ETHNOMATHEMATICS IN THE CLASSROOM

Athena Ross

Appalachian State University[1]

Cacey Wells

Appalachian State University, USA
wellscl1@appstate.edu

The elementary school years are fundamental for many children across the United States. Young children learn not only foundational knowledge, but social skills and independence as well. When recalling elementary school mathematics, many might think about learning principles associated with counting, arithmetic, pattern recognition, and simple equations. But, if many of us consider our most memorable learning experiences, mathematics is often not one of the first positive experiences that comes to mind (Wells, 2023). Oftentimes mathematics is met with anxiety and has the tendency to be many students' least favorite subject (Bursal & Paznokas, 2006). This can have a very negative connotation – especially for young girls and children of color (Boaler, 2016; Bursal M. & Paznokas, 2006). We see this manifest itself further in the field of education as mathematics anxiety in pre-service elementary teachers' impacts their confidence to teach mathematics and science. It is not a surprise then that students tend to be easily frustrated by math. This lack of joy seems to prevent students from making authentic connections between mathematics in classrooms and their lived experiences. What if instead of leaving students feeling disconnected from mathematics, we found culturally relevant ways to help young learners build connections? As teachers, we can utilize countercultural areas of mathematics education coined *ethnomathematics* to help our students build positive connections between students' lives and mathematics.

Before formally defining ethnomathematics, we have considered mathematics education and how it has been situated in Western culture. During the time of the Greeks, we used math for two purposes: "scholarly" and "practical" (D'Ambrosio, 1985, p. 44). The scholarly uses of mathematics were to educate Greeks and the practical uses of mathematics were for workers. The separation highlighted how only some people would receive education and others would not receive the same kind of education. In a way, certain groups of people were oppressed because of the separation of mathematics into separate areas of work and school. Mathematics education became something which only was deserved by those who were "primarily white, European and male" (Rowlands & Carson, 2002, p. 82). Education was a privilege for some and something rarely attainable for others. This bifurcation in mathematics education continued and manifested itself in different ways through social classes in the Roman World, Middle Ages, Renaissance,

[1] Department of Curriculum & Instruction, Appalachian State University, Boone, NC 28608, USA

and Industrial times. Then, in the 20th century, "mass education" was brought forward so all would be educated in a certain type of mathematics (D'Ambrosio, 1985, p. 45). This was essentially the genesis of the *math wars* that plagued US education throughout the latter half of the 20th century. The casualties of these wars, according to Schoenfeld (2004), are the children who are subjected to the ways in which we teach mathematics. Further, The United States, in particular, has seen multiple iterations of reform in mathematics education rise and fall over the past 100 years (Wells, 2022). This is in part due to "consistent reform rhetoric with little actual reform of the mathematics curriculum" (Stanic & Kilpatrick, 1992, p. 407).

During this time, though, the question arose: which type of math would be taught in mass education? The decision was made to teach mathematics which was "scholarly practical" in schools, and this would then be known as "academic mathematics" (D'Ambrosio, 1985, p. 45). Academic mathematics is what many have learned and continue to learn today. It is used to better or benefit society, and it is formal math education. It is not meant to be informal and is strongly rooted in the power roles from generations before us.

As mathematics education has continued to be shaped by mass education policies and social efficiency models of education throughout the 20th century, the mathematics we know today varies little from that in which D'Ambrosio described. Top-down models of *banking education* have continued to root themselves in public schools despite evidence that teaching mathematics so that students develop both procedural fluency and conceptual understanding is beneficial to students' learning mathematics (Flowers, 2003; Freire, 2000; Boaler, 2016; Wells, 2022). Because of this, it is important that mathematics teachers begin thinking differently about what their instruction and their curricula look like.

Ethnomathematics vs. Academic Mathematics

Culturally relevant pedagogies are not necessarily new ideas in education (Ladson-Billings, 2014). However, thinking about mathematics teaching in culturally relevant contexts is (Gutiérrez, 2013). In the education system in the United States, we could continue to use academic mathematics alone or we could introduce culturally relevant ideas to help students connect mathematics to the world around them. One way to do this is to consider integration ideas found in ethnomathematics with more traditional, academic mathematics.

