The Role of Culturally-Based Mathematics in the General Mathematics Curriculum.

A Case for Presenting Culturally-Based Mathematics Lessons to All Students.

Chadd W. McGlone

University of North Carolina at Chapel Hill

ICME 11 - Monterrey, Mexico

July 2008

Introduction

Scholars widely accept that reasoning about number and space occurs in people's everyday experiences. Because of the uniqueness of an individual's or groups of individuals' experiences, that reasoning occurs in diverse ways. For example, Papua New Guinea tribes employ number systems that are constructed by counting 27 different body parts (Saxe, 1981), while African tribes use a base 20 system that originated from counting toes and fingers (Zaslavsky, 1999). Developing a greater understanding of how these different concepts of number were developed and are used partially describes ethnomathematics. In general, ethnomathematics is the mathematics needed by particular groups in a population to perform occupational or cultural tasks (D'Ambrosio, 1997).

Two broad themes in the ethnomathematics literature are (1) the interaction between culture and mathematical knowledge and (2) the role of ethnomathematics in the curriculum (D'Ambrosio, 1997). Regarding the former, investigations of the interaction between culture and mathematics have shown that mathematics takes many forms depending on the needs of the society (Nunes, Dias Schliemann, & Carraher, 1993; Zavslavsky, 1999). For example, groups from such diverse locations and environments as the African plains, the artic, and the Brazilian jungle build round houses to maximize their resources (McGlone, 2007).

Much of the research that investigates the role of ethnomathematics in the curriculum has focused on the way ethnomathematics lessons might better address the needs of students in that culture. Noting the increasing diversity of the student population, Anderson (1997) emphasizes the importance of teaching mathematics that does not contain the racism and sexism found in traditional Eurocentric mathematics. Likewise, Davidson (2005) calls for a focus on culturally appropriate mathematics lessons to limited English-proficient students.

Little research has been conducted to investigate the role of culturally-based lessons in the curriculum of students who are not of that culture. Zaslavsky (1997) has offered a list of ways that

mathematics from other cultures can be utilized in mainstream classrooms and describes the potential benefits to all students. Similarly, Lipka and Adams (2004) report that both urban and rural students benefit from their culturally-based lessons. Neither of these studies, however, specifically investigates how contextualizing mathematics by connecting it to cultural experiences impacts learning for all students, even when they have little or no experience in that culture.

In this paper, I will examine the role of culturally-based mathematics lessons in a general classroom. First, I will briefly examine an epistemology of mathematical knowledge. Second, I will report the literature regarding the uses of ethnomathematics in the classroom. Finally, I will investigate the ways in which the culturally-based mathematics lessons would benefit all students.

Epistemology of Mathematical Knowledge

For many students, mathematics is a discipline that originated long ago in far away Europe. As they see it, the mathematics to which they are exposed is based on axiomatic systems derived from the work of ancient European mathematicians who developed mathematical concepts purely as an academic endeavor. In contrast, the literature has consistently demonstrated that mathematics has current, practical value, in that individuals create and learn mathematics outside the classroom (Gerdes, 1985; Walkerdine, 1990). An examination of the mathematics that individuals use to solve real-world occupational or social problems reveals sophisticated uses of mathematical knowledge that is not learned in a classroom setting.

For example, native people employ sophisticated mathematics when faced with task of building a home. Given scarce construction materials are scarce and limited human resources, people build round homes (Zaslavski, 1999). They demonstrate the geometric knowledge of maximizing the area of an object by making it round. Similarly, individuals in African society have learned that homes built with conic shaped roofs best endures the harsh weather conditions (Zaslavski, 1999). They have discovered that the triangular shape of a conic roof is, geometrically,

the strongest of all shapes. These mathematically sophisticated concepts were not learned in a school setting, rather they have been discovered through trial and error and communicated down though the generations.

Not only are mathematical discoveries made by entire cultures, they are made by individuals in order to solve occupational mathematics problems. Nunes, Schliemann, and Carraher (1993) found that elementary school-aged children can perform quite complicated arithmetic problems in a marketplace context. Without the benefit of formal training, these children have developed efficient and mathematically accurate methods of creating change when street vending. Interestingly, when these same children were placed in a school setting and presented with traditional arithmetic problems that required the exact same mathematical computations, they performed quite poorly.

Why are some children able to perform complicated arithmetic steps to solve difficult marketplace problems yet are unable to succeed with school-based tasks? How do teacher utilize this knowledge in their classroom to enhance the learning of all students? I will address these questions in the next section.

