ETHNOMATHEMATICS
IN GLOBAL EDUCATION PROGRAMS

Third International Congress of Ethnomathematics (ICEM-3)
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Full text, references, and links at:
http://www.towson.edu/~shirley/global.htm

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Extended Abstract

Many schools are recognizing the need for students to gain a broader world view, especially in the post-9/11 setting. There is concern about citizens' narrow view of the world, often lacking basic geographic knowledge such as locations of countries, and even less likely to know about cultures and societies. It is argued that much more global education needs to be included in school curricula. Whether it is one unit in one class or the overall mission of the school, it brings the world into the classroom. Often, it also takes the classroom out into the world.

Although schools often start global education with social studies, the arts, and literature, educators later realize that the sciences and mathematics also link to the world. This is where ethnomathematics can play an important role. Given standardized requirements in mathematics content, certain mathematical concepts and skills must be covered, but often even these can be treated from the point of view of mathematics from around the world and from the structures of world cultures. Examples and implications will be discussed.

Abstract in Spanish

Muchas escuelas reconocen la necesidad de que los estudiantes ganen una visión del mundo más amplia, sobre todo en el ambiente post-9/11. Hay preocupación por la visión estrecha del mundo que tienen los ciudadanos, con falta, a menudo del conocimiento geográfico básico como, por ejemplo, dónde se sitúan los varios países, y aún menos probable el conocimiento de las culturas y de las sociedades. Se dice que hay que incluir una educación mucho más global en los planes de los estudios escolares. Si es una unidad en una clase o la misión global de la escuela entera , así entra el mundo al aula. A menudo, también lleva el aula al mundo.

Aunque a menudo las escuelas comiezan la educación global con los estudios sociales, las artes, y la literatura, después los educadores se dan cuenta de que las ciencias y las matemáticas también unen el mundo. Es aquí donde las etnomatemáticas pueden desempeñar un papel importante. Dado ciertas exigencias estandarizadas en el contenido de las matemáticas y que hay que enseñar ciertos conceptos y las habilidades relevantes a las matemáticas, aun así hasta éstos pueden ser tratados desde el punto de vista de las matemáticas de alrededor del mundo y desde las estructuras de las culturas mundiales. Se presentarán y se discutirán ejemplos e implicaciones.

ETHNOMATHEMATICS IN GLOBAL EDUCATION PROGRAMS

Many American schools, public and private, at all levels of K-12 education, are recognizing the need for students to gain a broader world view. Students in America need to understand that their hometown and even the entire United States are not the center of the universe. The United States is indeed large in many ways. It has a vast area in which nearly all speak the same English language, go to schools with similar curricula, live under the same governmental structures, and shop in the same integrated economy. It gives one the impression of being a single entity in the universe and discourages students from recognizing or learning about the world "out there."

After the attacks of September 11, 2001, on New York and Washington, many Americans asked "Why?" but in fact, however horrible the attacks were, they represented in some sense, the resentment much of the world has for America and its closed-minded, narrow view of the rest of the world. Many Americans pay little attention to the world beyond its borders (or even beyond their own town or state!). They are not likely to be aware of other areas and their histories, languages, cultures, or societal concerns. Hence, they can become callous of world issues and problems.

The lack of global understanding is not only a matter of attitude. It already may be an economic issue. The rapid spread of computer and information technology around the world, coupled with new ease of communication through cell phones and information exchange through the Internet have all combined to take many businesses and other economic activities far from their Western origins. Places such as South Korea, Singapore, South Africa, and especially China and India are new centers of intellectual industry and new "Silicon Valleys." Friedman (2005) describes this great leveling of the playing field as a flattening of the earth, opening up new opportunities around the world and new competitors for technical achievement. If Westerners hope to stay in the competition, they must understand their competitors.

Global Education

However, the September 11 attacks and reports of new globalization of technology have also led to calls from educators to fight this parochialism by putting more of the world into school curricula. It is hoped that the next generation, familiar with easy, inexpensive, and instantaneous communication across vast distances with cell-phones and the Internet, should be more ready to recognize the rest of the world, if only they have the opportunity to experience it. However, in the crowded curricula of most schools, suggestions for additional content are not accepted or are difficult to implement. Specific courses on global issues may not squeeze into overflowing schedules, but sometimes global issues can be inserted into "regular" classes.

