Exploring World Cultures in Math Class

When math curriculums incorporate the study of world cultures, students learn to appreciate cultural differences and critically examine their own society.

Claudia Zaslavsky

How can you bring the world into the math class? People all over the world and in all eras of history have engaged in mathematical activities to solve the problems that they encountered in their lives. For example, they devised numbering systems, counted objects, constructed homes, and designed works of art based on mathematical principles. Perhaps they didn't give the name *mathematics* to these activities or attach the title *mathematician* to the people who invented the concepts, but the basic mathematics we practice today results from their efforts. According to the *Principles and Standards for School Mathematics* (2000) by the National Council of Teachers of Mathematics,

> Mathematics is one of the greatest cultural and intellectual achievements of humankind, and citizens should develop an appreciation and understanding of that great achievement, including its aesthetic and even recreational aspects. (p. 4)

The students in our classrooms represent most of the cultures on the planet, and their families differ widely in geographic origin, cultural style, and social class. With a high-level mathematics curriculum, including the study of mathematics as a cultural product, the mathematical community has embarked on a program to reach all students in our global village so that they can appreciate the rich world history of mathematical achievements. At the same time, these students can take pride in their own heritage and learn to participate fully in society.

The new term *ethnomathematics* expresses the relationship between mathematics and culture (D'Ambrosio, 2001), and a growing body of literature gives guidance to teachers on introducing cultural perspectives into the math curriculum.[1] The following lessons illustrate what some teachers are doing to develop students' knowledge and respect for world cultures within the study of mathematics.

Digging up Ancient Number Systems

Much of the foundation for the mathematics that students learn in elementary and middle school originated in Africa and Asia before the 15th century. A notable example is our current number system. Teacher Linda Lai's combined 3rd and 4th grade class at the Edith Bowen Lab School of Utah State University in Logan, Utah, researched back 5,000 years to learn about the hieroglyphic numerals of the ancient Egyptians (see fig. 1). They compared the hieroglyphic numerals with the 2,000-year-old Chinese rod numerals (see fig. 2) and the equally ancient system of the Maya of Mexico and Central America (see fig. 3). Both the Egyptian and the Chinese systems were based on grouping by tens and powers of ten, similar to our English numeration system, while the Maya grouped numbers by powers of twenty, with subgroupings of fives. Both the Maya and the Chinese used positional notation, a feature absent from the Egyptian hieroglyphic notation, but the Maya were unique for having a symbol for zero.

The students used Cuisenaire rods and counters to represent Chinese and Mayan numerals. Through their research, they learned about the societies that used these numeration systems and the contexts in which they were applicable. As a culminating activity, Lai challenged her students to invent their own numeration systems (Zaslavsky, 1996, 2001).

Recording Numbers the Inca Way

Bianka Crespo's 5th grade class in Intermediate School 218M in New York City investigated the history, culture, and mathematics of Inca society. The Inca controlled a vast area along the Pacific coast of South America from approximately 1400 until the Spanish conquest in the mid-16th century. They did not have writing as we know it, but represented numbers by a device called a *quipu*, a system of knots encoded in strands of wool or cotton of different colors in a base-ten, place-value system.

FIGURE 1

The ancient Egyptian hieroglyphic numeral for 1, 248

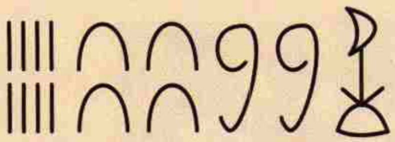


FIGURE 2

Ancient Chinese rod numerals

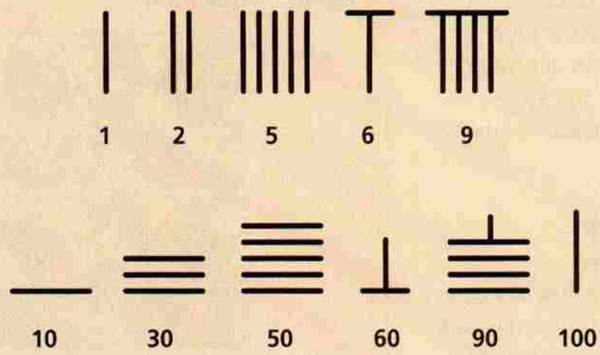
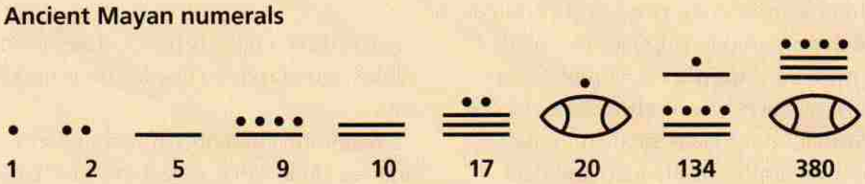


FIGURE 3

Ancient Mayan numerals



To begin the project, the students used library resources to learn about Inca art and history. Students chose an art piece—a pottery jar, a silver llama, or a gold armband—to write about in their journals. They learned how the government controlled the vast empire by keeping accurate records of population, produce, and tax levies and how runners in relays carried the information encoded in quipus to the officials in Cuzco, which is now in Peru.

Students analyzed diagrams of several simple quipus to discover the underlying mathematics of the system, and they used the diagrams to add and subtract. On the last day of the study, the students used colored yarn to construct their own quipus to indicate the quantity of potatoes consumed by each family in a typical month. As the students' journal entries demonstrated, the Inca had come alive (Ascher & Ascher, 1997; Bazin, Tamez, & the Exploratorium Teacher Institute, 2002; Zaslavsky & Crespo, 2000).

