Teaching Mathematics with "Cultural Eyes"

Author(s): Blidi S. Stemn

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Abstract: Mathematics is a dynamic, living, cultural product and the curriculum and instructional practices should reflect this. It should be taught in a living context that is meaningful and relevant to the lives of the learner. This article describes an approach for helping teachers develop skills in teaching mathematics with “cultural eyes.” This involves knowledge of the subject matter and the ability to connect school mathematics to our multicultural society. Specific examples of how teachers can achieve this are discussed using a framework that is an adaptation of Banks’ dimensions of multicultural education and Friere’s work on education for liberation. The framework seeks to develop critical cultural consciousness, content integration, prejudice reduction, and equitable mathematics pedagogy.

Keywords: mathematics; teacher education; critical cultural consciousness; multicultural education

Blidi S. Stemn is an Assistant Professor in the Curriculum and Teaching Department at Hofstra University, Long Island, New York. His research interests include mathematics, teaching and culture.

Address: Department of Curriculum & Teaching, Hofstra University, 128 Hagedorn Hall, Hempstead, NY 11549-1190. Ph.: (516) 463-7717, Fax: (516) 463-6196, Email: Blidi.s.stemn@hofstra.edu
What constitutes a multicultural approach to mathematics teaching and the validity of the idea itself continue to be debated even as the student population has increasingly becomes diverse. This is especially an issue because the elementary school teaching force remains predominantly White and female (Zumwalt & Craig, 2005). There is an overwhelming probability that students of color will be taught by mostly White teachers (National Center for Education Statistics, 2002) particularly in the area of mathematics. This cultural mismatch can result in teachers engaging in pedagogical practices that do not take into account the richness of the cultural diversity children bring to the classroom. Howard (2003) emphasizes that “teachers need to understand that racially diverse students frequently bring cultural capital to the classroom that is often times drastically different from mainstream norms and worldviews” (29). In order for teachers to connect with and engage students, they must construct pedagogical practices in ways that are culturally relevant, racially affirming, and socially meaningful.

Current reforms in mathematics education, spurred by the National Council of Teachers of Mathematics (NCTM) and other professional organizations, have emphasized connecting school mathematics to the real world experiences of children. For example, in the Curriculum and Evaluation Standards for School, (1989) the NCTM recommends that students have numerous experiences related to the cultural, historical, and scientific evolution of mathematics so that they can appreciate the role of mathematics in the development of our contemporary society” (p. 5). One promising approach for connecting mathematics and the cultural experiences of children is culturally relevant pedagogy (Ladson-Billings, 1994). Ladson-Billings describes culturally relevant pedagogy as “a pedagogy that empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills and attitudes” (pp. 17-18).

Proponents of culturally relevant mathematics pedagogy argue that it will help students of color overcome the deep-rooted biases in mathematics textbooks and other resources, which subtly affect the performance of students from marginalized groups (Joseph, 1993). In this article I describe an approach that I have used in helping elementary school teachers (prospective and practicing) explore mathematics teaching from a multicultural perspective by developing, what I refer to as, “cultural eyes”.

TEACHING MATHEMATICS WITH CULTURAL EYES

I conceptualize effective mathematics teaching in this multicultural society as involving deep subject matter knowledge, acquisition of research-based instructional methods, and possession of cultural eyes. I use the term “cultural
eyes" to denote a transformative instructional practice that connects the teaching of mathematics and multicultural education. This approach, which can be considered as a subset of a culturally relevant mathematics teaching paradigm, embraces the Deweyian fallibilist philosophy that there is no absolute certainty (Dewey, 1958). In this view mathematics is a living social construct, culturally bound, a process of inquiry, and a tool for posing and solving contextual and imaginary problems. Mathematical knowledge is eternally open to revision rather than a finished product to be learned like catechism (Ernest, 2007). A mathematics teacher who possesses cultural eyes transforms the curriculum by embedding students' cultural experiences, historical perspectives, mathematical practices of various cultures, and the contributions of subordinated cultures and racial groups, into their teaching. They also help students use mathematics as a tool to examine socio-cultural problems. They recognize and acknowledge that many cultures have contributed to the development of mathematics but are not being presented in textbooks and other materials.

Learning to teach mathematics with cultural eyes should begin with pre-service teacher preparation and continue throughout a teacher’s professional life. It is not about celebrating the holidays of different cultural groups through mathematics, but rather a transformation of the curriculum. In my approach to teaching with cultural eyes, I employ the idea of critical cultural consciousness developed by Paulo Friere (1973) and content integration, prejudice reduction, and equitable pedagogy drawn from James Banks’ dimensions of multicultural education (Banks, 1995).