The Role of Culturally Based Mathematics in the Classroom

In order to connect academic mathematics to ethnomathematics, D'Ambrosio (1997) proposes that mathematics curricula should be rooted in culturally-relevant mathematics. He believes that children bring a myriad of mathematical experiences to the classroom and have developed a variety of strategies for dealing with mathematical problems that arise in their environment (D'Ambrosio, 1990). Presenting mathematics lessons that draw an explicit connection between these experiences and academic mathematics will deepen that student's mathematical understanding (Boaler, 1993).

Significant research documents the impact of bringing lessons into the classroom that are based on the culture the students experience outside of it. For example, Nelson-Barber and Estrin

(1995) found that Native American children gain a deeper understanding of mathematical concepts when lessons provided contextual links to the children's culture. Likewise, Butterfield (1994) found that Native American student's self esteem and confidence in mathematics classrooms increased when presented with hands-on mathematics lessons that built on cultural knowledge. Moreover, Englas (in Barta and Brenner) reports that even the most "difficult" African American students became actively engaged when he presented lessons exploring patterns found in cornrow hairstyles.

The evidence therefore suggests that teachers who write lessons to capture the cultural and contextual meaning of the mathematics that children experience outside of school will help their student gain a deeper understanding of the concepts they are teaching. In the next section, I propose that culturally-based lessons also benefit children from different cultures.

A case for culturally-based lessons for all students

Although few have formally investigated the impact of culturally- based lessons in a general mathematics classroom, some scholars have written in support of it. Claudia Zaslavsky (1997) argues that culturally relevant instruction benefits all students in a variety of ways. First, this instruction helps children become aware of the role of mathematics in their society. Second, students gain appreciation for mathematical contributions of individuals in other cultures and pride for the contributions of people from their own culture. Third, students discover a link between mathematics and other disciplines such as history, language, and the fine arts. In addition, I would add that culturally based mathematics lessons lead students to discover their untapped inner source of mathematical knowledge. Finally, ethnomathematics lessons might motivate teachers to develop future lessons that are based on the cultures of the students in their classroom.

One study provides evidence to support the idea that culturally-based mathematics instruction might benefit all students (Lipka & Adams, 2004). In it, the authors presented one semester's worth of mathematics lessons to rural Alaskan Indian/Native Americans (AI/NA) students from the Yup'ik

tribe and to urban students from Fairbanks, Alaska. These lessons contained topics that were familiar to the rural students, like gathering eggs and berries or constructing a fish rack. The results indicated that both AI/NA and urban students' performance on a standardized mathematics questionnaire greatly improved when compared to control groups that did not receive the culturally-based lessons.

Mathematics involves six universal (actions, counting, measuring, explaining, playing, designing, and locating) that are independent of culture (Bishop, 1991). If all people have a culture, and ethnomathematics is the way that people utilize mathematics to solve problems that arise in work, at home, or in the culture, then culturally based lessons help students gain a deeper understanding of the mathematics in that lesson because they can place it in a context (Barta and Brenner, 2008). Culturally-based lessons that are rooted in other cultures have a place in a typical classroom because they help students and teachers begin to see the value of culture in the classroom. Discovering the benefits of these lessons will lead teachers to develop lessons that will make a connection to some cultural experience of the students in the classroom.

Implementing culture in the classroom

I propose that teachers progress through three phases as they move toward implementing culturally based instruction in the classroom. First, students and teachers discover the value of non-European knowledge by experiencing lessons that explore the mathematics native cultures have developed to solve the problems that arise in their world. Second, teachers begin to discover the pragmatic relevance of the mathematics in their own and their students' cultures. Finally, teachers present mathematical activities that are culturally relevant to their students.

When teachers see their students' positive reactions to ethnomathematics lessons, they realize the value of the mathematics discovered outside of school. Along with their students, teachers learn that people other than ancient academics make mathematical discoveries and that those discoveries have a place in the classroom. One lesson that I presented to North Carolina students explored the

benefits of round, one-room houses. At the end one of these presentations, I asked the students and teacher to tell me what they thought about this lesson. One student raised her hand and said, "It's amazing that people all over the world build the same kinds of houses." Someone else joked, "And they don't have internet!" Teachers who talk to me after the presentation make similar comments. These students and teachers are learning that even people who are not formally trained mathematicians can develop sophisticated knowledge.

When students experience mathematical activities that are placed in a culturally meaningful context, they become more excited about the tasks and engage in the lesson. Seeing this engagement, teachers begin to look for the mathematics in their own culture and the cultures of their students. I recently made a presentation to a group of teachers about the mathematics found in the games played by people in non-European cultures. Afterwards, one participant told me about a game that she used to play with her grandparents when she was younger. She stated that she planned to teach it to her students when she returned home. Another teacher said, "We have very diverse students in my school. I bet they have some interesting games from their cultures that we could play." Perhaps their experiences playing these mathematically-rich games from other cultures prompted those teachers to consider connections that they can make with their own and their students' cultures.

