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ABSTRACT

This paper defines ethnomathematics and reviews the methods used to incorporate this philosophy into the current teaching of mathematics. Ethnomathematics rejects inequity, arrogance, and bigotry while challenging the Eurocentric bias that denies the mathematical contributions and rigor of other cultures. A review of the literature shows that the teaching of ethnomathematics will bring awareness to students that Europe is not now nor was it ever the center of civilization. Ultimately, this method will present an accurate history of mathematics, use a variety of examples to solve problems from a variety of cultures, and recognize that learning mathematics is a unique process for every individual. (CCM)

WHAT IS ETHNOMATHEMATICS AND WHY SHOULD WE TEACH IT?

Crossing Cultures: Communicating

Through the Curriculum

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Orange Coast College

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BIOGRAPHICAL SKETCH OF THE PRESENTER

Dr. Eduardo Jesús Arismendi-Pardi was born in the Republic of Venezuela and is currently an Associate Professor of Mathematics at Orange Coast College in Costa Mesa, California where he has been teaching since 1988. He is the author of various publications in mathematics education, curriculum, and applied statistics. Dr. Arismendi-Pardi has been a statistical consultant to the Scandinavian Airline System in Oslo, Norway; the European Quality Alliance (Swissair, Finnair, Lufthansa); and other Southern California corporations including Sorin Biomedical in Irvine and Accuride in Santa Fe Springs. Dr. Arismendi-Pardi has also gained significant leadership experience: He has served as Division Senator and Vice-President of his local Academic Senate, Chair of Faculty Professional Development Institute, and Chair of Mathematics Adjunct Faculty. His biography appears in Who's Who in American Education and Who's Who in Science and Engineering. He was recently nominated as 1999 Faculty Member of the Year at Orange Coast College. Dr. Arismendi-Pardi is the recipient of the 1999 National Institute for Staff and Organizational Development (NISOD) Excellence Award. He resides in Southern California with his wife Cheryl, and his son Mikhail Andrej.

INTRODUCTION

The term "ethnomathematics" was coined by the Brazilian mathematician and philosopher Dr. Ubiratán D'Ambrosio in the early 1980s. He points out (as cited in McLeod, Stake, Schappelle, & Mellissinos, 1995) that ethnomathematics is important in building up a civilization which rejects inequity, arrogance, and bigotry (p. 8). Ethnomathematics is a field of study of the interaction between mathematics and culture. Researchers in this field take into consideration the culture in which mathematics arises and argue that the development of mathematics is not linear. Ethnomathematics challenges the Eurocentric bias that denies the rigor of Egyptian, Japanese, Chinese, Mayan, or Incan mathematics.

What is Ethnomathematics?

The field of ethnomathematics examines "the nature of mathematical ideas, the ways in which those ideas are manifested in cultures, and the ways in which our understanding of these manifestations can lead us to some cross-cultural harmony" (Rauff, 1998, p. 9). Shirley (1992) defines ethnomathematics as the application of mathematics by various cultural groups defined in terms of gender, occupation, age, and ethnicity (p. 2). According to Powell and Frankenstein (1997),

> 'ethno' not only refers to a specific ethnic, national, or racial group, gender, or even professional group, but also to a cultural group defined by a philosophical and ideological perspective. The social and intellectual relations of individuals to nature or the world and to such mind-dependent, cultural objects as productive forces influence products of the mind that are labeled mathematical ideas. (p. 176)

Ethnomathematics links cultural anthropology, cognitive psychology in relation to learning, and mathematics in an effort to correct Eurocentric distortions by challenging the dichotomy that exists between practical and abstract mathematical knowledge (Frankenstein, 1990, p. 341). The teaching of the mathematics curriculum from an ethnomathematical perspective should incorporate economic, political, social, and cultural issues (Frankenstein, p. 345).