DEVELOPING CRITICAL CULTURAL CONSCIOUSNESS

The first dimension of learning to teach mathematics with cultural eyes is for teachers to develop critical cultural consciousness about themselves and their students. Teachers examine their beliefs, assumptions, and attitudes about mathematics teaching and learning and the factors that have influenced their experiences. According to Hinchey (2004) reflecting on and questioning one’s assumptions and experiences are an important part of becoming an effective teacher of all children. This activity can help teachers realize and come to understand how they have been socialized in their attitudes towards various groups. It provides them with a forum for them to reflect deeply about the consequences of holding such beliefs and why they must be actively challenged. Through this process they become aware of the attitudes and beliefs they take for granted and how intentionally or unintentionally they reproduce these values in their teaching and daily interactions (Bell, Washington, Weinstein, & Love, 2003). It is only then that teachers are able to acknowledge their biases and work to diminish their effect (Strutchens, 2000).

One of the activities I use in my classroom is to have teachers respond to the prompt “what stereotypes or beliefs do you hold about other groups in relation
to mathematics learning and participation?” They answer in writing first, share responses with colleagues in small groups, and then discuss their experiences with the entire class. As a follow-up, I ask teachers to answer the following four questions individually prior to another full class discussion. How would your beliefs and assumptions affect your instructional practices? What are the consequences for students resulting from these beliefs and assumptions? How could you change the mind-set of someone who has beliefs and assumptions hindering student learning? How would you react if a teacher held negative stereotypes about the learning ability of you or your child? (Strutchens, 2000).

During one of these activities, a White teacher who suddenly realized how she had absorbed and taken for granted the values and beliefs she had grown up with expressed her new insights in this way. “Sometimes you grow up with something and you just believe that it is true. All along I was brought up to think and believe that math is for certain people. I never saw a black student in my AP classes although we had a good number of them in the school. So, I just assumed that they cannot do high level math and some of them believed that too.”

**CONTENT INTEGRATION**

Content integration deals with the extent to which teachers use examples and content from a variety of cultures and groups to illustrate key concepts and ideas (Banks & Banks, 1997). Mathematics teachers should be able to use examples such as computational practices (or algorithms) from various cultures to strengthen students’ understanding. In our discussion of whole number computation strategies involving multiplication, I introduced the teachers to Lattice and Vedic multiplication methods.

Lattice multiplication is a method of multiplying large numbers using a grid. This method breaks the multiplication process into smaller steps, which some students find easier. Digits to be carried are written within the grid, making them harder to miss. It originated from India and was passed on to the Europeans by the Arabs. Vedic multiplication, which is part of Vedic Mathematics, also has its roots in India. It is a mathematical system that provides fascinating and intriguing methods for doing mathematical calculations. The calculations are based on sixteen sutras or word formulas (Joseph, 1993).

These computational strategies provide fresh insights into the strengths of our place-value system, which are not fully exploited by the traditional multiplication methods. When we expose teachers to these unfamiliar computational strategies, they realize that there can be many methods for solving a problem and that they and their own students can even invent their own new ways. According to Joseph (1993), this may be a way of retaining a child’s interest as well as of overcoming difficulties in understanding traditional approaches.
Content integration encourages the integration of historical perspectives as a tool to developing students’ mathematics competencies. From the standpoint of the student, the historical perspective should increase his or her motivation by making the subject more human. It also shows students that the greatest mathematicians were human beings with human frailties who worked very hard to achieve results. Student confidence increases when they learn that famous mathematicians also had to work hard to find solutions to problems (Sander, 1989). Unfortunately, it is possible to study mathematics and become a mathematics teacher with little or no knowledge of the origins or historical development of mathematics.

One of the ways I have integrated historical perspective in my teaching of teachers is by doing activities involving both our present numeral systems and numeral systems from the past. I was surprised to find out that a majority of teachers do not know that our numeral system is called the Hindu-Arabic numeral system because it had its origins in those cultures. One of the assignments for my students is to select an ancient numeral system and write a brief background report with a calendar for a month of their choice and present it to the class. In their report they must include the advantages and disadvantages of the numeral system and how it compares with the Hindu-Arabic system. To the mathematician the interest in the origin of our numeral system is generally deep. The Hindu-Arabic system is one of the world’s greatest inventions because it developed the principle of place value and the use of zero. These two ideas make it easy to represent numbers and to perform mathematical operations that would be difficult within any other kind of system.

Another activity that I find valuable is for teachers to identify a mathematics-related game or puzzle from another culture and discuss its origin and how they could use it in their classroom. The magic square puzzle has its roots in Chinese civilization where it was called Lo-shu (Braxton, Gonsalves Lipner, & Barber, 1995). The game of Oware (the name is derived from Ghana) has many variations around the continent of Africa. In my experience these activities not only benefit students from underrepresented cultural and racial groups but also children from the dominant culture and they have the potential to reduce stereotypical attitudes about who can participate in mathematics.

