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Discovery and Transformation: Results of Teachers a New Mathematics Education Course

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by

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Introduction

After teaching mathematics methods to prospective elementary school teachers for seven years, I realized that few of those students showed appreciation for the notion that every culture on this earth has made some contribution to the field of mathematics. The students truly seemed oblivious to any notion that much of the mathematics we study today has non-European roots. They were not able to engage in meaningful discourse regarding the development or historical foundations of most mathematical concepts covered in the course, though many of the students had long lists of completed mathematics courses. They knew mathematical definitions, proofs, rules, procedures, and algorithms, but they did not indicate an understanding that people from other cultures often employ different definitions, proofs, rules, procedures, and algorithms (or different interpretation of the aforementioned items) as they employ mathematics to work, solve problems, create, and participate in recreation activities.

I was particularly alarmed because the students often voiced concern for how to motivate a diverse population of children with mathematics. However, the students showed only the slightest interest in leaving their cultural comfort zone and venturing out to discover the cultural side of mathematics, a side useful for designing motivating curriculum, instruction, and assessment that might enhance the mathematics learning of all children. In addition, I was challenged by my students' lack of effort to search for and use available resources (e.g., the Internet, textbooks) that might help them understand the many cultural underpinnings of mathematics. The students consistently voiced their concern for finding ways to pique children's interest in mathematics and ways to provide an anchor for children's lifelong engagement in mathematics. However, the students were not willing to explore the various cultures school-age children represent nor other cultures outside of their own to examine mathematics that encompasses interesting stories about people, places, events, etc. that relate to the mathematics we teach in our schools today.

At a time when I was thinking about how I could make a difference in these future teachers' lives related to this topic, the chair of my department offered me the opportunity to develop a new course for preservice elementary teachers. I was free to choose a topic of interest and need in the department. I quickly decided to design and teach the course, Multicultural Mathematics. What I thought was going to be just another mathematics education course to fill a need in the teacher education program, as I had previously observed, resulted in a very rewarding personal and professional experience. In this article, I share a description of the course and my reflections after teaching three semesters of the course.

Description of the Course

I designed Multicultural Mathematics to assist the students in an exploration of the multiculturalism of mathematics—to, in fact, help the future teacher of mathematics view the people, the culture, the ethnicity, the traditions, the historical applications, and the ingenuity

behind the mathematics we teach. A specific goal of the course was to empower these prospective teachers to develop and consider different perspectives about mathematics and the influences of people in various cultures on modern mathematics. We examined multicultural mathematics from a local and global perspective to collect ideas, skills, strategies, and concepts for teaching mathematics that would be meaningful, interesting, and relevant to the ever-changing population of America's school-age children. My goal was to facilitate the future teachers' examination of mathematics from an approach that incorporated the historical (past events), humanistic (humanity's use and understanding of mathematics), and cultural (personal and group influences) characteristics of mathematics. I designed the course to encourage students enrolled to look beyond the numbers and symbols of mathematical language and look at the people, places, how's, why's, and when's, etc. that have resulted in mathematics and its applications at various points in time.

Textbooks

Initially, I required two textbooks for the course. I chose *Multicultural Mathematics: Teaching Mathematics from a Global Perspective* (Nelson, Joseph, & Williams, 1993) because the authors provide a thorough discussion of the role of general multicultural education as well as specifics concerning multicultural mathematics. They suggest that

> the mathematics curriculum must provide opportunities for all pupils to recognize that all cultures engage in mathematical activity and no single culture has a monopoly on mathematical achievement. All pupils must be given the opportunity to enrich their mathematical experience by selection of appropriate materials to stimulate and develop the knowledge, understanding, and skills which they will need for adult life and employment ... in the 21st century. Mathematical experience may be enriched by examples from a variety of cultures (e.g., Vedic arithmetic enhances understanding of number, Islamic art patterns are based on complex geometric construction, and the Chinese had a rod numeral method of solving simultaneous equations that leads naturally to methods used in higher mathematics). (p. 19)

Claudia Zaslavsky can be considered a trailblazer for multicultural mathematics within the discipline of mathematics education. In the second book I chose for the course, Africa Counts: Number and Pattern in African Culture (Zaslavsky, 1973), Zaslavsky presents a thorough description of the contributions that African peoples have made to the field of mathematics. She focuses on numbers, counting, and patterns as well as on geometry, art, architecture, and games in African cultures. Zaslavsky introduces the reader to a variety of ways African cultures have influenced the mathematics we use today for working, playing, and solving everyday problems.

The second and third time I taught the course, I also used The Multicultural Math Classroom: Bringing in the World (Zaslavsky, 1996). In this text, Zaslavsky provides examples of mathematical ideas in a variety of cultures (e.g., American Indian, Egyptian, Chinese, etc.) and ideas for instructional lessons and units for multicultural mathematics. In addition, she provides some insight regarding the many ways that people currently use mathematics in a cultural context (e.g., in research and discussion of social issues like air pollution, smoking, mortality rates, etc.). This book provides ideas for lessons and projects that these future teachers could facilitate in their own classrooms.