A growing number of schools across the United States are attempting to put a school-wide focus on global education. Some of these schools are private with large populations of foreign students, such as schools in Washington DC that cater to children of diplomats and embassy staff members and, generally, to the large international population of Washington. Others are associated with universities, which also often have concentrations of international students. However, many are ordinary middle-American public schools with a core of concerned teachers who see the need for the global approach for ordinary middle-American children. Sometimes the school offers a program leading to the International Baccalaureate examinations or other internationally accepted credentials, but more often the school maintains its normal mandated assessment program but includes international content wherever possible.

Some of these schools have joined into a national organization, the International Studies Schools Association (ISSA) (http://www.du.edu/issa/), administered by Center for Teaching International Relations (CTIR) in the Graduate School of International Studies at the University of Denver, in Colorado. The ISSA offers schools resources, mostly available on-line. The website has many lesson plans, for all grade levels, on topics such as cultural studies, economics and trade, geography, history, government and politics, and human rights. There are also links to publications and curriculum units, special guides for foreign language teachers, and links to other organizations and foundations which can provide further resources. Through the CTIR, teachers can take in-service courses and obtain graduate credit. Every year ISSA holds a national conference, with educators, government and NGO officers, environmentalists, and others, speaking to teachers with more ideas and encouragement for global education.

The National Peace Corps Association (NPCA) (http://www.rpcv.org) is the "alumni" group of returned Peace Corps Volunteers. This group is separate and independent from the actual Peace Corps, but a key part of its mission is to help implement the "Third Goal" of Peace Corps, which is "to educate the people of the U.S. about the peoples of other countries and cultures", using the experience of the returned Volunteers. A branch of the NPCA that is especially directed toward schools is the Global TeachNet (http://www.globalteachnet.org). Global TeachNet collaborates with other organizations (e.g. Population Reference Bureau, Save the Children, the Association of Supervision and Curriculum Development, and others). They offer many resources: a newsletter of lesson ideas and references, a monthly magazine with news and commentary about the developing world, website resources and online lesson plans, a variety of publications, professional development workshops, and organized trips and travel awards for teachers. Also, through the Peace Corps' Coverdell World Wise Schools, there are opportunities for schools and children to link to schools around the world, including pen-pal arrangements, links to Peace Corps Volunteers at their sites, email exchanges, and Internet connections.

These are only a sample of organizational efforts to link American schools to the world. Whether it is just one unit in one class, a school-wide mission, or a national organization,

this brings the world into the classroom. Often, with letters, emails, or even travel, it also brings the children of American classrooms out into the world.

Mathematics?

Though these efforts are laudable, a careful reader may have noticed that, until now, the word "mathematics" has not yet appeared in this text. Usually, as schools begin to emphasize global education, the subject area of mathematics does not come to mind. Usually, the globalization campaign in a school is led by teachers of geography, followed by faculty in history, and then art, music, and literature. Geography has a natural jurisdiction of covering the world, history can reach out from Western history, and similarly, literature and the arts can find creative examples from around the world.

In early attempts to make a school program more global, environmental education is often the first area, outside of social studies, literature, and the arts, to take a world view. Global warming, air and water pollution, and industrial degradation of the environment are not limited to any one country and usually require not only a global viewpoint, but also a sense of the need for international cooperation. Environmental studies open the global curriculum to the sciences and offer topics for biology, such as biological diversity, endangered species, and health issues from pollution. Chemistry can pick up with issues of pollution on a world scale, and physics and earth sciences may study the ozone hole, ocean levels, and CO_2 emissions.

The general public and many educators still look at mathematics as unique and universal. The common notion would be expressed in the Platonist philosophical stance that mathematics is the same throughout the universe. Two plus three always equals five, from the gathering of five dinosaurs beside a Jurassic pond to five inhabitants of a planet in the distant Andromeda Galaxy. The universality of *pi* was a key element in the plot of Carl Sagan's novel, *Contact*, as humans encountered signals from an alien civilization. Even a bird recognizes Euclid's postulate that a straight line is the shortest path between two points. If mathematics is universal, the logical follow-up is that mathematics is culture-free. Hence, global mathematics is the same as mathematics.

