ED380295 1995-03-00 Multicultural Mathematics: A More Inclusive Mathematics. ERIC Digest.

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ERIC Identifier: ED380295
Publication Date: 1995-03-00
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Source: ERIC Clearinghouse for Science Mathematics and Environmental Education Columbus OH.

Multicultural Mathematics: A More Inclusive Mathematics. ERIC Digest.

One of the underlying themes of the NCTM Curriculum and Evaluation Standards is mathematical connections (National Council of Teachers of Mathematics, 1989). Students should be able to use a mathematical idea to further their understanding of other mathematical ideas, and they should be able to apply mathematical thinking and

modeling to solve problems that arise in other disciplines. Furthermore, they should understand the role of mathematics in our multicultural society and the contributions of various cultures to the advancement of mathematics.

MULTICULTURAL EDUCATION

Until recently there have not been many links to students' culture in the mathematics classroom. This may be one of the major barriers to achievement of many groups historically underrepresented in mathematics, for these students may see mathematics as a subject that has very little meaning or value for their current or future lives. Banks (1989) contends that preparing students to be functional in a competitive, pluralistic society and teaching them about their customs, heritage, history, and other aesthetic aspects are essential components of an effective educational program.
As mathematics educators actively look for ways of linking mathematics and our multicultural society (Bishop, 1988; D'Ambrosio, 1985; Frankenstein, 1990; Zaslavsky, 1993), the five dimensions of multicultural education identified by Banks (1994) provide a framework for empowering all of our students through multicultural mathematics:

- 1. Content integration, the illumination of key points of instruction with content reflecting diversity;
- 2. Knowledge construction, helping students understand how perspectives of people within a discipline influence the conclusions reached within that discipline;
- 3. Prejudice reduction, efforts to develop positive attitudes toward different groups;
- 4. Equitable pedagogy, ways to modify teaching to facilitate academic achievement among students from diverse groups; and
- 5. Empowering school culture and social structure, ensuring educational equality and cultural empowerment for students from diverse groups (pp. 4-5).

IMPLICATIONS FOR TEACHING MATHEMATICS

The examples below show how Banks' five dimensions of multicultural education can be used to make mathematics more culturally inclusive.
"Content integration." The first dimension of multicultural mathematics identifies diverse cultural contributions to mathematics. This dimension is important because so many people view mathematics as Eurocentric. Consequently, students from non-European backgrounds may feel that they cannot contribute to the field and thus develop a helpless and powerless attitude toward mathematics. Discussing the contributions of mathematicians from different ethnic groups, nationalities, and genders helps students from diverse cultures overcome some of their fears and negative attitudes toward mathematics.

For example, students can learn about Benjamin Banneker, a self-taught African-American mathematician, who assisted in the surveying of the District of Columbia, wrote almanacs, and created numerous mathematical puzzles (Reimer & Reimer, 1992). Students can talk about Banneker's life and have fun solving some of the puzzles he created.

Histories of mathematical concepts or skills also fall under the category of content integration. For example, several proofs of the Pythagorean Theorem have been found in countries as far apart as Babylonia, China, and India (Joseph, 1987). Discussing these proofs can help students see how different writers can think about the same idea in several different ways.

"Knowledge construction." This component refers not only to group consensus within a discipline but also to the process whereby individual students construct knowledge for themselves. In mathematics classes, teachers can help students understand that even though there are certain elements of mathematics that are universal--such as counting, locating, measuring, designing, playing, and explaining (Bishop, 1988)--there are differences in the ways diverse cultural groups view some of the major aspects of mathematics. For example, Indians and Chinese believe that a result in mathematics can be validated by any method, including visual demonstration, whereas Europeans expect a conjecture to be proven step by step, starting with self-evident axioms.

Teachers can help students see that mathematics is derived from real-life situations by exposing them to ethnomathematics, the mathematics "practiced among identifiable cultural groups, such as national-tribal societies, labor groups, children of certain age brackets, professional classes, and so on" (D'Ambrosio, 1985, p. 45). Ethnomathematical methods vary according to interest, motivation, and certain codes and jargons that do not belong to the realm of academic mathematics.

An example is the "case price technique" developed and used by milk drivers to compute delivery charges. Suppose a driver has an order of 32 quarts of milk at $.68 per quart. Instead of computing 32 x $.68, which is hard to do mentally, the driver might take the case price (a case holds 16 quarts) and double it. If a case costs $10.88, the

driver can compute the cost mentally as $10.88 x 2 (Scribner, 1984).

Discussion of ethnomathematical procedures can prompt the exploration of methods that students bring with them into the classroom. The validation of student-invented algorithms is important for self-esteem and belief in their ability to do mathematics. Moreover, these invented algorithms are grounded in real-life experiences and students' own construction of knowledge, thereby making the mathematics more meaningful.

"Prejudice reduction." Positive attitudes toward different cultural groups can be encouraged by using mathematics to study social or cultural issues. Statistical data can reveal and dispel stereotypes and myths that affect cultural groups. A critical understanding of numerical data prompts individuals to question taken-for-granted assumptions about how society is structured and enables them to act from a more informed position on societal structures and processes (Frankenstein, 1990).