Finally, discovering the value of the mathematics that their students bring from home will motivate teachers to bring the cultures of their students into the classroom. They learn that providing a meaningful cultural context for mathematical tasks can bring it alive for the students. For example, the aforementioned teacher of diverse students is holding a Math Game Night for her class. She has instructed her students to ask family members to suggest games that were important in their cultures. The students are to learn the rules and discover the mathematics in the games. On Math Game Night, the students will present their discoveries to their classmates and play these new games with their friends and families.

This teacher discovered the value of mathematics in the games from other cultures. Seeing the reactions of her colleagues to the games, she began to think of ways that she could include her students' unique cultures in the activity. By encouraging her students to present games from their cultures on Math Game Night, she has provided a culturally relevant context for students to learn mathematics. Her students, on the other hand, will are learning that they bring mathematics with them to the school that is rooted in their unique cultures. Through the Math Game Night presentations, the student will gain pride in the contributions that the mathematics found their and others' culture can make in the classroom.

Conclusion

A goal of ethnomathematics in the curriculum is to help teachers discover the value of culture in the mathematics classroom and to provide a guide for them on their quest to find mathematics in their own and their students' cultures. In addition, students learn that their cultural history plays an important role in their mathematical life. Finally, culturally-based lessons are accessible to the students because they place the mathematics in a context, thereby making the numbers dance.

Little research has been conducted to examine the role of culturally-based lessons in the general classroom and the impact that those lessons have on the students. Future research must be conducted to clearly articulate that relationship. A second area of future research might investigate the model presented here, concerning the steps through which a person might progress before she/he implements culturally-based lessons in the classroom.

References

Anderson, S.E. (1997). Worldmath curriculum: Fighting Eurocentrism in mathematics. In A Powell & M. Frankenstein (Ed), *Ethnomathematics: Challenging Eurocenrism in Mathematics Education*. (pp 291 – 306). Albany, NY. State University of New York Press.

Barta, J., & Brenner, B. (2008). Seeing with many eyes: Connections between anthropology and mathematics. Unpublished Manuscript.

Bishop, A. (1991). Mathematical Enculturation: A cultural perspective on mathematics education. Norwell, MA.: Kluwer Academic Publishers.

Boaler, J. (1993). The role of contexts in the mathematics classroom: do the make mathematics more real? *For the Learning of Mathematics, 1993, 13 (2).* 12 – 17.

Butterfield, R. A. (1994). Blueprints for Indian education: Improving mainstream schooling. *Rural Eduation and Small Achools*. Charleston, WV. (ERIC Document Reproduction Service No. ED37898)

D' Ambrosio, U. (1997). Ethnomathematics and its place in the history and pedagogy of mathematics. In A Powell & M. Frankenstein (Ed), E*thnomathematics: Challenging Eurocenrism in Mathematics Education*. (pp 13 – 25). Albany, NY. State University of New York Press.

Davidson D. (2005). An ethnomathematics approach to teaching language minority students. [Online] September 29, 2005. http://jan.ucc.nau.edu/~jar/NALI11.html>.

Gerdes, P. (1985) Conditions and strategies for emancipatory mathematics education in underdeveloped countries. *For the Learning of Mathematics 5 (1).* Pp 15 – 21.

Lipka, J. and Adams, B (2004). Culturally based math education as a way to improve Alaska Native Student's math performance. [Online] September 18, 2005. <http://acclaim.coe.ohiou.edu/rc/rc_sub/pub/3_wp/LipkaAdams20.pdf>.

McGlone, C.W. (2007). "Culturally-relevant mathematics lessons." Presented at the annual meeting of the National Council of Teachers of Mathematics, 2007.

Nelson-Barber, S., & Estrin, E. (1995). *Culturally responsive mathematics and science education for native students.* San Francisco: Far West Laboratory.

Nunes, T., Schliemann, A. D., & Carraher, D. W. (1993). Street mathematics a school mathematics. New York: Cambridge University Press.

Saxe, G. B. (1981). Body parts as numerals: A developmental analysis of numeration among remote Oksapmin in Papua New Guinea. *Child Development,52,* pp. 306-316.

Walkerdine, V (1990). Difference, cognition, and mathematics education. *For the Learning of Mathematics 10 (3).* Pp 51-56.

Zaslavsky, C (1997). World cultures in the mathematics class. In A Powell & M. Frankenstein (Ed), *Ethnomathematics: Challenging Eurocenrism in Mathematics Education.* (pp 307 – 320). Albany, NY. State University of New York Press.

Zaslavsky. C (1999). *Africa Counts: Number and Pattern in African Cultures (3rd ed.).* Chicago. Lawrence Hill Books.