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Mathematics of students' culture: A goal of localized ethnomathematics

Matemáticas de la cultura de los estudiantes: el objetivo de las etnomatemáticas localizadas

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Abstract

Ethnomathematics is the mathematics of cultural groups, but often those cultural groups are "others" and "elsewhere". However, it is also valuable to look inward to see the interaction of mathematics and one's own culture. An assignment in a graduate course offers this opportunity to students. The assignment is to find an area of the student's personal "culture" (sometimes defined rather broadly) and find its use of mathematics. Students are asked to write about (a) the cultural area; (b) how they are personally tied to it; and (c) how and where it uses mathematics. In addition to the paper, students make an oral presentation. Thus, all students learn (often surprising) aspects of their classmates' non-professional life, and the presenter digs into areas of family and heritage that may not have been reviewed before. Since all students are classroom mathematics teachers, finding their own cultural mathematics is not only enlightening for themselves, but also offers opportunities to include new mathematics applications in their teaching. This paper includes much personal background that led to this assignment and is a report on more than a decade of using it, including brief student examples.

Keywords: Ethnomathematics; Teacher Education, Classroom, Cultures of students and teachers, Cross-cultural education

Resumen

La etnomatemática es la matemática de grupos culturales, pero a menudo los grupos culturales son "otros" y están en "otros lugares". Sin embargo, también es valioso para mirar hacia adentro para ver la interacción de las matemáticas y la cultura de uno mismo. Una tarea en una clase de postgrado ofrece esta oportunidad a los estudiantes. La asignación es encontrar un área de "cultura" personal del alumno (a veces definida más bien en términos generales) y encontrar su uso de las matemáticas. Se les pide a los estudiantes a escribir sobre (a) el área cultural; (B) la forma en que están personalmente vinculados a ella; y (c) cómo y dónde se utiliza la matemática. Además del papel, los estudiantes hacen una presentación oral. Por lo tanto, todos los estudiantes aprenden aspectos (a menudo sorprendentes) de la vida no profesional de los compañeros, y el presentador indaga en las áreas de la familia y el patrimonio que pueden no haber sido consideradas antes. Dado que todos los alumnos son profesores de matemáticas del aula, la búsqueda de sus propias matemáticas culturales no sólo es esclarecedor para sí mismos, sino que también ofrece oportunidades para incluir nuevas aplicaciones matemáticas en su enseñanza. Este trabajo incluye los antecedentes personales que llevaron a esta tarea y es un informe sobre más de una década de uso de esta, incluyendo breves ejemplos de los estudiantes.

Palabras clave: Etnomatemática, educación del maestro, clase, culturas de los estudiantes y profesores, la educación intercultural

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INTRODUCTION AND BACKGROUND

This paper is about the interaction of the cultures of students and teachers, and how this interaction can contribute to mutual learning. It is drawn from personal experience, and especially a class assignment which will be described below. I write in first person to emphasize this personal reflective theme. My experience in ethnomathematics and my thoughts about the field are closely related, so, I want to begin by explaining my experience to demonstrate how I came to this topic.

There are two streams of experience that flow together in my ethnomathematics work. First, I am a mathematics educator by my training and my work throughout my entire career. I have now been a mathematics teacher and/or a teacher of mathematics teachers for forty-five years. I approach the teaching of mathematics from the point of view of the student and the teacher, so, like many teachers, I often incorporate my real-life experience into my personal mathematics curriculum and instruction. My encounters with out-of-school mathematics and cross-cultural mathematics situations, which constitute most of my personal ethnomathematics experience, become examples and even curricular programs in my mathematics teaching.

My other major experience was teaching secondary-level mathematics in Sierra Leone through the United States Peace Corps for three years and then independently teaching mathematics teacher education at Ahmadu Bello University in Nigeria for fifteen years. Although I have now taught one-and-a-half times as long in the United States, those eighteen years in West Africa provided much direction to my work. When I first encountered "mathematics of cultural groups" in West Africa, it was not yet called "ethnomathematics", but it became my academic interest for the rest of my career.