Building African Round Houses

Judy Richards's combined 3rd and 4th grade class at the Graham and Parks Alternative Public School in Cambridge, Massachusetts, had just completed a unit on Africa. On open shelves lay gameboards made from egg cartons that students had painted to play Oware, an African numbers game. A miniature compound of African-style round houses sat on a table. Their construction had been motivated by a mathematical experiment: to determine the shape of a house that has the largest floor space for a given quantity of material for the walls. The round house won out over other shapes, bringing up an interesting example of sensitivity to other cultures. An African round house is often called a "primitive mud hut." All three words imply backwardness and the inability to understand and use Western technology. Yet the students learned that the people who constructed these homes were using the optimal materials and design for their climate, available materials, terrain, lifestyle, and cultural traditions (Zaslavsky, 1996).

Ethnomathematics expresses the relationship between mathematics and culture.

The students compared these homes with the houses that they had viewed on a field trip in their community and wrote their conclusions in their portfolios, which also included drawings of gameboards for African versions of three-in-a-row games, an exercise in geometry and measurement (Zaslavsky, 1996). These students learned about African societies while making careful observations about their own society. In addition to mathematics, their study included social studies, writing, art, music, and science.

Creating Islamic Art

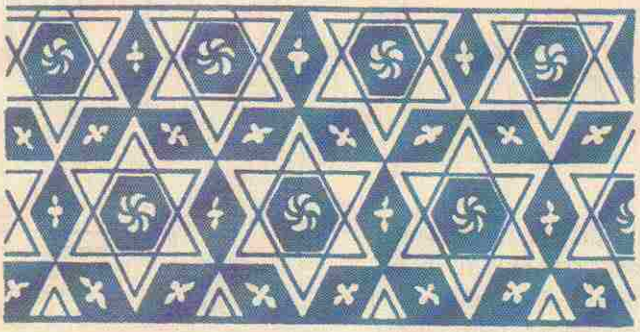
From the 8th century to the 15th century, Arabic was the language of science and mathematics. Arabic-speaking scholars included Persians, Jews, Central Asians, and North Africans. One of their contributions was introducing to Europe the Indo-Arabic system of numbers that we use today.

The art associated with the Islamic religion is justly celebrated. Beautiful examples of Islamic art and architecture exist in many lands, from Spain to India. Some sects forbade the depiction of human or animal forms in art. Therefore, artists chose to make geometric figures and floral designs and to use Arabic calligraphy for writing selections from the Qur'an. Tessellations—repeated geometric patterns constructed with a compass and straightedge—adorned the walls of mosques and palaces, including the celebrated Alhambra palace in southern Spain.

Pattern blocks and similar materials are an excellent medium for the exploration of tessellations. Students will discover that all pattern blocks tessellate—that is, cover the surface with no gaps. Can students form tessellations with a combination of two or more shapes? Older students can emulate tessellation patterns (see fig. 4) or create their own symmetrical compositions (Zaslavsky, 1993b).

FIGURE 4

Islamic tessellation



Adapted from the *Shāh-nāmeh*, The *Book of Kings*. From *Multicultural Mathematics* by Claudia Zaslavsky. ©1987, 1993 Claudia Zaslavsky. Published by J. Weston Walch. Published with permission.

Examining the World Outside the Window

As a secondary school teacher of mathematics in the 1960s, I introduced issues concerning the local community. Using a U.S. Department of Commerce publication, I drew a map of the five standard metropolitan statistical areas that the school district comprised, and I copied the data related to population, racial groups, education level, family income, housing, and several other categories of information for each area. Students received copies of the map and data and, after a group discussion, paired off to compare the areas with respect to two or three characteristics. They used tables and graphs to display their findings.

When the students came together to analyze their work, it was evident that the predominantly white, middle-class population enjoyed higher incomes, better housing, more education, and other attributes of a higher standard of living than the African American and working class populations. Certainly the students had been aware of these differences, but the impact was strong: Here were the numbers, and numbers don't lie (Gross, Morton, & Poliner, 1993; Zaslavsky, 1993a).

Swapna Mukhopadhyay of Portland State University in Portland, Oregon, electrified a mathematics teachers' workshop that I attended when she demonstrated one of her favorite projects. She distributed a Barbie doll and a measuring tape to each group and asked, "What would Barbie look like if she were as tall as you?" After we had measured and compared, we discussed the influence of Barbie—the distorted image of an adult female, the prevalence of anorexia, the addiction to consumerism—on girls not only in the United States but also in many other countries. Then we considered the conditions of sweatshop labor in the production of toys in Southeast Asia and what students could do about it (Mukhopadhyay, 1998).

Damian (2002) states that students who participate in well-designed cross-cultural projects are better prepared than are students without that background because they learn to think critically, apply their skills and knowledge, and use reason and logic to come to conclusions. When a math class, in particular, incorporates the study of world cultures, students can address an endless array of global challenges. Undoubtedly, meaningful applications of mathematics touch students' lives and empower them to participate effectively in our society. ■

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[1] Visit the Ethnomathematics Digital Library (www.ethnomath.org) and the International Study Group on the Ethnomathematics Web site (www.rpi.edu/~eglash/isgem.htm) for more information.

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