The Genesis of the Development of Mathematics

Gheverghese-Joseph (1997) argues that "to Aristotle (fl. 350 B.C.), Egypt was the cradle of mathematics" (p. 65). Since Egypt is in the African continent, this implies that mathematical knowledge developed in Africa as opposed to Greece. In fact, it is plausible that Euclid was an Egyptian since there is no evidence to the contrary (Lumpkin, 1997, p. 106). From an ethnomathematical perspective, "people of color were the original founders and innovators of mathematics and science" (Anderson, 1997, p. 303). According to mathematical historian Katz (1993), the Greeks recorded evidence suggesting that some of their earliest sages studied in Egypt (p. 56). Mathematical historian Rouse-Ball (1960) admits that the "Greeks ... were largely indebted to the previous investigations [made by] the Egyptians" (p. 1). He further argues that Greek geometry was derived from Egypt (Rouse-Ball, p. 6). "The mathematical attainments [and contributions] of other races [and cultures] is imperfect and conjectural" (Rouse-Ball, p. 1). According to Kline (1972),

"many Greeks went to Egypt to ... study" (p. 25). He also asserts that knowledge of Greek mathematics is not as authentic and reliable as that of the Egyptians (Kline, p. 25).

Lumpkin (1996) points out that many mathematical historians have found evidence suggesting that the Egyptians used the zero concept before it was supposedly invented (p. 10). According to Gardner (1978) as cited in Lumpkin (1996), "the Egyptian symbol for zero was a trilateral hieroglyph, with consonant sounds 'nfr'" (p. 10). Canadian mathematician Sangalli (1998) from Champlain College in Quebec, states that "some of the central ideas of differential calculus, such as infinite series, were known to the 15th-century Indian mathematician Madhava of Kerala long before Newton and Leibnitz" (p. 1). Perhaps the reason for the lack of recognition about Sangalli's (1998) assertion is that

> since knowledge is developed in cultures what happens [is that when] mathematical ideas of one culture are encountered by another, ... they ... engage in rivalry for imposing one on the other... Sometimes, when one culture meets another and informs itself of the other it will find a result or an idea known in one culture was also found or known in the other; but history is written by the victorious about the canonical (or official or authorized) version. The ideas of other cultures may be at best rate [just] a footnote... Most mathematicians neither know nor care for the mathematics of other cultures. Often they do not care for the culture of their own mathematics either. They treat mathematics as a subject which has no history and is not the product of past human contribution. (Rajagopal, 1993, pp. 2-3)

Finally, there is no way to deny some successes and contributions made by the Greeks and other Europeans in science and mathematics (D'Ambrosio, 1999, p. 3). However, mathematics

is a cultural product and there is evidence suggesting that its genesis was from the African continent (Anderson, 1997, p. 303; Rauff, 1996, p. 4; Stigler & Hiebert, 1998, p. 4).

Pedagogical Approaches That Challenge Eurocentrism in the Teaching of Mathematics

Western mathematicians often teach from the point of view that mathematics is a unique product derived as a linear progression of mathematical ideas (Rauff, 1993, p. 5). There is, however, a wealth of non-western mathematical knowledge that has been denigrated as "primitive" or completely disregarded (Rauff, p. 5). Powell and Frankenstein (1997), assert that in order to challenge Eurocentrism in the teaching of mathematics, educators must show

> [that the inclusion of] historical information about the mathematical contributions of people from Africa, Asia, and Latin America leads students of color, [women], and working-class students in the United States to develop self-confidence and replace previous feelings of alienation toward mathematics with an attitude that mathematics is intellectually stimulating. (p. 291)

A statement about literacy goals for mathematics and science from a report of the American Association for the Advancement of Science (1989) concurs with Powell and Frankenstein's (1997) assertion in that

> when demographic realities, national needs, and demographic values are taken into account, it becomes clear that the nation can no longer ignore the [mathematics] and science education of any students. Race, language, sex, or economic circumstances must no longer be permitted to be factors in determining who does and who does not receive a good education in [mathematics, science, and technology]. To neglect the science education of any (as has happened too often to [white and non-white] girls and minority [or underrepresented] students) is to deprive them of a basic

> education, handicap them for life, and deprive the nation of talented workers and informed citizens--a loss the nation [cannot] afford. (pp. 156-157)

According to Parnell (1990), the challenge of Eurocentrism in [mathematics] education will require colleges and universities of all kinds to help students to understand the contributions made by people of other cultures (p. 76). This challenge requires a less theoretical mathematics curriculum that is multicultural and international in nature (Botstein, 1997, pp. 217-218; Parnell, p. 76).