In Sierra Leone, I was just learning of the Mende/Sherbro culture of my area, so I did not immediately know any good examples, but my students helped teach me. I learned of grouping by fives in Sherbro counting and by twenties in the Mende language (the word for twenty is *nu gboiyango*, which literally translates as "one person is finished"—we used all his fingers and toes!). I learned about the design of fish-traps and the artistic/technical details of traditional tie-dye cloth. Reaching over to ethnoscience, when I briefly taught Form 2 General Science, I arranged for a government nutritionist to come to tell the class

about the food values of local foods—including the fact that certain bug larvae are high in protein. More formally, I was pleased to be a part of a curriculum implementation project of introducing a new mathematics textbook series, the Joint Schools Project (Mitchelmore & Raynor, 1968-1972)—the first to be written in West Africa and to incorporate true-life examples from the students' culture.

LEARNING NIGERIAN CULTURE FROM--AND BY--STUDENTS

I stayed in Nigeria much longer and picked up more of the culture, but once again, it was a case of the students teaching the teacher. I posted a flyer around the campus, asking students to tell me how they count in their home languages (English is the language of education throughout Nigeria) and received nearly thirty samples of counting systems in Nigerian languages (the most interesting was the Mada language, which uses a pure base-twelve system at least as high as 12^2=144) (Shirley, 1988b). A more significant effect on my teaching was when I started teaching History of Mathematics and felt embarrassingly Euro-centric as I told of Newton, Gauss, and Descartes. Although we eventually founded the African Mathematics Union Commission on the History of Mathematics in Africa (with Paulus Gerdes), it remains difficult to find good classroom examples of the history of mathematics in Africa. To broaden my search, I looked for examples that were not necessarily historical, but did demonstrate mathematics in Nigerian culture. For me, that was my doorway to ethnomathematics.

When ethnomathematics is defined as the "mathematics of cultural groups" there is often a tendency to interpret that as <u>other</u> cultural groups—especially among Western educators. Probably this is a left-over attitude from older anthropology studies of the "exotic Other" (note that I am using this terminology <u>not</u> as my own). Anthropologists encountered people whose culture is different from their own, so they studied it—somewhat with the implication that their own culture was the standard, so deviations must be interesting. However, when educators are working in their own culture or when outsiders stay long enough to feel at home, the "otherness" isn't so strong. We just want to look at mathematics of cultural groups, whatever they may be.

Similarly, one's own culture may seem so commonplace, that special details, especially in this context, mathematical details, may not seem interesting or worthy of study. Just as it is said that mathematicians may sometimes not recognize mathematics in other cultures, it may be difficult to note mathematics in one's own culture. Part of the ethnomathematical job of mathematics educators should be to help students find mathematics in their own home cultures. This is true for outsider mathematics educators as well as mathematics teachers teaching within their own culture.

I have already indicated that my students taught me about their cultures—and often, as they taught me, they learned new ways of looking at their own cultures. This became more formalized as I supervised undergraduate and post-graduate research at Ahmadu Bello University. I encouraged students at both levels to organize projects of observations, readings, and interviews to investigate aspects of their home cultures. In many cases, they had been immersed in the English-language, mostly-Western-oriented culture of formal education for so many years, it took some deliberate efforts to study their own home cultures. I suggested they talk with parents, uncles and aunts, and grandparents who were often much more closely connected to the traditional way of life. Many of the results looked like other ethnomathematical studies: they reported more on counting words; they described art, architectural, and craft products which showed geometrical design and structure; they played games of mathematical processes and strategies; and, perhaps most interesting, they found ways that unschooled relatives handled mathematical problems with creative techniques. I even reported some of the arithmetical examples at an ICME conference (Shirley, 1988a), calling them "ethnoalgorithms" (one notable example involved double-digit addition, where the unschooled respondents essentially added the tens column before the units—not very common in school mathematics, but supported by instructional scholars). One project group compiled a dictionary of mathematical terms and equivalent expressions in four local languages which would be a useful tool for mathematics teachers reaching out to students for whom English is still challenging.