**Prejudice Reduction**

The prejudice reduction dimension of the Bank’s multicultural taxonomy is about helping students develop positive attitudes towards different racial, ethnic, and cultural groups through mathematics instruction. According to Phiney and Rotheram (1987) children come to school with many negative attitudes toward and misconceptions about different racial and ethnic groups. This is particularly important in mathematics education because the subject is generally presented in textbooks and other materials as the sole creation of men from European
backgrounds, which contributes to the idea that only certain people can do mathematics.

To break this cycle of misconceptions and prejudice, it is important for teachers to integrate activities such as the contributions of underrepresented cultural groups and women to mathematics. For example, I ask teachers to research and write a biography of a female mathematician such as Sophie Germaine from France or Sri Ramanujan a male mathematician from India.

Although all cultures engage in activities involving counting, locating, measuring, designing, playing, and explaining (Bishop, 1988), how these practices are carried out differs from culture to culture. As part of learning to teach mathematics with cultural eyes, teachers investigate how a cultural group carries out these activities and describes how they would integrate some of them into their teaching.

**Equitable Pedagogy**

Equitable pedagogy within the context of teaching mathematics with cultural eyes involves teachers modifying their instructional practices to incorporate what is known about students from diverse cultural and social backgrounds to enhance learning. It is built on the idea that “mathematics can and must be learned by all students” (NCTM, 2000:13). For example, the Vedic approach to multiplication can be used to extend and deepen students’ understanding of multiplication. This method of doing multiplication opens the door for students to discuss social, political, and cultural issues relating to the Vedas and the Hindu people while they are improving their mathematical skills.

A teacher who promotes equity in his or her classroom provides opportunities for students to think, share, and compare a variety of strategies for solving the same problem. Students learn to argue amongst themselves about possible solutions to problems and in the process they generate their own understandings (Secada & Berman, 1999). One activity that I use to demonstrate these classroom norms is the “Teeth Brushing Project” (Stemn, 2008). The aim of the teeth brushing project is to use the everyday experiences of students to generate data and then to use the data to build their understanding of proportions. Students collect data on how much water is wasted when they brush their teeth over a period of time while the tap is running. The data is discussed and the mean tabulated. As we analyze the data, they discuss the factors that contribute to the different data sets. After the discussion I posed the following questions: You brush your teeth twice a day and each time you leave the water running. How much water would be wasted in five days? If two nonstandard cups of water is equivalent to one-quarter gallon of water, how many gallons of water will be wasted in five days, twelve days, thirty days, and any number of days if the trend continues?
Students had to first figure out how many nonstandard cups of water were wasted in the five days. I then guided the discussion to encourage the use of an algebraic approach to investigate the amount of water wasted in five, twelve, and thirty days and they came up with a generalization. After that they examined the missing-value method using guided discovery approach and the cross multiplying method. After completing sample problems each student computed the amount of water they each wasted and wrote a report about the project.

What was central to this project was that the problem evolved from the lives of the students. As a result they were eager to find out how much water was wasted and who wasted the most and who wasted the least amount. Furthermore, after finding out how much water was wasted, they took action by not leaving the water running while brushing. Through this project, they learned to reason proportionally which is at the heart of middle school mathematics. Additionally, they strengthened their process skills that involve problem solving, communication, reasoning and proof, connections, and connections. This project also provided them the opportunity to connect mathematics to other content areas including science, geography, and oral hygiene. They were also able to use the results to take make concrete decisions that directly affects their lives and that of the environment which is an example of gaining mathematical power.

CONCLUSIONS

Teaching mathematics with cultural eyes is a life-long process. What I presented here are examples of ways I have supported teachers in their effort to transform their teaching by drawing on the multicultural nature of our society to teach mathematics. Mathematics teachers, as do other teachers, have to think about the socio-cultural nature of knowledge and how we can open up subjects so that the cultural identity of the learner is seen as a resource in the learning and teaching process.

Teaching mathematics with cultural eyes can provide students with the strong knowledge base needed to think critically and be able to challenge the existing deep-rooted notion that mathematics is strictly the creation of men of European descent. It can also support student learning in other content areas.

Of particular importance is the way this approach to mathematics teaching helps students from minority backgrounds see their cultures through a positive lens, thus developing a participatory image of themselves in the mathematics curriculum. Furthermore, it enriches the mathematics curriculum with real-life examples from many cultures, thereby increasing students' ability to make connections within mathematics and across disciplines. The Principles and Standards for School Mathematics (NCTM, 2000) articulates that "by emphasizing mathematical connections, teachers can help students build a disposition to use connections in solving mathematical problems, rather than see mathematics as a set of
disconnected, isolated concepts and skills" (64). It can also give students the opportunity to explore a range of unconventional mathematical algorithms used by different cultures and people, in that process deepen their understanding of the concept they are learning.

If mathematics is to empower all students to become active and confident problem solvers, they need to experience mathematics as a human activity which they can make their own.

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