World Cultures in the Mathematics Class

CLAUDIA ZASLAVSKY

In the classrooms of the United States we have children representing most of the cultures of the world. Some arrived in our country in the past few years, while others are descendants of immigrants who came in previous decades and centuries, and still others trace their ancestry to the original inhabitants of the Americas. At one time the United States was called a "melting pot" of many nationalities and cultures. Yet there were groups that never had the opportunity to become part of the mix—most Native Americans, people of African descent, and Latinos from the colony of Puerto Rico and from the area that was formerly Mexico, now the Southwestern part of the U.S., to name but a few. They were the throwaways, like the garbage left over after the ingredients had been chosen for the melting pot. They constituted—and they still do—a disproportionately large segment of the population living in poverty.

Now we realize that the "melting pot" analogy is false; on the contrary, people have become more interested in recent times in seeking out their roots. The ethnic groups that have lived longest in the Americas—and have been most oppressed—are the Native peoples and the Africans who were brought to the New World in chains, to serve as slaves to European plantation owners. Now their descendants are determined to reassert their cultural heritage. Although their ancestors often included English, Spanish, and other Europeans, they frequently choose, or are compelled by societal pressures, to identify with the oppressed peoples. Incidentally, Native Americans and Africans also intermarried, and many African Americans can count American Indians in their ancestors. The United States Census includes people of Spanish origin with either Whites or Blacks, but also calculates the total Hispanic (of Spanish origin) population as a separate, additional group. Subdivisions and names are the subject of disagreement even among the people who belong to these groups, and discussions on the topic are often heated. In the media, in government and commission reports, the term "minorities" includes Blacks, Latinos (Hispanics), Native Americans, and Asian Americans. Members of these groups may resent the implication of the word "minority" as signifying "lesser." They also object to being lumped together as though they are all the same. Even within each of the groups I have named, people differ widely in geographic origin, cultural styles, and social class.

It is estimated that by the year 2000, one-third of all students will be "minority." Children growing up in these families and communities often differ from children of the dominant culture in their learning styles. They have less access to educational opportunities, both inside and outside the classroom. These "minority" students, except for those of Asian background, attend schools that are poorly serviced, score lowest in the all-important standardized "achievement" tests, and drop out of school at a high rate. A disproportionate number of these children are placed in the lowest track (or stream) from the earliest grades, where they are presented with a limited, outdated curriculum, taught by rote memorization methods, and tested by standardized paper-and-pencil, multiple choice tests.

The mathematics community in the United States is embarking upon a program to reach *all* students. As stated in the *Curriculum and evaluation standards for school mathematics* [NCTM, 1989]:

> It is crucial that conscious efforts be made to encourage all students, especially young women and minorities, to pursue mathematics. [page 68]

Recognition is given to the varied backgrounds and interests of the students:

> Students should have numerous and varied experiences related to the cultural, historical and scientific evolution of mathematics. [page 5]

It is not only children of minority groups who benefit from the inclusion of topics relating to their heritage. Students in our "global village" must learn to respect and appreciate the contributions of peoples in all parts of the world.

Educators are beginning to recognize the value of infusing mathematics with the achievements of world cultures, to "multiculturalize the curriculum." [Bishop, 1988; D'Ambrosio, 1989; Gerdes, 1988]

Introducing a cultural perspective

Leading educators in the United States deplore the extent to which standardized tests and textbooks drive the mathematics curriculum. Tests take priority. "If it's not on the test, don't teach it," is the prevailing viewpoint of many school administrators and teachers.

Here and there some teachers are motivated to implement the mandated curriculum by introducing a cultural perspective. Teachers may even present language, social studies or art lessons that have mathematical content without being aware of the mathematics, as the following incidents will show.

To celebrate Children's Book Week, the reading supervisor of a local school invited me to talk to eight-year-old students about my book *Count on your fingers African style* [1980]. The majority of the children in this school are low-income, dark-skinned, Spanish-speaking immigrants or children of immigrants from the Dominican Republic.

For the Learning of Mathematics 11, 2 (June 1991)
FLM Publishing Association, White Rock, British Columbia, Canada

The teachers had already discussed the book with the children, and the students were prepared with questions about counting, about writing books, about the process of publication. Many could count in Spanish, and several, from Haiti, knew French. We compared the counting words in the three languages—English, Spanish, and French—noting the similarities and the differences.