Some results received enough recognition such that this student work caused Ahmadu Bello University to be noted as an ethnomathematics center (Gerdes, 1997). More important, these students went out to be mathematics teachers, university faculty members,

officers in ministries of education, and contributors to textbooks and other curricula, where they could continue to report and use the ethnomathematical examples they and their classmates had found. Most significantly, they gained new appreciation of their home cultural practices (which some had left behind) and of the many applications of mathematics far from a classroom or textbook.

MY ETHNOMATHEMATICS IN THE UNITED STATES

After I left Nigeria to return to the United States, I began to seek new studies of ethnomathematics. I spoke about West African mathematics at some teacher workshops and conferences and contributed to some teacher journals. I again started teaching a course on History of Mathematics and found ways to include some of the West African examples I had learned in Sierra Leone and Nigeria. On a visit to Ghana, I took photos and collected artifacts to use in my classes and presentations. I was working to bring these ethnomathematical ideas from West Africa to American audiences, educating them in West African culture and in applications of mathematics.

These educational applications of ethnomathematics were successful and helped me to make my own transition back to the U.S., after a long time away from American educational curricula, instructional practices and research processes. However, it remained a way of looking back and not relating well to my new students. I had not yet recognized the idea raised early in this paper, that ethnomathematics in education should include encouraging students to study their own cultures, seeking mathematics in their own cultural groups. I had encouraged my Sierra Leone secondary students and my Nigerian university students to look away from and beyond their standard mathematics curricula to find cultural applications of mathematics. Now, back in the United States, I needed to have the same kind of assignment.

Multicultural education in the United States has often been characterized as emphasizing examples of African, Mayan, Chinese, and native American cultures. Again, it seems somewhat of a case of highlighting the Other. It might have been justified as raising levels of self-esteem of minority students, but it often did not bring the hoped-for integration of cultures, but only African studies for African-American students, Chinese examples for

Asian-American students, and so on. Rather, instead of re-segregating, the goal should be for all students to recognize values and achievements of all cultures. Besides missing the goals of integration, a side effect was that sometimes majority students came to feel they had no culture.

I received an opportunity to help students study their own cultures through a new graduate course in our then-new Master of Science in Mathematics Education degree program. The program included advanced mathematics content courses, courses in mathematics education curriculum, some courses drawn from Education master's degree programs—and a course entitled Cultural and Philosophical Background of Mathematics.

I described my original plans for this course at the First International Conference on Ethnomathematics (ICEM-1) (Shirley, 1998), and mentioned the course at the Fifth Brazilian Ethnomathematics Conference (Shirley, 2012).

"MATHEMATICS IN MY OWN CULTURE" ASSIGNMENT

This course is a broad overview of where mathematics comes from, with a review of philosophies of Platonism and formalism, discussions of the crises in mathematics from Pythagoras noticing irrational numbers, to non-Euclidian geometries, to the foundationalism early in the 20th century, and Gödel's Incompleteness Theorem. It looks at the culture of mathematics from number curiosities to famous puzzles and problems. And—of particular interest here—it includes several classes on ethnomathematics.

In the ethnomathematics portion of the course, we read from Ascher (1991), seeing her collection of examples of mathematical thought in non-western cultures. Also, readings from the Powell & Frankenstein (1997) anthology show more sociological and political examples. We also look at how ethnomathematics can help create a more global view of school mathematics. However, my favorite part of the class, and the part I consider most important, is an assignment called "Mathematics in My Own Culture". Students, who are all classroom mathematics teachers, are required to consider their own personal cultural background and find some mathematics. They report their findings in an oral presentation and a term paper.

