Context from the American Southwest and Methods from Brazil: An Upcoming Research Project

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Abstract

In anticipation of being a guest researcher with *Grupo de Pesquisa de Etnomatemática da Universidade Federal de Ouro Preto (GPEUfop)* in 2023, I explain my research interests and inspiration, share my project plans for upcoming research at GPEUfop, and seek collaborators for the projects. In this article, I outline the current state of an ethnomathematical research on archeological cultures in the American Southwest. Research interests in this area motivates questions about how to transfer ethnomathematics methodologies outside of the Brazilian context in which they were developed. In this paper, I demonstrate the need for ethnomathematical methodologies to be applied to the American Southwest and outline ways toward this goal.

Keywords: Ancestral Pueblo People, American Southwest, Methodology, Ethnomathematics, Non-textual Mathematics, Brazil.

Contexto do Sudoeste Americano, Métodos do Brasil: Um Iminente Projeto de Pesquisa

Resumo

Em preparação para ser uma pesquisadora convidada do *Grupo de Pesquisa em Etnomatemática da Universidade Federal de Ouro Preto (GPEUfop)* em 2023, eu explico os meus interesses de pesquisa e inspiração, compartilhando os elementos do futuro projeto com o GPEUfop, buscando colaboradores para esses projetos. Eu descrevo o estado atual da pesquisa etnomatemática sobre culturas arqueológicas no Sudoeste Americano. Os interesses de pesquisa nessa área motivaram questões sobre como transferir metodologias etnomatemáticas para fora do contexto Brasileiro em que se desenvolveram. Neste artigo, demonstro a necessidade de metodologias etnomatemáticas da Matemática não-textual a serem aplicadas ao Sudoeste Americano e delineio caminhos para esse objetivo.

Palavras-chave: Grupos Indígenas Ancestrais de Pueblo, Sudoeste Americano, Metodologia, Etnomatemática, Matemática Não-textual, Brasil.

Contexto del Sudoeste Americano, Métodos de Brasil: Un Inminente Proyecto de Investigación

Resumen

En preparación para ser una investigadora invitada en el *Grupo de Investigación en Etnomatemáticas de la Universidade Federal de Ouro Preto (GPEUfop)* en 2023, explico mis

intereses de investigación e inspiración, compartiendo elementos de proyectos futuros con *GPEUfop,* buscando colaboradores para estos proyectos. Describo el estado actual de la investigación etnomatemática sobre culturas arqueológicas en el suroeste de los Estados Unidos. Los intereses de investigación en esta área han suscitado preguntas sobre cómo transferir las metodologías etnomatemáticas fuera del contexto brasileño en el que fueron desarrolladas. En este artículo, demuestro la necesidad de que las metodologías etnomatemáticas de las Matemáticas no textuales se apliquen al suroeste de Estados Unidos y describo formas de lograr este objetivo.

Palabras clave: Pueblos Ancestrales, Suroeste Americano, Metodología, Etnomatemáticas, Matemáticas no-textual, Brasil.

Introduction

I grew up where the mountains meet the desert in Colorado. That place, at the nexus of the Rocky Mountains and the sagebrush plains, has come to define me. As Wendell Berry (1969), author, environmentalist, and cultural critic wrote:

> All that any of us may know is to be known in relation to place. Since I did most of my growing up here and have had most of my most meaningful experiences here, the place and the history, for me, have been inseparable, and there is a sense in which my own life is inseparable from the history and the place (p. 172).

My life, my place, and *all that I may know* is centered around the region, called the *four-corners area* of the Southwestern United States where the states of Colorado, Utah, New Mexico and Arizona meet. The history and landscape of this place have been woven into my life personally and academically. Figure 1 shows a Spruce Tree House in the winter at Mesa Verde National Park in Colorado.

Figure 1: Spruce Tree House in the winter at Mesa Verde National Park in Colorado

Source: Personal file of the author

Growing up, prehistory, was literally in my backyard. For the last ten years, my family's tradition during the winter holidays has been to visit Mesa Verde National Park to see the structures of the Ancestral Puebloans as seen in Figure 1. Witnessing the archaeology around me gave me a personal understanding of Berry's statement that one's own life is inseparable from the history of the place that they are from. My love of my homeplace has inspired me to learn more of its history, a journey that I am currently pursuing with a Master's degree in Archaeology. My initial inquiry into place-based history has led to a research project in Indigenous mathematics of the ancient American Southwest.

