fields of science and mathematics from prehistory through the nineteenth century.
- *Africa Counts: Number and Pattern in African Cultures* by Claudia Zaslavsky
This book describes the contribution of Saharan 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* by Marcia Ascher

This 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. It 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 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 .