Centro de Creación Contemporánea de Andalucía
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The value in mathematics: A Conversation between Margaret Gaida and Falke Pisano

**Falke Pisano:** The first text I read about the way cultural values integral to the Western construction of history have permeated the way we think about mathematics and the way mathematics education has been shaped instantly opened up a—for me—challenging field of revision. Although I was not completely unaware of how mathematics functions within power structures, in many cases maintaining and pushing them, I still accepted that there was a core of value-free-ness in the science itself.

After some research, however, I realized that this idea has in fact been largely dismantled by critical educators, philosophers, historians and philosophers of science, and to some extent those within the discipline itself. Within this intradisciplinary discourse, and particularly in the field of ethnomathematics, it is understood that, while people across the world and throughout time have used mathematics in similar ways—to count, measure, design, locate, explain, and play—methods, solutions, and applications diverge due to the exchange between mathematics and culture.[1]

Nevertheless, when it comes to mainstream mathematics education, the idea of one current global mathematical language, one global advanced mathematics, largely prevails. Maybe some attention is given to different conceptions of mathematics in the curriculum, but these practices are often placed in either historical or ethnographic context and thereby inevitably put at a distance.

**Margaret Gaida:** Similar arguments have been put forth to dismantle the idea that science is value-free, and as in the case of mathematics, these arguments have not always penetrated into a deep, lasting belief in the superiority of the advanced, progressive, rational, and dominant Western cultural heritage. This is perhaps why educational practices have not responded to cultural critics. While there may be an acknowledgment in Western intellectual discourse of the existence of different approaches to mathematics (clearly established by scholars working in ethnomathematics), there is a tendency to see these approaches as inferior to the Western mathematical tradition. This bias is most clearly evident in the privilege given to Western mathematics in educational curricula, which often begin with Greek geometry and end with Leibnizian or Newtonian calculus.

One reason for this reluctance on the part of educators to incorporate diverse approaches to mathematics into mathematics education is that the Western mathematical tradition came to dominate our understanding of nature and therefore of all science. As a result, mathematics is treated as foundational for the scientific and technological advances that have made us modern, and future advances are contingent on continuing this particular mathematical tradition through education. The view of mathematics as foundational, however, has a historical beginning. The sixteenth century was witness to a true renaissance in mathematics, with new applications of the discipline to navigation, surveying, engineering, and warfare. Drawing on these new practical applications, Galileo imagined the theoretical potential for a mathematics that described nature. He thus elevated mathematics to its pedestal when he made it the language of the natural world, applying it to physical problems of motion and kinetics that had previously been explained through Aristotelian natural philosophy. It was at this moment that mathematics became the "universal language," and this shift in thinking has long been seen as the watershed moment for "modern" science and technology. If the West was able to surpass the rest of the world in science and technological advancements, it is because of its privileging of mathematics. Thus, according to traditional Western doctrine, if mathematics is not progress, then what is it?

**FP:** If we look at the intertwinement of mathematics, the ambition for universalization, and the belief in progress that have reigned in the Western world for all these centuries and pluralize mathematics, what would that do? If we say there exist, and have always existed, several mathematics, what would the consequences be?

**MG:** Acknowledging that there are several forms of mathematics means letting go of the idea that mathematics is necessarily a progressive enterprise. The history of non-Western mathematics has indicated that mathematics has a plurality of features, which may or may not appear "progressive" or "advanced" according to Western criteria. The problem is that in their efforts to understand non-Western, ancient, or so-called primitive approaches to mathematics, historians find it difficult to view these practices without their "progressive" lens. I believe that they can overcome this problem by looking at moments of cross-cultural exchange and the transmission of ideas, to better understand how different cultures both generate and appropriate ideas (mathematical and otherwise) from other cultures they encounter. We should rethink, also, the history of Western mathematics as a series of cross-cultural encounters that came to constitute a pluralistic mathematics. This means that the classic narrative that puts mathematics on a pedestal would itself be dismantled and that one "advanced" global mathematics would be shown, even today, to be a set of mathematics appropriated by various cultures.