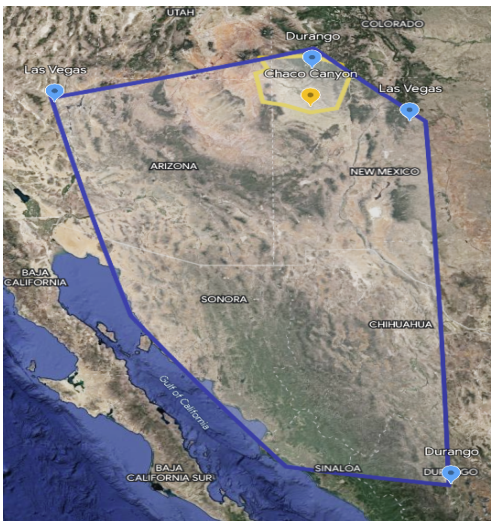
Southwestern Cultural Context

I will provide a short summary of the history of the American Southwest and its relevance to ethnomathematics. This is only a brief overview and I refer the reader to the bibliography for a more robust treatment of these topics. The Southwest[1] has been defined as between Las Vegas, Nevada and Las Vegas New Mexico and Durango, Colorado and Durango, Mexico (Cordell & McBrinn, 2016).

This region encompasses the arid, high elevation plateaus, desert slickrock and shrublands, grasslands, and pine forests. Figure 2 shows a map of the Southwest region as well as the Chaco World, which will be discussed in more detail.

Figure 2: The Southwest, as defined by Cordell & McBrinn (2016), shown in blue and the *Chaco World*, as defined by Mills et. al. (2018), shown in yellow

[1]This region is also sometimes referred to as the Southwest/Northwest as it encompasses much of Northwest Mexico and does not respect today's discrete national boundaries. The term Southwest demonstrates the academic bias for the global North, however for stylistic reasons, I will use *Southwest*.



Source: Google Earth, Illustration by the author

This region has been occupied for over 12,000 years first by peoples living a *PaleoAmerican* lifestyle hunting big game. Archaic settlements then inhabited the region, with populations adapting to a changing climate (Crow Canyon, 2021).

About 2000 years ago, subsistence patterns in the Southwest began including some domesticated corn, squash and beans; and basket-making technology was the state of the art. After about 500 CE, many peoples in the Southwest began living sedentary, agricultural lifestyles. Patterns in material culture have archaeologically defined the cultural groups of Ancestral Pueblo, Hohokam, Mogollon, Mimbres, Singagua, and Pitaya Peoples, among others who inhabited the Southwest (Lekson 2009).

While all of these groups have untold mathematical stories, I focus here on the Ancestral Pueblo people, who are known in some literature as Anasazi. Figure 3 shows a structure at Wupatki National Monument, Arizona, a site that has architectural features of both Hohokam and Ancestral Pueblo.

Figure 3: Wall of volcanic and sedimentary rock at Wupatki National Monument in Arizona

Source: Personal file of the author

The Ancestral Pueblo people were largely dryland farmers, who hunted, gathered, and migrated across the American Southwest with dynamic and ever-changing lifeways. Ancestral Pueblo people built masonry buildings, cliff-dwellings, granaries, and elevated roadways. They raised turkeys and dogs and used yucca fibers to create cordage and textiles. Ancestral Pueblo created rock art panels of anthropomorphic, animal and geometric designs on sandstone faces. Astronomical alignments have been documented at several ancient Pueblo sites (Malville, 1993). Pueblo pottery is ornately designed with a range of localized styles, including geometric black-on-white styles, representative figures, multi-colored designs, and glass-like glazes (Crow Canyon, 2021).

Around 900 CE years ago, a wide wash in Northern New Mexico became a cultural capital of the Ancestral Pueblo people. Chaco Canyon, an inconspicuous seasonal waterway in the desert of Northern New Mexico, became an urban political center commanding a territory with approximately a 160-kilometer radius (Lekson, 2009).

There is a notable lack of family cooking hearths at Chaco, instead, there are large communal hearths suggesting that most of the people who lived in the Great Houses and did not do their own cooking possessed an elite status (Lekson, 1999). The ornate burial assemblages of certain, but not other individuals, indicate social hierarchy and a stratified social-political structure (Lekson, 2009).

Chaco is home to fourteen masonry *Great Houses*. These Great Houses reach over three stories high and were constructed with roof beams carried from over 65 kilometers away. Traded goods from hundreds of kilometers away including cacao, turquoise, macaws, and copper bells have been found at Chaco and other Pueblo sites across the Southwest (Lekson, 2009). This indicates that Chaco was a center of economical and regional power.