I asked the children to pretend that they were visiting a market in an African country, where no one spoke their language. How would they ask for eight oranges? Of course, they suggested using their fingers. Then I proposed that each child imagine how he or she would indicate eight, and, when I gave the signal, to raise their hands showing "eight" on their fingers What a variety of ways! Some children used the methods described in the book, while others invented unique styles Many ways to solve one problem, all equally valid, and a good mathematics lesson in the guise of a talk about books!

We discussed numbers and how useful they are. One boy contributed a remark about "playing the numbers," the illegal gambling game that is popular in low-income communities, in conflict with the legal state lottery The teacher quickly interrupted: "But watch out for the cops (police)." The boy seemed bewildered by her comment, but she did not explain.

As I left the school I noticed a beautiful patchwork quilt hanging in the lobby, the work of a class of nine-year-olds. It was composed of thirty squares in a 5×6 arrangement. The squares were identical in construction, each consisting of small squares and triangles of print or solid color cloth sewn together. By mixing and matching the colors and patterns of the fabrics as their fancy led them, the children were able to achieve a varied and pleasing effect.

I arranged to interview the teacher to learn more about this mathematical production. "I was an art major," she said, "and I had them make the quilt so that they would get a feeling for life in colonial times (18th century). I like to combine social studies with art Now we are doing Native American bead patterns " When I added that the children were also doing very good mathematics, she seemed surprised. After all, this activity was not in the mathematics curriculum, nor were these applications included on the standardized achievement test. Later I read about an exhibit of African-American patchwork quilts. The author commented on the similarity of many standard quilt patterns to traditional African textiles and the possibility that patchwork quilting was introduced into England and America by African slave women. [Barry, 1989]

I asked the teacher whether the boys had objected to sewing. "Oh, no," she replied. "I told them that tailors sew. No problem whatsoever." The photographs of the quilt and of the students working with beads will appear in the *Arithmetic Teacher* [Zaslavsky, 1990].

In this article, I shall describe some of the mathematical practices of African peoples and of the indigenous peoples of the Americas.

Numbers and numeration

Work with numbers has dominated the mathematics curriculum since the beginning of public schooling, satisfying the needs of shopkeepers, clerks, farmers, and factory workers. All peoples have developed numeration systems to the extent of their needs. The English system of numeration and most European systems are based on grouping by tens and powers of ten. Why is ten commonly used as a base? Is it because we have ten fingers (digits)? The peoples of West Africa and Middle America, as well as the Inuit of the far north, group by twenties. In some languages, such as Mende of Sierra Leone, the word for twenty means "a whole person"—all the fingers and toes.

Children can learn about numeration systems by examining the construction of larger numbers. In the Yoruba (Nigeria) language, for example, the name for 65 means "take five and ten from three twenties," using the operations of multiplication and subtraction, rather than multiplication and addition, as in most European languages. Different solutions to the same problem, one just as good as the other. [Zaslavsky, 1979a: page 207]

Finger gestures to express numbers are commonly used by people who do not speak each other's languages. These gestures may be related to the number words; or, again, they may be quite different. When the indigenous peoples of North America were pushed westward by European settlers, tribes speaking different languages were thrown together. Of necessity, they developed systems of finger signs, including signs for numbers. [Zaslavsky, 1979b]

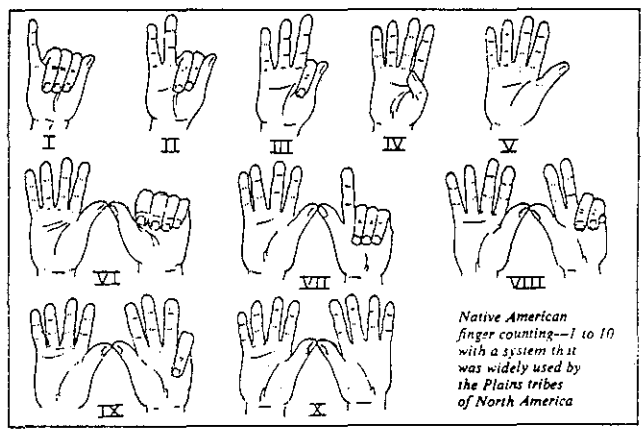

Figure 1

Illustration from William Tomkins: *Indian Sign Language* (Dover, New York)