For many, the hardest part is finding their own culture! As described earlier, their multicultural experiences have often focused on the cultures of Others (still upper-case "O"!), such that they often feel they do not have any culture! To help them, I do allow a rather broad definition of "culture". It may be their heritage from ethnic, religious, geographical, and/or social class background. It can draw on long-standing family activities and customs, or experiences of family members, or their own life experiences. If they still have trouble finding their culture, they can even use their hobbies, favorite sports, cooking, or other personal activities. The definition of culture almost becomes "any part of your life—except your job as a mathematics teacher". I especially like them to choose topics that require them to dig into family history and even to interview family members. They do research on the topic, often gaining more formal content than they even know from their experience. Then, since this is a mathematics class and this is an ethnomathematics assignment, they look for mathematics within the topic.

The results have been exciting and often surprising. In many cases, the students have been together as a cohort group for several semesters, but they know little about each other. The assignment shows the human side of each student—beyond their job role as a mathematics teacher. A few examples:

- A very serious, quiet student let the class know that for over a decade, he had spent summer vacations working as a clown, notably doing juggling—which has been studied for its application of group theory and other mathematics.
- One student came from a long-time Maryland family, working for several generations in the fishing and crabbing business; he brought a large fish-trap to class, and explained the engineering design of the trap and other aspects of successfully catching crabs
- Several students explained their family's dancing heritage and described intricate rhythm patterns (One got the entire class to dance around the room!); also we learned of punk rock music and marching bands.
- One student explained she had recently been caught up in her fiancé's strange hobby of "pumpkin chunking" which uses large hand-made wooden catapults to shoot

pumpkins in competition for distance flown—this requires much mathematics in physics and engineering

- Several students have described their activities in sports; however, one *started* to research a family tradition of playing football, only to learn that for three generations, his family had been involved in volunteer community development (youth football was only a small part of the work), including scheduling, logistics management, budgets, and demographics—public service and support, helped by mathematics
- Foods, cooking, and baking have been popular topics—cheese-making, cakes, gingerbread houses, and pancakes; the class was often treated to samples!
- Biblical numerology, Jewish Torah codes, Islamic architecture, Ukrainian Easter eggs, and Polish paper-cutting art integrated religion, mathematics, and often art.
- Geographically, we learned of the Pittsburgh steel industry, small town life, a historic old neighborhood of Baltimore, and early tobacco farming in southern Maryland
- Often personal situations have become culture: buying a house; caring for a new baby (the baby was born during the class' semester!); overcoming dyslexia; and taking care of a family member with multiple sclerosis, including modifications in structures in the house to accommodate a wheel-chair.

An extra challenge for me came when I taught the same course in Shanghai, China—in a culture that was new to me. The assignment worked just as well—again asking mathematics teachers to look into their personal cultures, find some mathematics, and report to their classmates. We learned of Chinese calligraphy and Beijing's Temple of Heaven, but also of the Minesweeper game, badminton, and an active concern for environmental protection.

The assignment has more than met its objective. It demonstrates to students that, with some probing, mathematics can be found nearly everywhere, and that ethnomathematics as the mathematics of cultural groups can tie together this wide range of applications. It encourages students to look into their families and themselves to recognize cultures they

barely realized they had—indeed, it does increase self-esteem. However, much more broadly, it teaches that all cultures can be interesting and have value, often demonstrating surprises about people they thought they knew. This assignment was used in a graduate class of on-the-job teachers. Several reported back that they had also made similar assignments in middle and secondary school mathematics classes, thus spreading the ideas of mathematics and culture ever wider.

CONCLUSION

Since I first taught in Sierra Leone and advised research projects in Nigeria, I have always learned ethnomathematics from my students. With this class assignment, I get the opportunity to learn of more cultures each semester. Each time I use this assignment, I feel the students and I learn much about each other, about cultures and about the "mathematics of cultural groups"—that's the definition of ethnomathematics. If we sometimes accuse ethnomathematics of exploiting other cultures, here is an antidote: We can use ethnomathematics, as in this assignment, to open doors of our own cultures and highlight mathematics in the cultures. Ethnomathematics can show the way to better understanding of faraway cultures, of our neighbor's cultures, and our own. I fear that often ethnomathematical research is not appropriately reflected in classrooms. I hope these thoughts can encourage teachers at all levels to consider using ethnomathematical education for the mutual benefit of themselves and their students.

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