Chaco's status as a capital decreased in the 1100s and social structures adapted. The Southwest faced droughts in the 1200s and the Pueblo People endured political unrest and migration. By 1350 much of the Chaco region was depopulated and the opulent structures left uninhabited (Lekson, 2009). Pueblo communities along the Rio Grande River in New Mexico grew, collecting people and modifying traditions from Chaco. In the 1400s immigrating Navajo Athabaskans people moved into the region (Crow Canyon, 2021).

In the 1540s when Spanish expeditions embarking northward from Mexico City traveled through the Southwest, the Puebloan people they encountered mostly lived near the Rio Grande in central New Mexico (Reid, 1997). The Spanish colonized the Pueblos building Franciscan missions and focusing on conversion. In 1680 Puebloan tribes unified and ejected the Spanish in what is known as the Pueblo Revolt, until the Spanish returned forcefully 12 years later (Crow Canyon, 2021).

The Pueblos were subjugated as Spanish citizens until 1821, Mexico until 1846 and the U.S. thereafter. The Puebloan lifeway is still vibrant across the Southwest today. The descendants of Ancestral Puebloan people today make up the tribes of Hopi, Zuni, Acoma and a total of 20 tribes in Northern New Mexico and Arizona (Crow Canyon, 2021).

I have lived my life and made my home on lands ancestral to the Pueblo people and tried to learn the history of the place that I have grown to love. But as a lifelong lover of mathematics, it was no surprise when I declared a math major in college. To my dismay I was quickly overwhelmed and bored by the traditional cycle of 'lecture, problem set, test, forget' that was used in my classes. It seemed like being a mathematician was not only unachievable but unpleasant, so I changed my major.

In my second year of college, I stayed in one mathematics class: History of Mathematics. Homesick, I decided to investigate the mathematical traditions of the Ancestral Puebloan people. In class we had discussed Babylonian cuneiform stone tablets that contain mathematical problems from a 4000-year-old civilization. We read about Sanskrit mathematical verse from India circa 1000 CE. We compared Inca quipu from the pre-Colombian Andes to Mayan calendrical systems.

I was sure that every next reading would be about the massive masonry architecture at Chaco Canyon, astronomy at the site of Chimney Rock, or the rock art panels on the San Juan

River. I wanted to know what kinds of mathematics the Ancestral Puebloan people were doing 1000 years ago. Could we understand their ancient quantitative cognition based on archaeology and the culture of their descendants?

I quickly found that there was no one researching these things, despite astronomical alignments in Puebloan architecture, geometrically patterned pottery and cyclical calendar systems. As I tried to articulate how these material artifacts embodied mathematics, I found out about the idea of ethnomathematics and was exposed to philosophical, cultural, and anthropological views on mathematics. Ethnomathematics reminded me that there is more to mathematics than working with equations. It is about people and culture!

I presented exploratory ideas about the relationship between ethnomathematics and Southwestern archaeology as a workshop for a group of undergraduate students in 2019. The participants had positive feedback and reported having learned to think of mathematics as a far more expansive subject than they had before. However, my work was just getting started.

My research reached a plateau when I struggled to find the methods needed to conduct culturally sensitive research related to material mathematical artifacts and cognition. Then, I read about ethnomathematics fieldwork originating in Brazil and recognized these projects as similar to my own.

Ubiratan D'Ambrosio (2000) wrote that "every culture generates something equivalent to mathematics and science that works satisfactorily within its own context" (p. 79). Thus, we can assume that Ancestral Puebloan people used and created a type of mathematics. Through an extensive literature review of archaeological, ethnomathematics, and history of mathematics papers, I have documented a lack of substantial published literature on Ancestral Pueblo mathematics. Using a database system, I sifted through thousands of articles to find only a handful relevant to this topic (see McKown, forthcoming).

This literature review, though not revealing a great quantity of relevant literature, has helped to outline studies of Ancestral Pueblo mathematics that could be based on geometry, units of measure, number concepts, and astronomy (see McKown, forthcoming). Without a full-fledged research project these remain speculative open questions. As I discuss later, the methods with which to carry out this research are not clearly established.