Ancient Egypt provides a rich source of material about numbers, numeration systems, written numerals, computational methods, and applications. [Gillings, 1979, Joseph, 1991] Less well known is the African origin of this great civilization in the upper Nile valley of the land that is now Sudan and in the once fertile Sahara region. Prior to the rise of modern imperialism, historians had acknowledged that the ancient Egyptians were dark-skinned people. However, Europeans could not admit that the peoples they had conquered and enslaved, the Black people of Africa, were kin to the inventors of ancient Egypt's high civilization. Africans had to be portrayed as less than human and

denied their history, in order to justify their enslavement, while Egypt was detached from the African continent. In his book *Black Athena,* Martin Bernal [1987; see also Davidson, 1987] discusses this issue in great detail and with voluminous documentation Furthermore, many of the Greeks whom we revere as the "fathers of mathematics" either studied in Egypt or were Egyptians themselves—Pythagoras, Eudoxus, Euclid were but a few. [Joseph, 1987] Beatrice Lumpkin [1983a] discusses the three great periods of African participation in the development of mathematics: the ancient period of the pyramids and temples, the classical Hellenistic period, and the Muslim period.

The peoples of Middle America developed their own systems of written numerals, in the case of the Maya dating back at least two thousand years. The systems were based on twenty and powers of twenty, and included the use of zero, positional notation, addition, and the repetition of symbols. When applied to Mayan chronology, the groupings proceeded in this fashion: 20, 18×20, 18×20×20, etc., to represent the twenty-day months, 18-month year, and larger groupings. The secular year consisted of eighteen months of twenty days each, plus five additional days to make 365, with cycles of fifty-two years. The sacred year consisted of thirteen twenty-day months. Both counts were used simultaneously For an excellent reference work on the mathematics of the Americas, see Closs [1986].

The Inca *quipu* represents a unique system of record-keeping. A positional numeration system, based on ten and powers of ten, is embodied in a collection of colored strings resembling a tangled mop. Yet the quipu can encompass a whole census For an entrancing discussion of quipu construction and usage in the context of the Inca empire, which included all of Peru and a large section of the Andean region five hundred years ago, see Ascher [1981].

Another aspect of number is the ability to do mental arithmetic. The year 1990 marks the 200th anniversary of the death of the slave Tom Fuller, known as the African Calculator. Shipped to North America in 1724 at the age of fourteen, he developed remarkable powers of calculation, although he was forbidden access to any kind of schooling, as were all slaves, and he could neither read nor write. Late in his life he was used by anti-slavery advocates to demonstrate the mental capacity of Black people [Fauvel & Gerdes, 1990]

Design and pattern

Most cultures have developed characteristic designs, which they incorporate into their cloth, basketry, wooden objects, and buildings. For example, the Navajo of the southwestern United States are known for their beautiful rugs, the and fine workmanship of these rugs, sometimes called the "first American tapestries," earn for them a well-deserved place in museums. When the Spanish conquistadores introduced sheep in the sixteenth century, the Southwest tribes, traditionally weavers of cotton, turned to the use of wool The Navajo learned weaving from the Pueblo tribes, probably in the late seventeenth century. From weaving plain cloth and blankets with simple designs for their own use,

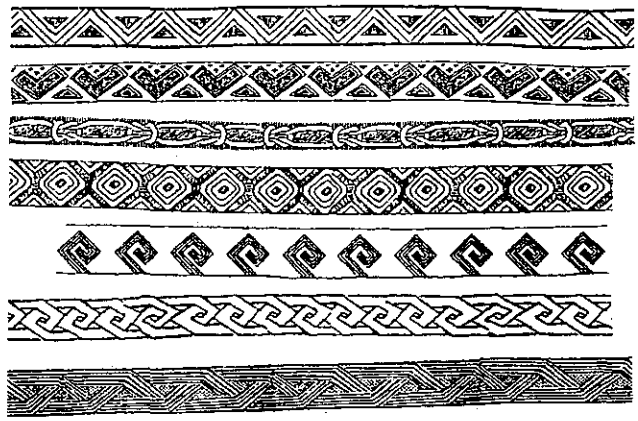

Figure 2
The seven one-color one-dimensional patterns
(Bakuba, Zaire)