**FP:** The narrative that put mathematics on a pedestal is a crucial narrative in modernity. Seeing that it's so connected with how we're inclined to perceive the world, a dismantling too would have to take place on different levels, be pluralistic itself. How is it possible to question a system that has been built up over centuries and that permeates so deeply in all areas of life? Who would dismantle what, how, where, for whom, and with what consequences? To stay with mathematics and education: the historian could dismantle the classic narrative in academia. The ethnomathematician develops an approach in which mathematics is a part of a broader program of striving for equality between different groups of people; this takes place in large part in academia too. The teacher can apply ethnomathematics and introduce a different (historical) perspective in the classroom, where students develop critical skills that help them to interpret how mathematics is employed and how they can apply it to serve and protect their interests. But what about people practicing their ethnomathematics outside of these institutions? What is their role? Are they only objects in this "progressive" scientific endeavor? Does "defrosting" mathematics or developing it from a practice represent a neutral activity without consequences? What do they get from the dismantling we are talking about? For instance, if the different backgrounds are brought into the classroom, does that reproduce inequalities? What kind of conversation is to be had? How can all layers of dismantling support one another, without reproducing inequalities?

**MG:** These are really difficult questions and only raised more complexities for me. First, how can we (as students, teachers, or historians and social scientists) access different sets of mathematical systems? They might be available to us through an ethnographer's study (such as the Kayabi and Juruna in Mariana Ferreira's article) or through historical research, but they will always be one step removed and in some sense objectified by scholars.[2] This automatically sets up some form of inequality, but is it an inequality that we want to avoid? What would the alternatives be? There is also the question of <u>which</u> ethnomathematics is actually taught, which also results in inequalities. There must be just as much emphasis on <u>why</u> ethnomathematics is being taught and what precisely it means as there is on teaching ethnomathematics itself. And the conversation should be open and transparent and as inclusive as possible. Students and educators alike should be in dialogue with historians and social scientists and even diverse groups of mathematical practitioners, if possible, to explore various possibilities and learning objectives. A self-conscious and self-critical approach to education is crucial to any sort of dismantling that can take place.

**FP:** It seems to me that, more than accessing a mathematical system as a given at a certain moment, it is important to become familiar with and understand what has constituted the process of development of this system: what practical necessities were involved but also how the practical and the symbolic intertwine and influence the development of mathematical activities. It is important to understand how people in different cultures envision their future. Is there a desire for a difference from the current situation? Does mathematical knowledge play a role in creating this difference or in maintaining the current situation? Is mathematics playing a role in resisting a development that is not desired?

**MG:** You've got another key point here because we have to rely on scholars to determine what these power relations are and to describe the contexts for us. Thinking deeply about these questions for ourselves will challenge us to imagine how it might be different for other cultures. In the Western intellectual tradition, the march toward progress was quite fierce until we reached the postmodern. Postmodern discourse has certainly challenged the notion of "progress," but it has done little to change the dominant attitude that science and technology are progressive enterprises. Most Americans, for example, would support the idea that becoming a more scientifically or technologically advanced society is a good thing. This reflects their underlying desire for a difference in their current situation, namely one that is more advanced. And of course mathematical knowledge plays a crucial role here. This view, however, is taken for granted by most and questioned by very few. By examining the historical context in which these values for science emerged, we will better understand our own attitudes toward mathematics and will be primed for evaluating why we continue to hold onto these values.

**FP:** Yes, this critical evaluation of values would be important for any cultural group: not only to understand better where values come from and how mathematics functions in relation to these values within the culture but also in order to better determine the strengths and weaknesses of the group's mathematical knowledge and practices in relation to the knowledge and practices of other cultural groups. There's always exchange, and I'm interested in the kinds of negotiation that take place. What kind of negotiations are, for instance, necessary in the context of economic exchange between cultures with different value systems? What happens when one group wants to use the knowledge developed by another group for purposes that might be in conflict with the values of the latter? I am also interested in the negotiation and balancing act existing within the different layers of ethnomathematics, in the practices, education, and discourse: how to think, for instance, about the balance between culture and curriculum.

**MG:** I think the negotiation just needs to be as transparent as possible, and cultural values need to be made explicit. If strengths and weaknesses are identified, then the reasons for this identification regarding cultural values should be made clear. Teaching what might be considered a "weakness" for one cultural group, once the values have been made clear, could be considered a "strength" according to that culture's values. Consider the Brazilian tribes who assign symbolic capital to objects that have no identifiable material/monetary value. If Westerners can let go of the idea that all objects must be assigned some material value through, for example, thinking deeply about objects with sentimental value for them, they can come to understand how objects of symbolic value are exchanged in these Brazilian tribes. But that is merely the first step in a much more complex set of negotiations that must then take place in cross-cultural exchange.