In order to challenge Eurocentrism in the teaching of mathematics and to shatter the myth that mathematics was or is a "White man's thing", Anderson (1997, pp. 295-301) suggests that educators must

1. Not separate arithmetic from algebra
2. Teach mathematics from a historical perspective
3. Avoid the use of elitist textbooks
4. Consider cooperative learning approaches to the curriculum
5. Abandon the myth that mathematics is pure abstraction and antithetical to one's cultural and working environment
6. Teach reasoning and problem solving skills as opposed to reinforcing memorization
7. Incorporate lectures and discussions on the historical, cultural, and sociopolitical implications of mathematics
8. Point out that early mathematical developments lead to the building of the pyramids in Egypt and Mexico, the Great Wall of China, and the road to Kathmandu

9. Point out that Egyptian, Mexican, and African cultures developed techniques in iron smelting, metal plating, and surgery--thousands of years before the European civilization

10. Point out that Egyptians, Chinese, and Indians used different styles of mathematical generalizations in algebraic problem solving

11. Discuss the fact that Euclid spent twenty-one years studying and translating mathematical tracts in Egypt

12. Point out that Pythagoras also studied in Egypt; possibly traveled to East India or Persia where he "discovered" the so called Pythagorean Theorem in the Indian Sulbasutras, a collection of mathematical documents (c. 800-500 B.C.)

13. Ask students: "How could a theorem whose proof was recorded in Babylonian documents dating 1,000 years before Pythagoras was born be attributed to Pythagoras?"

14. Point out that certain aspects of European mathematics could have not been developed had not the Europeans traded with more advanced societies

It is important for students to know that Europe is not now, nor was it ever, the center of civilization of the world surrounded by wildness and chaos (Anderson, p. 301). In relation to Eurocentrism in the curriculum it is important to reflect on the tradition that began with Thomas Jefferson, founder of the University of Virginia,

> [urging] his friends not to send their children to Europe to school but rather to keep them in the United States, where a sophisticated education for a young adult might assume a distinctively American stamp and where the life of the

> college student would not be infected by the aristocratic traditions of England or the European continent. (Botstein, 1997, p. 228)

Finally, mathematics educators must teach students to look for more than one way to establish the validity of mathematical statements and results by making connections between different mathematical concepts and ideas (Szombathelyi & Szarvas, 1998, p. 677).

Ascher's Multicultural Mathematics Model

According to the book <u>Ethnomathematics: A Multicultural View of Mathematical Ideas</u> by Ascher (1991) and published by Brooks/Cole, the goals of multicultural mathematics are:

1. To present a more accurate history of mathematics

2. To use mathematical problems and examples from a variety of cultures

3. To recognize that learning mathematics is a unique process for each individual

The application of Ascher's Multicultural Mathematics Model to the curriculum may bring about the following outcomes: (a) increase the mutual respect, pride, and understanding that comes from the knowledge that all cultures have made contributions to the development of mathematics, (b) improve instruction by relating college mathematics to real-world applications, (c) provide opportunities to implement the National Council of Teachers of Mathematics (NCTM) standards, (d) humanize mathematics by demonstrating that the field developed as a human response to human needs, and (e) inclusion of all students from all cultures in mathematics--it is imperative to do this since

cultural diversity is likely to continue to increase in California. One pedagogical reason for the inclusion of this model is that in relation to the branch of constructivism, the mathematics curriculum should consider the personal, social, and cultural views of students. Another pedagogical reason for inclusion of Ascher's (1991) model is that "mathematical learning is both an active individual process and a process of enculturation into the mathematical practices of ... society" (Cobb, 1994, p. 13). The teaching of mathematics, from a multicultural perspective, has a variety of different cultural basis and reasoning schemes of logic derived from a variety of societal groups (Flores, 1999, pp. 1-2).

The educational benefits of implementing Ascher's (1991) Multicultural Mathematics Model are:

1. Increased student awareness of the role of mathematics in all societies

2. Realization that mathematical practices arose out of people's needs and interests

3. Increased appreciation of the contributions of other cultures from their own

4. Linking the study of mathematics to other disciplines

5. Recognizing the cultural heritage of underrepresented students in an effort to build their self-esteem and encourage them to become interested in mathematics.

