The Importance of Ethnomathematics in the Math Class

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Abstract

We contend that the teaching and learning of mathematics should reflect and embrace the cultural diversity found in our mathematics classrooms and in our increasingly interconnected world. The goal of this article is to convey a simple message: ethnomathematics, that is, culturally-based mathematics, should be (further) integrated into the mathematics classroom. To achieve this goal, we discuss what ethnomathematics is and why it should be (further) incorporated into mathematics curricula. We also present examples of ethnomathematics in the math class, some of the arguments against inclusion of ethnomathematics into the curricula, as well as some ways in which these arguments can be successfully countered. Ultimately, we hope to demonstrate that ethnomathematics, which has the potential to show our students' multicultural views of mathematics, may help students develop a greater interest in mathematics.

Not only is Canada in the midst of a vicious and senseless war where traditional math is being pitted against reform math (Anderssen, 2014), but mathematics and mathematics education is being further divided along ideological lines of those who perpetuate the idea of a single dominant worldview and those who support and cherish diversity (Mukhopadhay, Greer, & Roth, 2012). The former group believes mathematics is independent of culture and therefore it should be taught in a homogenous curricula and pedagogy. Conversely, the latter group views mathematics as a human activity very much entrenched in culture and, as such, can be greatly enriched by intellectual diversity in curricula and pedagogy. Mathematics education, we contend, should reflect/embrace the cultural diversity of our classrooms, and of our increasingly interconnected world. Further, mathematics educators should (continue to) adopt ethnomathematics into their lesson plans.

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Although we live in a society that is dominated by math-based technology, most people typically only think about 'school math' when they think about mathematics. Quite early in their schooling, most students learn to hate math or believe that they cannot "do" math, as it is defined by the traditional academic approach (Mukhopadhay, Greer & Roth, 2012). In fact, Wolfram (2010) suggests that the future technology-based math should probably not even be called "math" due to its negative connotations and the potential changes to the curricula and pedagogy. Instead of instilling fear and loathing, math education should foster a greater understanding of how mathematics is applied in our increasingly technologically-driven world. School math needs to expand its parameters and become more inclusive of the mathematics found in the world that the students inhabit. One way to do this is to include aspects of *ethnomathematics,* culturally-based mathematics, in order to help students develop a greater interest in mathematics. As their interest in math grows, students will be in a better position to see that math extends beyond the classroom, that it has real importance in the 'real' world.

Not only does the word 'math' conjure up bad memories for many people, but most have grown to understand and interpret math in only one way – a Eurocentric way of knowing. Based mainly on Greek texts, Eurocentric math has become the *de facto* standard way of understanding the world of math (Ascher & D'Ambrosio, 1994). This is unfortunate because mathematics should reflect mathematical understandings and practices from the whole world, not just part of it. By taking such a limited view of what constitutes as mathematics, we are doing ourselves and our students a great disservice as we are ignoring many beautiful and engaging ideas from all the unique cultures of the world. Ethnomathematics holds the potential to bring to our students multicultural views of mathematics that will challenge and support the mathematical practices and ideas brought forth by the Eurocentric method.

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As Presmeg (1998) points out, there are a number of critical questions that arise from the initial question of *what exactly is ethnomathematics*? Is it solely the mathematical ideas from traditional societies? Does it cover the mathematical ideas inherent in all societies? If so, then it stands to reason that formal academic Eurocentric mathematics should also be considered as ethnomathematics because it too comes from cultural practices. However, if this is true, then doesn't ethnomathematics lose its value and purpose? We would suggest that it does not, so long as the mathematics curricula facilitates explaining, understanding, and reflecting on a variety of cultural mathematics practices and is not limited to "one true way." In essence, ethnomathematics shifts mathematics from strictly the domain of schools and universities, and places it within the world of people, their cultures, and everyday activities (Pais, 2010).

Perhaps the best way to understand what ethnomathematics looks like is to share some examples. Let's start with music, which is essentially the arrangement of various pitches over time (both of which can be analyzed through a mathematical lens). Music is one of the prime examples of ethnomathematics because every culture has their own understanding of what music is and how it should work. Ethnomathematicians can analyze the various patterns, rhythms, chord progressions, and melodies that are found in music (Presmeg, 1998). The beauty of bringing music into the classroom is that it appeals to many children and is highly diverse in its range. Students can be encouraged to bring in samples of music that their families enjoy at home. Teachers need not be musically inclined; they can encourage musical parents/guardians to join the class to play an instrument or sing songs from their culture.