Ethnomathematics is a term coined by D'Ambrosio (2001, p. 308)) in the 1980s and is valuable in connecting mathematics to students' lived experiences and cultural backgrounds. The term itself is comprised of two parts: *ethno* and *mathematics*. *Ethno* meaning "all the ingredients that make up the cultural identity of a group: language, codes, values, jargon, beliefs, food, dress, habits, and physical traits." *Mathematics* meaning "a broad view of mathematics which included ciphering, arithmetic, classifying, ordering, inferring, and modeling" (D'Ambrosio, 2001, p. 308). This type of mathematics does not eliminate academic mathematics, but rather positions itself alongside to benefit students' connection to mathematics. Ethnomathematics bridges the gap between mathematics and culture, and helps students connect with mathematics more authentically (Newmann et al., 1995). While cultural connections explored in an ethnomathematical context might reflect the culture of students in classrooms, it also might look completely different from the cultural diversity present in classrooms. D'Ambrosio encourages the use of ethnomathematics to "teach children to value diversity in the mathematics classroom and to understand both the influence that culture has on mathematics and how this influence results in different ways in which mathematics is used and communicated" (D'Ambrosio, 2001, p. 309). By integrating ethnomathematics into classrooms, we can help students broaden their

perspectives, gain empathy towards others, understand that mathematics is impacted by our culture, and that mathematics is used to communicate critical ideas throughout the world (Ladson-Billings, 2014; Gutstein, 2006). Further, François contends that "Ethnomathematics is no longer reserved for so-called nonliterate people; it now refers to the cultural diversity in mathematics education" (2016, p. 195). This adds richness and relevance to the mathematics we teach in schools.

Why Use Ethnomathematics?

When educators use ethnomathematics, they are valuing the identity and perspective of their students and their ancestors. Students may have different cultural backgrounds, understandings of concepts, and may be able to articulate something completely different from their classroom teacher. When in the math classroom, if we ask students to take part by using their own knowledge, we are bringing the classroom together. This idea removes the power roles which have been present for generations by creating partnership between students and teachers. In the math classroom, we as teachers are not meant to have all the power. We do not own all the knowledge to give students. We are not to dominate the classroom through formal knowledge we impart on our students. Instead, "knowledge emerges only through invention and re-invention, through the restless, impatient, continuing, hopeful inquiry human beings pursue in the world, with the world, and with each other" (Freire, 2018, p. 32). Knowledge is a process, and this is particularly important in a math classroom. When educators go beyond the boundaries that knowledge is only meant to be owned by someone more powerful, and use ethnomathematics, they are valuing dialogue, community, and even those beyond the classroom walls. In this way, math is less about memorizing and deciding, and more about forming a connection. Furthermore, the richness of mathematics shines through while seeing it foremost as a human right (François, 2016).

Ethnomathematics Around the World

To form a connection to math even beyond the classroom, we can look outward. We can use ethnomathematics to connect to our very own lives. It does not have to be about memorizing, instead it could be about our jobs, hobbies, activities our families have passed down from generation to generation, and so much more. We can view the "mathematical practice of national groups, people living in shantytowns, fishermen, basket weavers, rug weavers, knitters, and seamstresses" to better ethnomathematics (Millroy, 1992, p. 10). Each of these can help us see elements of math alongside our lives such as patterns, geometry, angles, and more. Instead of only looking at Western culture, we can look at other cultures as well. Specifically, if we look at South African carpenters and their work, we can see straightness, parallels lines, intersections, the importance of center, symmetry, angles, diagonals, shapes, bisection, congruence, proportion, volume, place value, proof, and more (Millroy, 1992, pp. 150-158). If we look at Columbian kite makers' work, we might see measuring, tying, defining the center, noticing patterns, and the specific types of kites (Rodríguez-Nieto & Alsina, 2022, p. 10). If we look at Mexican agriculture (either as daily activity or for profit), we might see distance between plants, the amount of produce per sack (to sell it), growth of the product, and more (Rodríguez-Nieto & Alsina, 2022, pp. 11-12). In each of these, different cultures are utilizing math in unique ways. Every culture uses mathematics, and we can learn just as much about mathematics by understanding how others use it.