But, mathematics is not universal, nor is it culture-free. Hersh (1997) notes that even if a sum remains the same, the interpretation of the result of a calculation can vary considerably. An equation is a matter of notation—even great mathematicians have used different notations and obtained different interpretations of the same mathematical statement. Hersh points out that "If there's intelligent life on Quasar X9, it may be blobs of plasma we can't recognize as life. What would it mean to talk about their literature, art, or mathematics? To ask if their mathematics is the same as ours requires a possibility of comparing. Comparing demands communication."(p. 38).

We do not have to go so far in time or place as the dinosaurs or extra-terrestrial civilizations. Even as Ascher (1991, 2002) reports that Western-trained mathematicians may not recognize activities from non-Western cultures as mathematics, she shows there is considerable mathematical thought taking place in those activities. Mathematical

procedures, patterns, and structures are developed by human beings, living and working in societies. Dehaene, *et al.* (2006) reports finding fundamental geometrical knowledge among the Mundurukú people in the Amazon, people without mathematical contacts to the rest of the world. This has caused some pro and con discussion in ethnomathematical circles, but it does demonstrate the basic sense of geometry understanding, upon which cultures can build in many directions. In an earlier work, Bishop (1988) specifies six activities of all societies, throughout history and around the world, that lead to mathematical thinking: counting, measuring, locating, designing, explaining, and playing. More deeply, D'Ambrosio's (1995) breakdown of the word "mathematics" shows it to be the art or technique of knowing. Most techniques of knowing will not look at all like Euclid's geometry, Hindu-Arabic arithmetic, Viète's algebra, nor Leibniz's calculus. But they will show intricate patterns, beautiful symmetries, organized structures, and careful strategies. They will be mathematical.

This is the ethnomathematical argument that mathematics also requires a global presentation. The knowledge of Western mathematics is a useful tool for doing jobs and even creative thought, but it is limited and limiting. Looking at mathematics from cultures from around the world does more than teaching students about the world. It also teaches them about mathematics—in ways they would never see in the traditional Western curriculum.

Now the advocates of global education have realized that mathematics needs to be included. In recent years, mathematics educators, ethnomathematicians, and historians of mathematics have led workshops for Global TeachNet and presented sessions for the International Studies Schools conferences. Local workshops on global education have also invited mathematics teachers and speakers on ethnomathematics.

The implementation questions remains: What can ethnomathematicians tell global educators? How can ethnomathematics be used to further the goals of both global education and mathematics education?

Using Ethnomathematics

Just as there are several kinds of ethnomathematical research, there are several ways that ethnomathematics can contribute to a global education course or program. Ethnomathematics can play an important role for the students, but also can enlighten teachers, parents, and school administrators. One big obstacle that must be overcome is that nearly every school is bound by a certain system of assessment with an official syllabus of topics to by "covered", and, usually, a standardized or required examination structure. Anything that seems to deviate from the approved curriculum may appear superfluous, time-wasting, or even counter-productive in terms of achieving good test scores and good reports. Hence, any use of ethnomathematics at the very least needs to be justified as valuable enrichment to broaden the student learning experience. However, in many cases, ethnomathematics can be inserted into the standard content as examples, exercises, or clarifications. Sometimes, the innovative view of mathematics from ethnomathematical examples can even improve the "coverage" of the standard topics. In

any case, the teacher who uses ethnomathematics needs to be prepared to defend the use of this content against challenges of divergence from the syllabus, "watering down," and "fuzzy mathematics." (Note: my state's Governor was quoted as calling multiculturalism "crap--bunk!" I became involved as a local television station interviewed me, defending multiculturalism, on the nighttime news!)

Probably the easiest way of using ethnomathematics to emphasize a global viewpoint is simply to show examples of mathematical thinking from other cultures. This might be as trivial as demonstrating alternative algorithms as taught in other countries. Subtraction and long division algorithms, while following the same general models, are sometimes written differently, showing alternative ways of handling re-grouping in subtraction ("borrowing", "paying back", "complements", etc.) and the repeated partial subtractions of long division. Sometimes when teachers have international students in class, they can ask the students to demonstrate their own algorithms.