Additional Readings

The first and second semester I taught the course, I required each student to choose two articles from a reading list (see reading list at end of this article) and to present an overview and implications of the article to the class. The students' reviews were stimuli for engaging discussions about the role multiculturalism can play in helping school-age children develop understanding of and appreciation for mathematics. These discussions also led to opportunities for debate of issues such as which cultures should receive focus when teaching multicultural mathematics, whether or not mathematics is a true universal language, and whether or not multicultural mathematics should be taught in February during Black History Month or year round. A variety of comments, questions, concerns, and suggestions created a rich platform for classroom discourse.

The third semester I taught the course, I allowed students to choose their own articles, as I realized that my list, though it provided focus, also presented limitations on the kinds of articles students could possibly read. The alleviation of an assigned list of readings allowed the students to chose Internet articles and articles from journals that were not available in our university library, but which the students ordered from other libraries. This broadened our exposure to literature about multicultural mathematics. Furthermore, the students felt that they were making a greater contribution to the class by presenting articles they had chosen as worthwhile. Throughout all of the semesters, many articles were revisited on various occasions to support or refute current ideas or suggestions.

Assessment

I included a variety of assessment techniques to determine what the students were learning about multicultural mathematics. While planning the assessments for the course, I kept in mind the goal of using alternative methods and methods that would support the curriculum for the course. The assessments also represented my attention to providing opportunities for students with various learning styles to have opportunities for success with the assessments. During the three semesters, I used a combination of assessment methods chosen from those described below.

In-Class/Weekly Activities. There were hands-on, individual, and group activities on a weekly basis. (The courses met just once per week.) These activities involved the students' development and use of ideas and tools for teaching and learning multicultural mathematics in the elementary classroom. The students' feedback related to these weekly activities revealed that the students appreciated the intense nature of the course. The activities included, but were not limited to, those listed in Table 1.

Table 1. In-class/weekly activities.

Activity	Example Contexts
View and discuss videotapes	The Fantastic World of M. C. Escher (Emmer, 1994)
Participate in explorations	Examine the mathematics of world landmarks
Review and discuss readings	From texts and articles
Solve and pose problems	Use Egyptian method of multiplication
Participate in hands-on activities	Make a set of Tangrams (a Chinese puzzle)
Take impromptu quizzes	Recall numbers in various languages
Develop and use teaching	Make abaci from everyday materials (Japan)
Give impromptu or planned presentations	Topics chosen by students
Participate in out-of-class activities	Find artwork that employs African Adrinka patterns
Play games	Mancala (African), Nim (Chinese)

Maps of the World. Each semester, I assigned every student a map of some portion of the world. All of the seven continents were included. Some students received maps that had only one continent represented. Some students received maps that had pieces of several continents. For each meeting day of the course, I required the students to present an activity to the class based on the mathematics contribution of some city, state, country, province, etc. in the region designated by the map. These 10 to 20-minute, hands-on, interactive activities included the distribution of a prepared handout with directions and explanations regarding the particular multicultural aspect of the context in which the mathematics was presented. The students were required to make enough materials for everyone so that all persons could build a file of multicultural mathematics materials for future use. In Table 2, I list some of the topics the students explored and shared with the class and that represent the types of activities I shared with them.

Table 2. Examples from maps of the world assessment.

Region of the World (Historical/Current)	Exploration Topics	Mathematics Topic
Africa	Mende Addition method	Addition
Babylonia	Babylonian numerals	Numerals
China	Chinese fraction reduction	Fractions, simplification
China	Magic Squares	Addition
Egypt	Sieve of Eratosthenes	Prime numbers
France	Pascal' s Triangle	Patterns
Germany	Mobius Strip	Geometry, topology
Greece	Golden Rectangle	Area, proportion, geometry
India	Vedic Square	Shapes of numbers
Japan	Soroban (abacus)	All basic operations
Maya	Bul - Mayan game of chance	Probability
Rome	Kalendarium	System of dating (time)
Scotland	Napier's Bones	Multiplication
South America	Quipu/Khipu	Count, record keeping
United States	Native American Art	Geometry, patterns

Portfolio. The students were required to complete a multicultural mathematics portfolio. The portfolios provided an opportunity for students to explore their perceptions of their cultural selves and to plan for application course experiences and concepts in their future classrooms. From the portfolio assessment, I could determine students' level of growth on the topic of multicultural mathematics and its application in today's classrooms. The students' synthesis of information and development of original and personal ideas related to the topic were key components in my evaluation of the portfolios.

The model for the portfolio is given in Figure 1. Each section and subsection contained a personal reflection paper and at least two supportive tangible documents or evidence (e.g., photographs, newspaper clippings, etc.). Because I reassured the students that the portfolios would be returned without any materials removed, the students were free to add personal artifacts and treasured pieces of evidence (e.g., great grandmother's hand-written recipes of traditional meals). I encouraged the students to insert additional components in the portfolio that they thought might assist them when they were using the portfolio when planning for teaching multicultural mathematics. Many students took this opportunity to select model assignments that I and other students had given, additional articles they had found in journals, and a host of other materials that they thought would benefit them in their own classrooms.