Audio frequencies can be explored through the use of an African mbira (thumb piano)

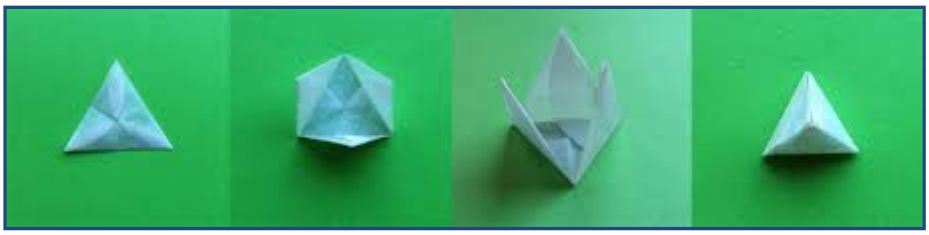
Further examples of ethnomathematics include: the examination of ratios, patterns and symmetry in Japanese origami; logic of kin relations (e.g., Warlpiri in Australia); chance and strategy games and puzzles from various Native American tribes; symmetric strip decorations found in Incan and Maori cultures; symmetry and concepts of impermanence in the mandalas of the East; measuring and ratios in traditional quilting patterns (Presmeg, 1998); counting and understanding of time-keeping in the pagan Misseri Calendar, which was created by Icelanders who were greatly influenced by their environment (Bjamadottir, 2010); fractals in African design (Eglash, 2007); shapes and design in graffiti from hip-hop culture (Eglash, 2012); and, the khipus or quipus, which are an ancient Incan system of mathematics and accounting that was based on an elaborate system of tying knots in colored cords of cotton or camelid fibers (Urton, 2012). The list, of course, could go on and on. Not surprisingly, math is found nearly everywhere one looks; we just need to find ways of including these alternative viewpoints into our classrooms.

With a further understanding of ethnomathematics and how it looks in various cultures, we now examine *why* it should be included in the mathematics classroom. Perhaps the most important benefits stem from how ethnomathematics can promote social justice. For those who are interested in teaching about acceptance and celebration of cultural diversity, incorporating ethnomathematics into the lesson plan is not an option but a necessity (Presmeg, 1998). D'Ambrosio (2007) suggests that ethnomathematics has the potential to create equity and social justice because, as he maintains, mathematics is the universal mode of thought and the universal struggle of humans is to survive with dignity, so it stands to reason that ethnomathematics holds the key to linking these two ideas. Through ethnomathematics, we can help students find success in school and in life because the fundamental values of ethnomathematics include respect for the other, solidarity with the other, and cooperation with the other (D'Ambrosio, 2007). D'Ambrosio further states:

> *To be effective in building up a civilization that rejects inequity, arrogance, and bigotry, education must give special attention to the redemption of peoples who have been for a long time subordinated, and must give priority to the empowerment of the excluded sectors of societies.* (p.179)

By bringing ethnomathematics into the classroom, educators are empowering those whose voices and ideas have traditionally been marginalized.

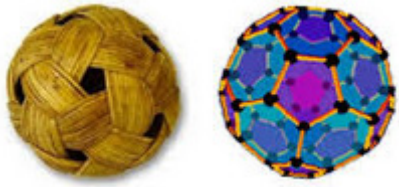
It must be noted that teaching and promoting multiculturalism is only half of what is needed to combat racism. The other, and perhaps more important, part of these lessons is to analyze power dynamics and the ways in which dominant groups have obtained their power and how they hold onto it (Sensoy & DiAngelo, 2012). This is where integration of subjects is critical, so that math lessons are integrated with social studies and English language arts. In this way, students can be given more time to use examples from ethnomathematics and its history within cultures to investigate and critically think about the power structures within society and analyze who *holds* that power and what systems are in place so that the dominant group can continue to oppress others (D'Ambrosio, 2002).