Since the 1990s there has been much interest in creating curricula that include Ancestral Pueblo mathematics (Zaslavsky, 1995, Berken, 1996). For example, Victor Katz, a well-known historian of math, included the mathematics of Chaco Canyon in his article entitled *Ethnomathematics in the Classroom* (1994). After discussing the geometry and archeoastronomy in the layout of Chacoan buildings, he said:

> The use of geometry by the [Ancestral Pueblo][2] People [...] demonstrate how mathematical ideas grow out of the needs of various peoples. It is clear that in all of these cases, important attributes of mathematical thinking, such as logic, pattern recognition, and application of previously known results, existed even if the participants in their development would not be called 'mathematicians.' But it is vitally important in the present day to convince students in North America in particular that such ideas were considered all over the world. Mathematics is not only a Western cultural phenomenon but one which appears in many diverse civilizations (Katz, 1994, p. 29).

In this assertion, Katz's mention of Ancestral Pueblo mathematics is only a few paragraphs in a short article. Since its publication in 1994, research has not been done to figure out what exactly could be taught about Ancestral Pueblo geometry.

As Rosa and Gavarrette (2017) summarize that "the implementation of a mathematical perspective in classrooms must be *preceded* by a full investigation in the mathematical ideas, procedures, and practices developed by the members of the diverse cultural groups" (p. 15, emphasis mine). As such, a research project is called for, if we are to ever consider the implementation of a place-based ethnomathematics curriculum in the American Southwest[3], particularly, one with relevance to the descendants of communities at Chaco Canyon.

One roadblock to investigating Ancestral Puebloan mathematics is that methodology is not well established. Historians of math study texts, which do not exist in the Ancestral Pueblo context. Archaeologists do not frequently research mathematics through material culture[4]. Ethnomathematics focuses mostly on ethnographic contexts, not material culture from long ago.

While a singular research methodology to use in studies of Ancestral Puebloan mathematics is not clearly developed, some ethnomathematical works do offer insights into how

[2]Katz (1994) used the term Anasazi, which is no longer used universally in academia. This means 'ancient enemy' in Navajo and is thus seen as unfavorable and reductive by Pueblo people (IPCC, 2020).
[3]As an example of a successful ethnomathematical program in the Southwest in the Navajo context, see Csicsery, 2016 and Lamb, 2017, which discusses the project *Navajo Math Circles*.
[4]This is, in part, due to many pseudo-archaeologists supporting ill-founded ideas of ancient mathematics and technology. See, for example, Bianchi (1991) for a discussion of this.

to conduct a study such as studies of Marshall Island stick maps (Asher, 2002), US Plains tipis (Orey, 2000), and African sand paintings (Gerdes, 1994), among others. These ethnomathematics methods can be adapted and defined for non-textual and non-ethnographic mathematical contexts.

Through my work with *GPEUfop*, I hope to research the ethnomathematics methods necessary to fill this gap in the literature of Indigenous history and to better understand ethnomathematics education as a decolonizing project. This research will encourage a wider dialogue about ethnomathematics outside of Brazil and promote research methodology for non-textual mathematical traditions.

The Importance of Brazilian Ethnomathematics Program

Brazil is the heart of ethnomathematics. According to its founder Ubiratan D'Ambrosio, ethnomathematics lies on the borderline between the history of mathematics and cultural anthropology and uses anthropology, cognitive theory, and history to investigate the way various groups of people use mathematics (D'Ambrosio, 1985).

Ethnomathematics puts research into practice by designing inclusive, innovative, culturally relevant mathematics education. It is a two-pronged field of research and application through education. Brazil is the world leader and inventor of ethnomathematics, and a project to learn ethnomathematics methods makes sense only there. The Brazilian roots of ethnomathematics have defined the field. For example, a review of D'Ambrosio's 1990 book, *Etnomatematica*, says that:

> If for a North American reader, *Etnomatematica* exhibits excessive faith that better education results directly in a better society, we should be aware of the Brazilian context in which education is conceived more broadly (Fisher, 1992, p. 546).

The Brazilian context in which D'Ambrosio (1985) worked and founded ethnomathematics was influential to his vision. Furthermore, Francois and Kerkhove (2010) emphasize that ethnomathematics "originated in post-colonies that have opposed themselves to importing a Western curriculum, instead developing their own mathematical practices that could serve as an instructive basis" (p. 140). The field's challenge to Eurocentric narratives is rooted in post-colonial multicultural Brazil.

In 2008, Daniel Orey, cited in D'Ambrosio and Rosa (2008), estimated that "80% of the research in the field of ethnomathematics is published in Portuguese or lies in university archives in Brazil" and that "publications in Portuguese outpace attempts to translate it" (p. 90). Brazil has also embraced ethnomathematics in the classrooms. In 2016, in the *Journal of Mathematics and Culture* it was stated that "ethnomathematics is part of the Brazilian national curriculum" (Shockey, 2007, p. 14).