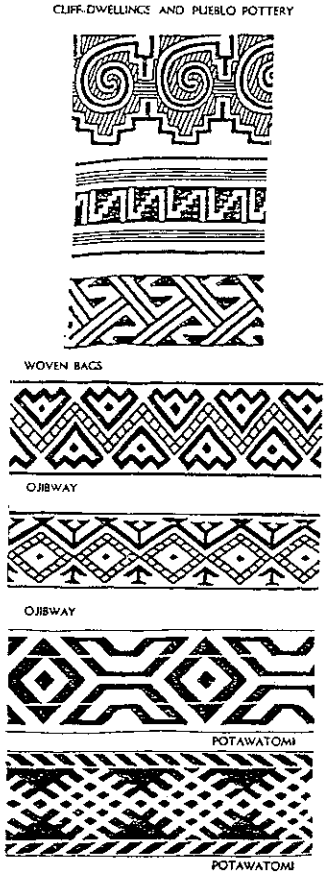

Figure 3
The seven one-color one-dimensional patterns
(Native American) from Le Roy H. Appleton,
American Indian design and decoration

they turned to creating richly-patterned blankets and rugs for the commercial market. By the mid 1800s these weavings commanded a good price. In recent years individual women have become famous for their fine weaving and innovative designs. Navajo rugs, with their geometric motifs and repeated patterns, provide an excellent medium for the analysis of symmetry. [Zaslavsky, 1990]

The Bakuba people of Zaire are justly famous for their embroidered raffia cloth, known as "Bakuba velvet," and for their marvelous wood carvings. Characterized by the repetition of traditional geometric motifs, these art works, too, have found their way into many museums in Europe and the United States. Some of the pieces in the British Museum date back more than two centuries. A visit to a museum to study these works of art might inspire students to create their own patterns. [Zaslavsky, 1979a; Washburn & Crowe, 1988]

Architecture

Most of us are so accustomed to living in a rectilinear environment that it is difficult for us to imagine different surroundings. Our furniture and accessories are designed to fit along straight walls and into right-angled corners. Yet, people of other cultures would be just as uncomfortable if they had to give up their circular houses for our rectangles. The Native peoples of the Great Plains (northcentral U S.) traditionally lived in conical *tipis*, portable tents made of animal skins and decorated with meaningful symbols—a dwelling appropriate to the life style of the people Early in this century, Black Elk, one of their leaders, lamented:

> We made these little gray houses of logs that you see, and they are square. it is a bad way to live, for there can be no power in a square. You have noticed that everything an Indian does is in a circle, and that is because the Power of the World always works in circles and everything tries to be round.

Why has the round house been traditional in some societies? One must consider the available materials and technology, as well as the way the society makes its living. A settled agriculturalist builds for the future, while a pastoral nomad may abandon a shelter after a few months, or pack it up and move on. Consider this aspect, too: a family that builds its own home, using hard-to-find materials, wants to achieve the largest possible floor space for a given quantity of materials for the walls. In other words, maximize the area for a given perimeter. The circle is the answer

Circular homes can take a variety of forms: the conical *tipi*, the hemispheric *igloo* of the northern Inuit, the beehive-shaped thatched dwelling on Mt Kilimanjaro, the tall mud-brick, thatch-roofed cylinders of West Africa. For suggested lessons based on these ideas, see Zaslavsky [1987, 1989].

Who has not been impressed by the splendor and accurate construction of the Egyptian pyramids, now five thousand years old? The early inhabitants of the land that is now Mexico also built pyramids, some over two millenia ago. This fact, as well as other evidence, indicates a link between ancient Africa and ancient America. [Lumpkin, 1983b, 1986]

Less well known than the Egyptian pyramids is the African city-state, Great Zimbabwe ("great stone house"), with its complex stone architecture Started perhaps eight or nine centuries ago, it served for several centuries as the seat of government for the rulers of a vast kingdom in southern Africa. Several hundred smaller stone structures, spread across the land, are a memorial to the former power of the realm. [Asanti, 1983]

Sufficient information is available about the pyramids and Great Zimbabwe to enable students to analyze their measurements, to compare the labor time and the quantity of materials that went into building these edifices, and to construct models.