Tetrahedron, as explored through Japanese Origami

Ethnomathematics has a huge potential to help engage, inspire, and empower Aboriginal children, as well as English language learners (ELL), in ways that traditional school mathematics has failed. Russell (2010) cites reports on education that indicate that there is a much higher percentage of First Nation's people without a high school diploma, compared to their non-Aboriginal counterparts. In addition, Russell notes that Aboriginal students tend to have much lower passing rates in mathematics compared to non-Aboriginal students. Yet, as she and others point out, there is no math gene, so why are Aboriginal students doing so poorly? Since they tend to have different ways of knowing, it is likely that it is more difficult for Aboriginal students to engage in and understand the traditional Eurocentric ways of thinking about mathematics. By incorporating Aboriginal understanding of numbers and mathematics into the curricula, we should see greater levels of passing rates, and more Aboriginal adults who have high school diplomas and university degrees. Similarly, by incorporating mathematical ideas from the cultures from which ELL students originate, there is a greater chance that they will also find success.

In addition to helping empower Aboriginal and ELL students, ethnomathematics can help students of all kinds to develop their capacity for thinking 'outside the box.' When students are exposed to many different lines of thinking, they begin to see that diversity in thought is valuable and can spark creativity (D'Ambrosio, 2001). Instead of focusing on one 'right way,' students will start asking different questions, which may lead them to different solutions. Or, they may still arrive at the same solutions but develop different ways of presenting and sharing them. The value in this cannot be overstated; as teachers it is our job to help students develop their *creativity* to solve problems using a *variety* of strategies, and then be able to express themselves through *multiple* methods.



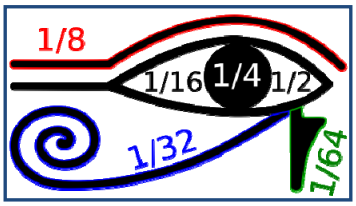
Viewing a dodecahedron through different lens

While ethnomathematics is being championed by many as a way to incorporate students' own cultural and historical knowledge into mathematics class and encourage the acceptance of diversity, many researchers and educators are hesitant to promote the idea of ethnomathematics in the classroom. Some fear that teachers will focus too much on the mathematics practices of ancient empire cultures, such as the Chinese, Hindu, Muslim, or Mayan, which will negatively reinforce the falsehood that mathematics is only the product of these great civilizations, and that lesser-known Indigenous societies did not have complicated forms of mathematics (D'Ambrosio, 2001; Eglash, 2012). This can, obviously, be remedied by incorporating mathematical concepts from a wide range of sources including local cultural groups, as well as examples from present day to show that ethnomathematics is something that is currently being practiced (e.g., the Inuit in Northern Quebec).

Educators must also take precautions to ensure that there is a balance of cultures represented in the curricula. As Eglash (1997) indicates, educators run a risk of perpetuating the same forms of alienation of students found in traditional mathematics classes if the examples being presented all tend to be from one specific ethnic or cultural group. There is also a risk of singling out students who represent a minority, and thereby reinforcing the perception of their 'otherness.' To counter these potential problems, educators must strike a balance between the cultural examples that they study in the classroom, as well as try to present the material as more universal than localized (Eglash, 1997).

Another challenge facing teachers of ethnomathematics is how to share various Indigenous designs and mathematics without losing touch with the cultural context of those ideas (Eglash, 2012). In other words, it is difficult not to end up analyzing Indigenous ideas from a strictly western standpoint. Along the same vein, it is imperative not to romanticize foreign cultures because in doing so it tends to reinforce the stereotypical idea of primitivism rather than combating it. One way to reduce these possibilities is to invite members of various cultural groups to present their knowledge to the class.

Yet another area of concern that educators must guard against is the tendency to rely solely on less challenging, or simplified, mathematics problems. Asher and D'Ambrosio (1994) note that this typically occurs when mathematics teachers limit their inclusion of ethnomathematics to 'simple' counting procedures. Educators must work to encourage higher-level mathematical problems, while at the same time making sure not to completely discount the various innovative methods of counting that have been developed.



The Eye of Horus – Egyptian notation for measures of capacity

There is the chance, of course, of misconstruing the notion of ethnomathematics. Since many examples of ethnomathematics are hands-on and can be taught in group project settings, many teachers feel that ethnomathematics is an obstacle, or time-waster, that prevents them from covering the requirements found in the curriculum (Presmeg, 1998). Missing is the importance of having students make and find

hands-on connections to the mathematics curriculum through their own cultural and historical backgrounds. Theory informs us that learning is greatly enhanced when teachers integrate students' backgrounds (Diez-Palomar, Simie & Varley, 2006). Surely, having students explore the mathematics in their own cultures is an effective way to bring life to mathematics and give students the possibility to see the relevance of mathematics. Of course, implementing a project-based environment in the mathematics classroom is also crucial for success. What is needed is the renegotiation of what a mathematics class should look like and how it can be structured.