Multicultural Mathematics Portfolio

I. My Cultural Self
II. Examples of Mathematical Contributions from or Participation by African Americans, Asian Americans, Mexican Americans, Native Americans, and Puerto Ricans
III. How I Plan to Connect to the Community in Which I Teach
IV. My Goals for Teaching Multicultural Mathematics
V. How and What to Learn about My Multicultural Students
VI. How to Create a Multicultural Classroom Environment/What One Looks Like
VII. How to Teach Mathematics from a Multicultural Perspective
VIII. Plans for Informing Students, Parents, Colleagues, and Administrators about Multicultural Mathematics
IX. Examples of Multicultural Resources and Activities for Teaching Multicultural Mathematics

Figure 1. Model for portfolio

Group Project. Each semester, I divided the classes into groups of three or four students. Each group was responsible for the development and facilitation of a multicultural mathematics display table (similar to a freestanding poster presentation) during the last week of class. The groups displayed their projects for two hours and each person in the group was required to be at the table at all times. I encouraged the groups to place the tables in conspicuous places in or outside of the building to encourage the greatest amount of attention from students, staff, professors, and visitors in the college. The groups were responsible for the publicity and content of their display. The groups prepared several brief experiences that persons who stopped by the tables could participate in. These experiences were similar to the explorations and activities the students experienced in class. At least one person was responsible for documenting how many persons visited the table, what they did while at the table, and coordinating a summative report

about what happened during the two hours. The groups also prepared informational pamphlets and sample packets of materials (e.g., multicultural mathematics games, articles) that were distributed to the persons who stopped by the tables.

The goal of this assignment was to assess (1) what the students learned about multicultural mathematics, (2) their strategies for presenting the information to other people, (3) their development and/or collection of materials for promoting multicultural mathematics, and (4) their effectiveness in promoting multicultural mathematics to people from various backgrounds (e.g., academic major, cultural, ethnic, socioeconomic, etc.). In addition, I wanted the students to experience people's reactions to the topic of multicultural mathematics in order that they might be prepared to handle a variety of reactions in the future.

Reflections and Conclusion

My review of the three semesters for which I have taught Multicultural Mathematics leaves me with one main conclusion: It is the best course I have ever taught. I developed this conclusion for two reasons. First, from a professional point of view, the course has given me an opportunity to make a difference in how these prospective elementary teachers potentially will approach the teaching of mathematics to children. The nature of the course (exploratory, experiential, and emergent) has allowed me the flexibility to model a variety of assessment methods that can be used to examine children's mathematics learning. Some of the methods were obvious in the description of the course and some were subtly used in the course. Table 3 lists at least ten ways I was able to assess the students.

Table 3. Assessment methods.

General Method	Example Specific to the Course
Demonstration	Modeling the making of objects
Discourse	Discussions resulting from review of texts and articles
Games	Playing various multicultural games with mathematical foundations
Group Project	Multicultural Mathematics Display
Homework	Develop extensions to explorations experienced in class
Observation	Observation of students during group project display
Oral Presentation	Presentation of map of the world exploration
Portfolio	Multicultural Mathematics Portfolio
Questioning	Questions resulting from a variety of in-class experiences
Writing	Written article reviews, reflection papers in portfolio

To date, I have not used written tests in the course. I have been able to gather sufficient assessment and evaluation data without using written tests. In addition, I plan to continue to focus on helping future teachers develop awareness of multicultural mathematics, plan for ways to teach multicultural mathematics, and explore various tools and resources that might assist them in this endeavor. I do not want written tests to focus the students' attention on the memorization of facts related to multicultural mathematics, as those facts are easily accessible from a variety of sources. The students applaud the absence of written tests and the accompanying pressure of studying for them. The students do not in any way take the assessment for the course less

seriously than for any other course just because there are not written tests. In fact, several students have "wished" for a test instead of several other assessment methods as they recognize the effort involved in preparing for the assessments used in the course.

As a mathematics educator, I feel that this course is one of the many ways I make a contribution to the discipline of mathematics education. I want to be a part of improving the teaching and learning of mathematics in today's classroom. This course helps to prepare future teachers for the task of presenting mathematics as a human product, an interesting and worthwhile subject, and subject related to many other disciplines and subjects. In addition, several students enrolled in the course shared that they did not even consider themselves as having a culture. My efforts in this course have helped future teachers of mathematics feel more confident about who they are as people and to value not only their own newly-realized culture, but the culture of the children they teach. This alone has been a very rewarding result for me as an educator.

On a personal note: For many years I felt detached from my position as a mathematics educator. What I mean is that I was committed to doing a good job, but I was never able to see "me" in my job until I developed and implemented this course. It has made a remarkable difference in my attitude as a professor that I am able to be a real part of something that I am teaching. For all the years I studied mathematics and taught mathematics, I never saw myself in any concept, skill, idea, etc. Teaching Multicultural Mathematics has made me a better educator in all of the courses that I teach.

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