Farther from the standard curriculum, teachers can draw examples of non-Western cultures' use of symmetries, combinatorics, and patterns in textiles and other designs. Algebraic structures may be shown in traditional societal norms—a notably complex example being Ascher's (1991) report on Warlpiri (from Australia's "outback") kinship structure fitting the pattern of a dihedral group of order eight (This might be an opportunity to use a global example in a university-level mathematics class). The class might learn to play a strategy game such as *Oware (Mancala)* or *Mu Torere* where the mathematics is as simple as counting and moving the seeds and as complex as plotting a winning strategy. Similarly, symmetries for elementary classes may involve spotting symmetries in designs or attempting to draw symmetrical patterns, but at higher levels students can analyze lines and orders of symmetry or fit patterns in symmetric group structures. Washburn and Crowe (1988) demonstrate a rather sophisticated study of frieze patterns from many world cultures. There are many other resources for examples such as these, such as Bazin, *et al* (2002) and several from Zaslavsky.

Beyond basic enrichment of content, ethnomathematical examples might introduce new mathematical ideas or carry ideas forward as a central part of the curriculum. This is especially true of historical examples from around the world, where the historical development might become the instructional development. Yoruba or Mayan numeration could introduce non-decimal bases or even place-value in the lower grades. Arab development of trigonometry relationships could be used directly in trig classes. Beyond the historical approach, the same trigonometry lessons could lead to discussions of location techniques—on the open sea, in the empty desert, and within thick rainforest. This could be taught as problem solving, vectors, latitude and longitude, or other geometry-related topics. Gerdes (1999) used examples of traditional basket-weaving in Mozambique to introduce important ideas of geometry such as the area of circles and the Pythagorean Theorem. Normally, fractals are introduced with computer graphics and complex functions, but the examples offered by Eglash (1999) could help demonstrate the wide distribution of real-life examples. These examples, and others similar to these, can be introduced into the lesson as a part of the regular content presentation or as legitimate examples or exercises to follow initial presentation. Students gain a view of

the world even as they are learning mathematics. In particular, they learn that it is not just the Europeans who have done mathematics—contributions to mathematics have come from peoples around the globe.

Often, the role of ethnomathematics in the mathematics class can highlight world issues even when that is not the stated topic of the class. Most often this can implemented through the choice of examples and exercises, without affecting the mathematical content, and in fact, often enhancing the presentation, because the discussion of the issues become important to students, motivating their mathematical work.

Probably the easiest mathematical content to accommodate social issues is statistics and probability. The instructor presents the statistical techniques, but draws examples from the many statistical resources available. Some resources include the United Nations, the World Bank, UNESCO, the Population Reference Bureau, the Joint UN Programme on HIV/AIDS, the UN Millennium Development Goals, and others. Nelson, *et al* (1993) offers good examples and suggestions for using handling statistics in this way. As students learn the technical details of reading graphs and charts, or even of calculation of means and correlations, they are simultaneously exposed to problems of overpopulation, the gap between rich and poor, environmental degradation, the spread of AIDS (e.g., Shirley, 2005), and other world issues that can often be missed by the average student. By working with the statistics of the problem, they become involved in finding solutions, even in this classroom modeling situation.

More broadly, a good choice of examples and follow-up discussion in class can alert students to many global issues. Knijnik (1997) described algorithms of Brazilian peasants for finding areas and volumes, but then explained how the Landless People's Movement (Movimento dos Sem-Terra, MST), as a community development group, not only works for political objectives, but also works in schools to develop curricula from the local culture. Steele (2005) exposes students to issues of fair-wages and third-world sweatshops while teaching lessons on graphs and business arithmetic. Gutstein (2005) shows how maps and map projections can demonstrate bias in one's overall view of the globe.

These examples and many more can be found in the references cited.

The need for a global point of view in K-12 education has been recognized. Now the global educators are beginning to look to mathematics to be a part of global education. It is the task—and the opportunity—for ethnomathematicians to become a part of this movement. Students not only need to know more about the world; they need to know more about mathematics in the world.

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Global Statistics Resource Links

United Nations: http://unstats.un.org/unsd/
World Bank: http://www.worldbank.org/data/
UNESCO: http://www.uis.unesco.org
Population Reference Bureau:
http://www.prb.org/
Joint UN Programme on HIV/AIDS:
http://www.unaids.org/bangkok2004/epi_graphics.html
UN Millennium Development Goals:
http://unstats.un.org/unsd/mi/mi_goals.asp