Games of chance and skill

From time immemorial human beings have tried to divine the future. Some divining practices led to games of chance, and eventually to the important and growing field of mathematical probability and statistics. Tossing a coin is one of the simplest forms of gambling. The Igbo (Nigeria) game of *Igba-ita* ("pitch and toss") involved tossing cowrie shells, still used as currency into the twentieth century, and noting whether they landed with the openings up or down With the adoption of coinage, the game became known as *Igba-ego* (*ego* means "money"). The British commentator G.T Basden observed groups of men gambling in the market place. The challenger tosses twelve cowries. "Quick as lightning the players note the positions and forfeit their stakes or collect their gains. The play becomes exceedingly fast, and soon a cloud of dust encircles each group of gamblers. I have watched players at this game, and it has always been quite beyond me to note the positions of the fall; the cowries have been counted and snatched up again long before I could begin to count" [quoted in Zaslavsky 1979a: page 114]. Students can play the game with macaroni shells or other asymmetric objects, and compare these outcomes with the results of tossing symmetric coins. The Native American Bowl Game involves tossing four peach or plum pits that have been marked on one side, and noting the outcomes.

It is claimed that diagrams for three-in-a-row games were chiseled into the roof slabs of the temple to the Egyptian pharoah Seti I about the year 1300 BC No doubt the evidence, if it ever existed, has since been worn away by the elements and by pollution. The British play Noughts and Crosses and Nine Men's Morris, children in the United States play Tic-Tac-Toe, while "Mill" is the name of the game in several European countries. One of the most complex versions of three-in-a-row games is the Lesotho *Murabaraba*. In simple or complicated form, such games of strategy help children to acquire the necessary skills in problem-solving and decision-making. [Zaslavsky, 1982]

In the British Museum is a beautifully carved wooden statue of the ninety-third king of the Bakuba (Zaire) people. Early in the seventeenth century he bought the peaceful arts to his people, and taught them the game they called *Lela*, a variation of the universal African game of transferring, usually known by its Arabic name, *Mankala*. To celebrate his reign, the king is portrayed with a model of the gameboard in front of him.

This ancient African stone game, played in different versions in most of the continent and in parts of Asia, is considered among the world's best games of strategy. In its simplest form, the game is appropriate for children just entering school, and affords practice in counting and in the concept of one-to-one correspondence. At a more advanced level, all four operations of arithmetic come into play. Yet the game is so sophisticated as to challenge adults in national competitions. [Zaslavsky, 1979a: pages

116-136] African teenagers play with such speed that it is virtually impossible for an inexperienced onlooker like me to follow, much less understand, what is going on

The game has proved its usefulness in several ways. African captives brought it to the Americas, and social scientists have analyzed the rules of the versions popular in the United States the Caribbean islands, and Brazil, in order to trace the ancestry of Black people living in those regions. In the month I wrote this I received a letter from a teacher in the state of Texas requesting permission to use the sample game in *Africa counts* in her award-winning project entitled "Lasers from the Jungle: Turning Primary Students on with African Legends." I readily granted permission, but asked her to substitute "rain forest" for "jungle" in the title. For one thing, Africa does not have jungles. Secondly, the word "jungle" in connection with Africa has negative connotations, evoking the Tarzan image.

Children can invent new versions of a game by changing the rules, varying the shape of the gameboard, or using a different quantity of playing pieces. Games of strategy encourage young people to develop skill in logical inference, as the following incident will illustrate. In his book *Games of the North American Indians* [1907], Stewart Culin describes a three-in-a-row game called *Picaria,* played by Pueblo youngsters in the Southwest. [Zaslavsky, 1982: pages 46-50] Culin's description of the rules is ambiguous. I had seen one version in several recent publications, but it seemed to me that an alternative set of rules would make a better game. I asked a group of eleven- and twelve-year-old students to play according to the first set of rules. Within a few minutes they complained: "The first person to move always wins." Then I suggested that they try the other version, without telling them that it was the one I favored. They were unanimous in declaring it the better game.