**FP:** Yes, transparency is important to understand what one is dealing with, but at the same time strategic opacity can function as a form of a protection or resistance, for instance, in the case of an imbalance in power relations in which it might not be in a cultural group's interest to give access. The case of the Brazilian tribe is interesting because the symbolic capital they gave to the spears that a trader wanted to buy was largely based on their knowledge of the profit the trader would make from these objects. Even if it is in theory possible to define what is functional—the way a person or a community wants to function—separately from global dynamics, economic models, etc., in reality this will happen in constant negotiation with a dominant culture that is violent in many ways.

A crucial question for mathematics education that tries to support the development of a critical citizenship concerns the sort of competences that might be developed: which competences express an empowerment?

Empowerment can mean the development of strategies of resistance against damaging forced participation or integration in the dominant culture. At the same time, empowerment can mean as well the development of methods to interpret that which has been made opaque, for instance, to understand the nature of "expertise" in a highly technological society.

**MG:** To continue my last point, I think a critical awareness of not only one's own value system but others' value systems as well, along with a willingness to engage in discourse with these values laid clearly on the table, is certainly a competence that could be developed through the teaching of ethnomathematics. But it is true that there is already an enormous gap in American culture between the expertise of, for example, climate change scientists and the scientific or mathematical competence of a majority of the population. Without adequate training in the dominant mathematical culture, the populace relies on "experts" and "authorities" to inform them about and to evaluate scientific claims. This gets tricky when there are one or two vocal "experts" who use the media to voice their "expert" opinions and confuse the public into thinking there is a debate over climate change when clearly the vast majority of climate scientists have said that climate change is real and is the result of human behavior. I bring up this example because I think it challenges the idea that a critical population will be better able to evaluate scientific expertise. If all the "experts" are using one form of mathematical discourse, then what would be the value of the citizenry learning a plurality of mathematical forms? A similar argument could be made about the role of evolutionary biologists having to explain to the public that “creation science” (put forth by fundamentalist Christians) is not actually a science. If we are advocating that we teach different forms of mathematics, can we use the same argument for teaching “creation science”?

**FP:** This is an interesting point because it brings us back to our first conversation, in which we spoke mainly about how to deal with plurality. In a reflex reaction to exchanging the idea of one global mathematics for several ethnomathematics, I assumed that the only proper way to deal with this plurality was to attribute to each mathematical practice the same value. You proposed that I should first try to understand the practices before a priori attaching value to them. Dealing with plurality means as well dealing with differences in appraisal. In that sense it is crucial that everyone has access to the conversation about what is true, what is useful or desirable. This means being able to analyze reasoning and argumentation just as much as evidence. And in some situations, dealing with plurality will also entail accepting two accounts to be equally valuable.

**MG:** Exactly, which brings us back again to the question of curriculum. We should work to ameliorate the gap between scientific or mathematical authorities and the populace by educating a critical citizenry, but this education should not entail the uncritical acceptance of mathematical and scientific programs developed by these authorities. This is a radical shift away from traditional mathematics education, but what sorts of new features would this educational curriculum have?

**FP:** I understood that the ethnomathematical program is not so much concerned with students learning as many different mathematics as possible. Instead it emphasizes that each student is already an active participant in a context (within a home life, a social life, several groups, one or more cultures) and has already developed mathematical knowledge and competences. As Paulo Freire says, from the moment we get up in the morning, we use mathematics. Ethnomathematics is important because it assumes that learning is most valuable for the student when it takes place in relation to this background. Additionally it aims to make comprehensible the relation between mathematical knowledge and practices in the student’s own life and how mathematics functions in the broader societal context. In this way ethnomathematics in the classroom stimulates students to think actively about the value mathematics can have for their own lives, and at the same time it opens up math and sciences to other forms of knowing, destabilizing them from their authoritarian position.

Notes

1. See Alan J. Bishop, *Mathematical Enculturation: A Cultural Perspective on Mathematics Education* (Dordrecht: D. Riedel, 1988), 100–103.

2. Mariana K. Leal Ferreira, "When 1 + 1 ≠ 2: Making Mathematics in Central Brazil," *American Ethnologist* 24 (February 1997): 132–47; also published in *Mapping Time, Space, and the Body: Indigenous Knowledge and Mathematical Thinking in Brazil* (Rotterdam: Sense, 2015).