Ethnomathematics through Games

Another way to utilize ethnomathematics is through games. Games can be a source of using math during free time or lead to a discussion of bigger mathematical concepts. If we use math games in our free time, we can also integrate their history and story. When we learn the history and story, we can see how others use math to create fun games. An example is "Shisma from Kenya" which is a three-in-a-row game from western Kenya that uses math ideas such as counters, octagons, circles, and diameters (Zaslavsky, 1998, pp. 4-7). We can also introduce a math concept through a game. If we use games, it is a fun way to show math. For example, we could introduce the same game to discuss characteristics of an octagon. We could have students draw the game board (an octagon), and we can ask what students notice about the game board (Zaslavsky, 1998). Eventually we can make the connection that the board is an octagon, and we can then remember the characteristics through a game. Either way, these games are a way a culture uses math for fun.

Ethnomathematics in Curriculum

In understanding and talking about ethnomathematics, it is important to relate it back to Western culture and education. We can use math daily to help us through hobbies or jobs. We can also use games to talk about math. Most importantly, we can teach ethnomathematics in schools to build the connection between math and our students. This does not mean educators have to completely overtake the curriculum with culture, but instead use aspects of culture in our curriculum. It means creating lessons which connect math to a culture either just like ours or completely different. We can listen to music from around the world, look at Japanese origami, talk about the symmetric strip decorations from Inca and Maori people, create our own mandala like people of the East, understand traditional American quilting patterns, and so much more (Presemeg, 1998, p. 331). We can compare our number systems to those around the world like the Mayan Numeral System. There are so many ways we can incorporate different cultures. All these ideas can be in full group instruction, small group, or even student led. We can allow discussion and conversation about what students see mathematically. This shows students all cultures are valuable no matter where they originate, and all cultures use mathematics in lots of ways.

Another way we could use ethnomathematics is through the development of personal connections with students. As teachers, we can enact simple strategies, like asking students about something they enjoy doing in their spare time or something they do every week, and then discuss the math which surrounds it. We could use sports, horseback riding, coin collecting, buying things, housework, other parts of the school day, or anything which students enjoy (Presemeg, 1998, p. 323). We can ask students to discover ways math is involved in their life. Then we could ask them to compare it to somewhere around the world. In both ways, we could integrate ethnomathematics into our curriculum. Every student can understand math culturally and for themselves.

Lastly, we could ask students to bring in their families and their values to our classroom. Ethnomathematics can connect even beyond students and teachers. Students can share parts of themselves in the classroom. As much as we learn about others, we can also value those inside our classroom. We could do this by asking students to "bring in samples of music that their families enjoy at home" and sharing it with the class (Brandt & Chernoff, 2015, p. 32). We could talk about our origin story and learn a mathematical idea from our origin. This could lead to field

trips locally, connections globally, and an understanding that everyone is part of a global community and is valued in it.

Ethnomathematics to Aid Limited English Proficient Students

Using ethnomathematics can also particularly help Limited English Proficient (LEP) students. LEP students "are from different cultures, speak languages other than English as their primary language, and have preferred differences in cognitive processing" which impacts their ability to learn mathematics (Davison, 1989, p. 143). These students are learning a new language, while also learning math in that language. To develop their understanding of the terms used in math, they also have to develop their understanding of the English language terms (Davison, 1989, p. 144). Some of these students only speak English inside the classroom walls. When they leave, their families speak their home language. These students may struggle to understand context on English math problems, the mathematical terms we so commonly use, and struggle in comprehending the English language overall. If the students are not able to comprehend the context, understand the words for themselves, or connect to their own life, they struggle with their work and inevitably the standardized tests. To help these students, we can use culture. If educators use ethnomathematics, "the interaction of native culture and mathematics ideas can be mutually reinforcing" to the LEP student (Davison, 1989, p. 145). The students can connect their own culture, or they can connect to a new culture the entire class is learning about. This would allow LEP students to be on a common ground with their classmates. Ideally, if students can understand a cultural context, they will better understand mathematics. The idea of combining culture and mathematics is ethnomathematics. Using ethnomathematics in the classroom "allows students whose voices have historically been marginalized to be empowered" (Lopez Leiva et al., 2023, para. 21). The culture and math will connect for students of all backgrounds and levels of language development. This means as teachers, we can utilize ethnomathematics for all our students' growth.