Conclusions

The introduction of multicultural, interdisciplinary perspectives into the mathematics curriculum has many points in its favor:

- Students become aware of the role of mathematics in all societies. They realize that mathematical practices arose out of people's real needs and interests.
- Students learn to appreciate the contributions of cultures different from their own, and to take pride in their own heritage.
- By linking the study of mathematics with history, language arts, fine arts and other subjects, all the disciplines take on more meaning.
- The infusion into the curriculum of the cultural heritage of "minority" students builds their self-esteem and encourages them to become more interested in mathematics. As one eleven-year-old boy wrote in his evaluation of a classroom activity based on African culture: "As you probably don't know I feel very strongly and am in deep thrust with my black people, and the math has made me feel better." There is little that one can add to this heart-felt comment!

Note: For lessons incorporating some of the concepts described in this article, as well as other activities, see Krause [1983], Seattle Public Schools [1984], and Zaslavsky [1987], as well as references in the text of the article.

References

Asanti, M. & K. Asanti [1983] "Great Zimbabwe: An ancient African city-state." In Van Sertima: 84-89

Ascher, M. & R. Ascher [1981] *Code of the Quipu.* University of Michigan Press

Barry, A. [1989] "Quilting has African roots, a new exhibition suggests." *New York Times* (November 16): p. C12

Bernal, M. [1987] *Black Athena: the Afroasiatic roots of classical civilization.* Free Association Books, London

Bishop, A.J. [1988] *Mathematical enculturation.* Kluwer, Dordrecht

Closs, M.P. (ed.) [1986] *Native American mathematics.* University of Texas Press, Austin, TX

D'Ambrosio, U. [1989] Project: "A research program and a course in the history of mathematics: Ethnomathematics." *Historia Mathematica* 16: 285-286

Davidson, B. [1987] "The ancient world and Africa: whose roots?" *Race & Class* 29, 2: 1-15

Fauvel, J. & P. Gerdes [1990] "African slave and calculating prodigy: bicentenary of the death of Thomas Fuller." *Historia Mathematica* 17 (1990), 141-151

Gerdes, P. [1988] "On culture, geometrical thinking and mathematics education." *Educational Studies in Mathematics* 19: 137-162

Gillings, R.J. [f1975] *Mathematics in the time of the Pharoahs.* MIT Press, Cambridge Massachusetts, USA

Joseph, G.G. [1987] "Foundations of eurocentrism in mathematics," *Race & Class* 28, 3: 13-28.

——— [1991] *The crest of the peacock: non-european roots of mathematics.* I.B. Tauris, London

Krause, M. [1983] *Multicultural mathematics materials.* NCTM, Reston VA

Lumpkin, B. [1983a] "Africa in the mainstream of mathematics history." In Van Sertima: 100-109

——— [1986] "Pyramids—American and African: a comparison." in Van Sertima

NCTM (National Council of Teachers of Mathematics) [1989] *Curriculum and evaluation standards for school mathematics.* Reston, Virginia

Seattle Public Schools [1984] *Multicultural mathematics poster and activities.* NCTM, Reston, VA, USA

Van Sertima, I. [1983] *Blacks in science.* Transaction Books, New Brunswick, NJ USA

——— [1986] *African presence in early America.* Transaction Books, New Brunswick, NJ, USA

Washburn, D. & D.W. Crowe [1988] *Symmetries in culture.* University of Washington Press, Seattle, WA, USA

Zaslavsky, C. [1979a] *Africa counts: number and pattern in African culture.* Lawrence Hill Books, Brooklyn, NY, USA

——— [1979b] "It's OK to count on your fingers." *Teacher* 96 (February): 54-56

——— [1980] *Count on your fingers African style.* Crowell, NY, USA

——— [1982] *Tic-tac-toe and other three-in-row games.* Crowell, NY USA

——— [1987] *Math comes alive: activities from many cultures.* J. Weston Walch, Portland, Maine, USA

——— [1989] "People who live in round houses." *Arithmetic Teacher* 37, 1 (September): 18-21

——— [1990] "Symmetry in American folk art." *Arithmetic Teacher* (in press)