Finally, Shirley (1992) concurs with the above benefits of implementing Ascher's (1991) model in that

> this can help build the self-esteem of students as they see their home culture or the culture of their ancestors [using] mathematics and [contributing] to the development of mathematics. It can encourage students from underrepresented groups ... to excel in mathematics by demonstrating historical and present role models and generally by showing that people of their groups can indeed succeed in mathematics... reaching out to include more positive roles of women in mathematics and, notably, applying the NCTM Standards of Mathematical Connections to see mathematics in many different careers and the daily life of children and adults. (p. 2)

Improvement of the Educational Process

Educational practice in higher education should be improved because it is expected that the teaching of ethnomathematics will encourage students and faculty to view mathematics as a product of society. The teaching of ethnomathematics can also improve the educational process in that the field presents an overview of how mathematical knowledge is not neutral and discusses the ways in which mathematical knowledge is shaped by cultural influences.

DISCUSSION AND CONCLUSIONS

Discussion

Mathematical concepts do not exist in isolation. Ethnomathematics challenges the view held by many educational practitioners that mathematics is an objective and neutral field free from human concerns. This Eurocentric view of mathematics coupled with the myth that white men are biologically superior to women and members of other cultures make a career in the mathematical sciences less attractive to women and other underrepresented students.

Ethnomathematics challenges and questions the Eurocentric views held by great mathematicians, Paul Halmos and G. H. Hardy, that applied mathematics is bad mathematics. This view may imply that the pyramids of Egypt and Mexico are examples of bad mathematics. A true mathematician, in my opinion, has respect for all parts of mathematics. The segregation of the field into labels such as "applied", "theoretical", "computational", "conceptual" is elitist. Ethnomathematics also challenges the belief held by many mathematicians that proofs are the only road to understanding mathematics.

The mathematical contributions of Africa are still unacknowledged by European and North American historians. Unfortunately--and sadly enough--many of my colleagues and thousands of practicing mathematicians and educators still teach the accepted history that mathematics is of European origin. They, according to this view, teach a version of history that mathematics began in Greece and that after the decline of the Greek Empire, no progress was made until Europe was ready to advance again during the Renaissance.

The Egyptian contributions to mathematics did not end by the conquest of Alexander the Great. In fact, the intellectual center of the Greek speaking world was Alexandria, a city built by order of Alexander who was attracted by the great wealth and learning of Egypt. The people of Alexandria were, according to historical evidence, African people of Egypt with a few immigrants from Greece, Asia, and other neighboring African countries. Though Alexandrian mathematicians wrote many

documents in Greek, their use of the Greek language does not make them European just as the use of English by Nigerians does not change their nationality.

Conclusion

Ethnomathematics rejects inequity, arrogance, and bigotry while challenging the Eurocentric bias that denies the mathematical contributions and rigor of other cultures. Ethnomathematics teaches that Egypt was the cradle of mathematics. Mathematics is a cultural product and as such educators have the responsibility to include historical information concerning the contributions to the field by people of various cultures.

The teaching of ethnomathematics will bring awareness to students that Europe is not now nor was it ever the center of civilization. Educational practitioners of mathematics should teach students to consider multiple approaches in their efforts to validate mathematical statements by making comparisons between different ideas. The goal of ethnomathematics is to present an accurate history of mathematics, use a variety of examples to solve problems from a variety of cultures, and recognize that learning mathematics is a unique process for each individual. Ethnomathematics recognizes the cultural heritage of underrepresented students in an effort to build their self-esteem and encourage them to become interested in mathematics.

Finally, the ramifications of an ethnomathematics curriculum will bring about various benefits to higher education:

1. Greater awareness of faculty and students that

mathematics and culture are linked on the premise that mathematical knowledge manifests itself through symbols, jargons, codes, myths, and ways of reasoning and making inferences.

2. Greater probability of success in mathematics by underrepresented students.

3. Increased awareness of the mathematical contributions made by women and members of other cultures.

4. Challenge the myth that men have more mathematical aptitude than women.

5. Create faculty and student awareness that all people, whether literate or illiterate, are cultural actors in the development of mathematics as a cultural product.

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