Conclusion

Ethnomathematics has the potential to empower students. Over time, as students feel empowered, they grow in their identities as learners and are able to see themselves as mathematicians. As teachers continue to grow in their teaching they begin to form connections between teacher knowledge, identity, and passion (Hobbs, 2012). Seeing teachers embrace ideas in ethnomathematics propels their passion and expands their content knowledge into new areas of mathematics. Education has been shown to serve as a pathway for many students to better themselves and their station in life. Ethnomathematics can benefit all students. It has the potential to help students see the world and understand they have a unique place in it. It teaches students that mathematics is more than what they may traditionally see in textbooks and classrooms. Ultimately, integrating ethnomathematical ideas empowers children to better understand the world around them and creates spaces for empathy and inclusion. Ethnomathematics can be a unifying force in our polarized world and creates opportunities for students to consider perspectives different from their own. Integrating ethnomathematics into classrooms would be a change from traditional mathematics curricula, but it has the potential for students to appreciate the essences of mathematics that go well beyond its immediate utility. Yes, it would be a change from the top-down approaches which have governed education for years. But, this change is worth it. It will take time, effort, understanding, and growth from all stakeholders, but this change can be a beautiful one.

References

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching.* First edition. San Francisco, CA: Jossey-Bass; a Wiley Brand.

Brandt, A., & Chernoff, J. A. (2015). The importance of ethnomathematics in the math class. *Ohio Journal of School Mathematics*, No. 71, 31-36.

Bursal M., & Paznokas, L. (2006). Mathematics anxiety and pre-service elementary teachers' confidence to teach mathematics and science. *School Science and Mathematics, 106*(4), 173–179.

D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For The Learning of Mathematics, 5*(1), 44–48.

D'Ambrosio, U. (2001). In my opinion: What is ethnomathematics, and how can it help children in schools? *Teaching Children Mathematics, 7*(6), 308-310. Retrieved Aug 4, 2023, from https://doi.org/10.5951/TCM.7.6.0308

Davison, D. M. (1989). An ethnomathematics approach to teaching language minority students.

Françios, K. (2016). Ethnomathematics as a human right. *Critical Mathematics Education: Theory, Praxis, and Reality* (P. Ernest, B. Sriraman & N. Ernest, Eds.). Information Age Publishing.

Freire, P. (2018). *Pedagogy of the oppressed*. (4th ed.). Bloomsbury, USA. https://appstate-bookshelf.vitalsource.com/books/9781501314155

Gutiérrez, R. (2013). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education*, *44*(1), 37–68.

Gutstein, E. (2006). *Reading and writing the world with mathematics*. New York, NY: Routledge.

Ladson-Billings, G. (2014). Culturally Relevant Pedagogy 2.0: a.k.a. the Remix. *Harvard Educational Review*, *84*(1), 74-84.

Lopez Leiva, C., Brown, C., & Llamas-Flores, S. (2023, May). *Ethnomathematics: Mathematics de todos.* TODOS: Mathematics for ALL.

Millroy, W. L. (1992). An ethnographic study of the mathematical ideas of a group of carpenters. *Journal for Research in Mathematics Education. Monograph, 5*, i–210. https://doi.org/10.2307/749904

Presmeg, N. C. (1998). Ethnomathematics in teacher education. *Journal of Mathematics Teacher Education, 1,* 317–339. https://doi.org/10.1023/A:1009946219294

Rodríguez-Nieto, C. A., & Alsina, Á. (2022). Networking between ethnomathematics, steam education, and the globalized approach to analyze mathematical connections in daily practices. *EURASIA Journal of Mathematics, Science and Technology Education*, *18*(3).

Rowlands, S., & Carson, R. (2002). Where would formal, academic mathematics stand in a curriculum informed by ethnomathematics? A critical review of ethnomathematics. *Educational Studies in Mathematics* 50, 79–102 (2002). https://doi.org/10.1023/A:1020532926983

Schoenfeld, A. (2004). The Math Wars. *Educational Policy, 18*(1), 253-286.

Wells (2022). Perspectives, histories, and countercultures: A discussion about reform in mathematics education. *Philosophy of Mathematics Education Journal. 39*(1).

Wells, C. & Reeder, S. (2022). The other first days of school: A case study of two teachers in an urban setting. *Journal of Learning Spaces. 11*(1), 1-12. doi: http://libjournal.uncg.edu/jls/article/view/2142

Zaslavsky, C. (1998). *Math games & activities from around the world.* Chicago Review Press.