For example, the Percent Culture Inclusive Module (Strutchens, 1992) helps students appreciate the importance of mathematics in their career choices. The module includes national statistics on 8th graders' attitudes toward classes, expected occupations, feelings about school, and problems teenagers have, reported by race and ethnicity. Students are asked to complete surveys on these topics before the national statistics are discussed. Later, the students tally, present, and compare their data to the national data.

Multicultural literature can not only help with content integration but can also help with prejudice reduction by depicting what is unique to a specific culture and what is universal to all cultures. By portraying the nuances and variety of day-to-day living, multicultural literature presents a true picture of the culture it reflects (Bishop, 1992).

For example, The Black Snowman (Mendez, 1989) provides an excellent context for discussing African-American heritage while learning the mathematics involved in recycling bottles and cans. In this story, a teenager and his younger brother discuss collecting bottles and cans to purchase a gift for their mother. The story provides a context for students to talk about environmental and economic issues. Students can discuss whether, in a given amount of time, it is more profitable to collect bottles, or cans, or both. They might also want to contact local recycling companies and compare rates, distance, and hours of operation to see which company provides the best deal.

"Equitable pedagogy." This dimension is concerned mainly with interactions between teachers and students and requires a mutual respect for culture, not just in terms of historical contributions and artifacts, but in every aspect of instruction. Teachers help students make connections between their community, national, ethnic, and global identities (Ladson-Billings, 1990).

Teachers believe that all students can learn mathematics and teach accordingly.

Teachers see themselves as facilitators helping students to construct their own knowledge of mathematics. Teachers understand and accept that learning styles are baseline essentials for providing educational equity in the classroom.

Teachers are passionate about content. Teacher-student relationships are fluid, humanely equitable, and extend beyond the classroom into the community. Teachers encourage students to learn collaboratively; students are expected to teach each other and be responsible for each other (Banks, 1989; Heckman & Weisglass, in press; Ladson-Billings, 1990).

An example of a program that fosters equitable pedagogy is The Algebra Project, a program founded by Robert P. Moses, an African-American mathematician and parent who wanted to ensure that his and other children develop a concrete understanding of algebra. The Algebra Project provides sixth graders with a smooth transition from arithmetic to algebra through a home, community, and school culture and a model of intellectual development based on motivation rather than ability (Moses, Kamii, Swap, & Howard, 1989, p. 423).

For example, to develop understanding of signed numbers, students begin with the physical activity of riding a subway train. As the students and their teacher travel on the subway, they notice where the train stops. Their entry point is considered the origin; stops before the origin are denoted with negative numbers, and stops after, with positive numbers. In this typical lesson, students are taken through five steps to help them understand the concept: (1) a physical event, (2) a picture or model of the event, (3) an intuitive (idiomatic) description of the event, (4) a description in regimented English, and (5) a symbolic representation of the event (Moses et al., 1989).

"Empowering school culture and social structure." Finally, in order to make higher level mathematics accessible to all students, we must examine the dimension of multicultural education that deals with the school culture and social structure. Some of the variables considered here are grouping practices, social climate, assessment practices, participation in extracurricular activities, and staff expectations and responses to diversity.

One of the most critical aspects of mathematics is that it is viewed as a filter that limits students' career aspirations (Sells, 1978). Many students fail to qualify for certain college programs because they have not been adequately prepared in mathematics. Researchers have found that African Americans and other ethnic groups are the predominant groups in lower level classes, where they generally receive substandard instruction and are not adequately prepared to function in society (Oakes, 1990).

College preparatory mathematics or alternative mathematics courses that lead to gainful employment should be available to all students. One such alternative program is the Tech Prep Applied Academics program. Tech Prep is a collaborative effort between

industry and school systems to provide rigorous, competency-based, hands-on, applied academic courses in physics, math, communications, biology, and chemistry to prepare students for high tech careers whose entry point is an associate degree from a community college. Through Tech Prep, students can take applied academic courses along with vocational-technical classes in their junior and senior years in high school and earn credit toward their associate degree (Gayton, 1995). More initiatives of this sort must be devised to provide all students the opportunity to succeed in our technological and multicultural society.

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This digest was funded by the Office of Educational Research and Improvement, U. S. Department of Education under contract no. RR93002013. Opinions expressed in this digest do not necessarily reflect the positions or policies of OERI or the Department of Education.

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Title: Multicultural Mathematics: A More Inclusive Mathematics. ERIC Digest.
Document Type: Information Analyses---ERIC Information Analysis Products (IAPs) (071); Information Analyses---ERIC Digests (Selected) in Full Text (073);
Target Audience: Practitioners
Available From: ERIC/CSMEE, 1929 Kenny Road, Columbus, OH 43210-1080 (single copies free).
Descriptors: Bias, Cultural Enrichment, Elementary Secondary Education, Equal Education, Mathematics Instruction, Multicultural Education, Social Structure
Identifiers: Diversity (Student), ERIC Digests
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