In summary, it is time that ethnomathematics is integrated into every mathematics class. Ethnomathematics fits well within the constructivist theory of having students build understanding and knowledge through what they have already learned and been exposed to previously. Ethnomathematics has the potential to help students feel accepted, become more accepting of others, and even help in the fight against racism. Mathematics is everywhere; it is experienced and practiced by every culture and must be incorporated into the school mathematics curricula. Although there are a number of wrinkles that need to be ironed out (i.e., worries of promoting primitivism or romanticizing foreign cultures), these can easily be addressed by educators who think critically and creatively about the material they share with the students and how it is presented. Bringing ethnomathematics into future classrooms has the potential to change the way students view themselves, each other, and their place within the world… and students might even enjoy it.

References

Anderssen, E. (2014, March 2). Why the war over math is distracting and futile. *The Globe and Mail*. Retrieved from http://www.theglobeandmail.com/news/national/education/why-the-war-over-math-is-distracting-and-futile/article17178295/?page=all .

Ascher, M. & D'Ambrosio, U. (1994). Ethnomathematics: A Dialogue. *For the Learning of Mathematics, 14(2)*.

Bjarnadottir, K. (2010). Ethnomathematics at the margin of Europe: A pagan calendar. *The Journal of Mathematics and Culture, 5(1)*, 21–42.

D'Ambrosio, U. (2007). *The Role of Mathematics in Educational Systems. Zdm, 39(1-2)*, 173–181. doi:10.1007/s11858-006-0012-1.

D'Ambrosio, U. (2002). Cultural framing of mathematics teaching and learning. In Biehler, R., Scholz, R. W., Straber, R., & Winkelmann, B. (Eds.). *Didactics of Mathematics as a Scientific Discipline*. New York, Boston, Dordrecht, London, Moscow: Kluwer Academic Publishers.

D'Ambrosio, U. (2001). What is ethnomathematics, and how can it help children in schools? *Teaching Children Mathematics, 7*(6), 308–310.

Diez-Palomar, J., Simie, K., & Varley, M. (2006). "Math is everywhere": Connecting mathematics to students' lives. *The Journal of Mathematics and Culture,11*(2), 20–36.

Eglash, R. (2012). *How to Tell the Difference Between Multicultural Mathematics and Ethnomathematics*. Presented at the 2012 NCTM Annual Meeting.

Eglash, R. (2007). *The Fractals at the Heart of African Designs*. TedGlobal. Retrieved from http://www.ted.com/talks/ron_eglash_on_african_fractals.html .

Eglash, R. (1997). When math worlds collide: Intention and invention in ethnomathematics. *Science, Technology, & Human Values, 22*(1), 79–97.

Mukhopadhyay, S. & Roth, W.M. (Eds.) (2012). *Alternative Forms of Knowing (in) Mathematics: Celebrations of Diversity of Mathematical Practices*. Rotterdam / Boston / Taipei: Sense Publishers.

Pais, A. (2010). Criticisms and contradictions of ethnomathematics. *Educational Studies in Mathematics, 76*(2), 209–230. doi:10.1007/s10649-010-9289-7.

Presmeg, N. C. (1998). Ethnomathematics in teacher education. *Journal of Mathematics Teacher Education*, *1*, 317–339.

Russell, G. (2010). Guest Editorial: First nations and Metis content, perspectives, and ways of knowing. *Journal of the Saskatchewan Mathematics Teacher's Society, 2*(2), 7- 9.
Sensoy, O., & DiAngelo, R. (2012). *Is Everyone Really Equal: An Introduction to Key Concepts in Social Justice Education*. Teachers College Press: New York and London.
Urton, G. (2012). Mathematics and accounting in the Andes before and after the Spanish conquest. In Mukhopadhyay, S., & Roth, W. M. (Eds.), *Alternative Forms of Knowing (in) Mathematics: Celebrations of Diversity of Mathematical Practices*. Rotterdam / Boston / Taipei: Sense Publishers.
Wolfram, C. (2010). Teaching Kids Real Math with Computers. TedGlobal. Retrieved from http://www.ted.com/talks/conrad_wolfram_teaching_kids_real_math_with_computers .

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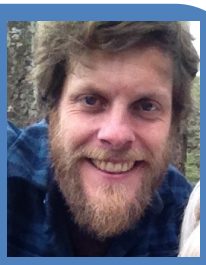

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