The emphasis on ethnomathematics has landed to the *Brazilian tradition in Mathematics Education research, whose contribution to the international debate is well recognized*, which is featured in 2021 as a special edition of the journal *The Mathematics Enthusiast* (Barbosa, 2021, p. 348).

By contrast, ethnomathematics is underrepresented in the United States. Recently in California, ethnomathematics reforms have sparked controversy. The proposed Mathematics Framework would implement multicultural perspectives on mathematics and utilize culturally relevant problems (California, 2022).

But an open letter to Governor Gavin Newsom rejecting the Framework has been signed by over 800 people in academia and industry (Evers & Wurman, 2021). Pushback to California's proposal and similar situations in other states, reflect that U.S. educators, policymakers, and mathematicians are unfamiliar with the robust international research in ethnomathematics.

As a further illustration of the difference between U.S.-based English ethnomathematics and the Brazilian field, a quick YouTube search demonstrates the difference in public sentiment. English YouTube searches for 'ethnomathematics' turn up a handful of explanatory recorded lectures and a disheartening amount of poorly-informed conservative critics of the ethnomathematics curriculum (John Locke Foundation, 2020 & Swaine, 2020).

These videos mostly focus on 2020 reform in Oregon and Seattle schools to use ethnomathematics and culturally-relevant math education. These conservative critics claim that ethnomathematics is an attempt to teach that $2+2 \neq 4$ and find the idea of viewing mathematics as a culturally-constructed concept to be preposterous (John Locke Foundation, 2020 & Swaine, 2020).

Unfortunately, these dis-informing videos have thousands of views. The same YouTube search in Portuguese leads to the interviews with Ubiratan D'Ambrosio, and the *Virtual*

EthnoMathemaTicas Brasil (VEmBrasil), and *Matemática Humanista* channels, which feature weekly interviews, research presentations, resource sharing, and short aesthetic videos to promote multicultural perspectives of mathematics. These professional channels demonstrate the widespread and accessible nature of ethnomathematics in Brazilian Portuguese. These sites are well-trafficked with thousands of views by researching far beyond the academic community.

The ethnomathematics community in Brazil offers a model that shows it is possible to research localized cultures of mathematics and incorporate those findings into the classroom. One goal of ethnomathematics is to "build curricula around the local interests and culture of the students" (Rosa, 2021, p. 9). But, of course, what is local and culturally relevant in one part of the world is not everywhere, meaning that a plurality of ethnomathematics research and lessons must be developed to engage with diverse populations the world over.

Ethnomathematics research and practice is contextually specific. However, the methodology with which that research is a process applicable around the world. It is that methodology that is needed to pursue research like the project on Ancestral Puebloan mathematics in the ancient American Southwest.

Understanding the social, political, and historic factors that contributed to the creation and success of ethnomathematics in Brazil will allow for the adaptation of ethnomathematics methodology abroad. Ubiratan D'Ambrosio and Gelsa Knijnik (2020) wrote that to "socialize these ethnomathematical works and the pedagogies used in teaching and learning is one of the main goals of ethnomathematics as a program in present times" (p. 287).

It is with that goal to socialize, understand, and adapt the Brazilian ethnomathematics program that I outline my upcoming research in Ouro Preto, Minas Gerais, Brazil.

Project Announcement

This paper is a call for collaboration. It is with gratitude and excitement that I announce that I will be joining the *Grupo de Pesquisa em Etnomatemática da Universidade Federal de Ouro Preto (GPEUfop)* from March 1, 2023 to September 1, 2023, as a guest researcher, working under funding through a Fulbright Fellowship from the US State Department.

First and foremost, I would love to *volunteer* as a research assistant for any of *your* projects! In regard to my own project, I will investigate 1) *How do scholars conduct*

ethnomathematical research: what is the ethnomathematics methodology? and 2) *How does the Brazilian contextualization of ethnomathematics make the field successful there?*

This research will inform how the ethnomathematics program of Brazil can be a model for formulating place-specific histories of mathematics and culturally significant mathematics education in other Indigenous contexts around the world.

I plan to meet with ethnomathematicians, students and teachers who incorporate ethnomathematics into their classrooms. Please contact me if you are interested in participating. I hope this is just the beginning of this conversation.

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